New Developments in Marine Science and Technology: Economic, Legal and Political Aspects of Change

Edited by
Lewis M. Alexander
Scott Allen
Lynne Carter Hanson

New Developments in Marine Science and Technology: Economic, Legal and Political Aspects of Change

New Developments in Marine Science and Technology: Economic, Legal and Political Aspects of Change

THE LAW OF THE SEA INSTITUTE

1988 STAFF

John P. Craven, Director
Scott Allen, Associate Director
Maivan Lam, Assistant Director
Carol Stimson, Administrator/Editor
Elizabeth Ng, Publications
Philomene Verlaan, *Los Lieder* and Membership

1988 EXECUTIVE BOARD

Lewis M. Alexander
Department of Geography
University of Rhode Island

Lee G. Anderson
College of Marine Studies
University of Delaware

Richard B. Bilder
School of Law
University of Wisconsin

Thomas A. Clingan, Jr.
School of Law
University of Miami

Edgar Gold
IITOPS
Halifax, Nova Scotia

Lee A. Kimball
Council on Ocean Law
Washington, D.C.

Tommy T.B. Koh
Ambassador of the Republic of
Singapore to the United States

Dale C. Krause
UNESCO
Paris

Tadao Kuribayashi
Keio University
Tokyo

Edward L. Miles
Institute for Marine Studies
University of Washington

Max K. Morris
Arthur Vining Davis Foundation
Jacksonville, Florida

Satya Nandan
Undersecretary General for the Law
of the Sea United Nations

Myron Nordquist
Attorney
Washington, D.C.

Francisco Orrego Vicuna
Institute of International Studies
Santiago

Willy Ostreng
Fridtjof Nansen Institute
Oslo

Tullio Treves
Permanent Mission of Italy
to the United Nations

Jon Van Dyke
Wm. S. Richardson School of Law
University of Hawaii

Conrad G. Welling
Ocean Minerals Company
Mountain View, California

New Developments in Marine Science and Technology: Economic, Legal and Political Aspects of Change

Proceedings of the
22nd Annual Conference of the
Law of the Sea Institute

co-sponsored by the

Center for Ocean Management Studies
The University of Rhode Island

June 12–16, 1988
Narrangansett, Rhode Island

Edited by
Lewis M. Alexander
Scott Allen
Lynne Carter Hanson

Published by
The Law of the Sea Institute
William S. Richardson School of Law
University of Hawaii • Honolulu

The Law of the Sea Institute is housed and sponsored by the William S. Richardson School of Law, University of Hawaii, and is a project (PP/R2) sponsored by the University of Hawaii Sea Grant College Program under Institutional Grant No. NA85AA-D-SG082 from NOAA, Office of Sea Grant, Department of Commerce. The United States government is authorized to produce and distribute reprints for governmental purposes notwithstanding any copyright notations that may appear herein. This is Sea Grant publication UNIHI-SEAGRANT-CR-89-01.

International Standard Book Number: 0-911189-20-3

Library of Congress Cataloging-in-Publication Data

Law of the Sea Institute. Conference (22nd : 1988 : Narragansett, R.I.)
New developments in marine science and technology.

"Proceedings of the 22nd Annual Conference of the Law of the Sea Institute, co-sponsored by the Center for Ocean Management Studies, the University of Rhode Island, June 12-16, 1988, Narragansett, Rhode Island."
Includes index.
1. Marine resources conservation--Law and legislation--Congresses. 2. Maritime law--Congresses. 3. Oceanography--Research--Law and legislation--Congresses. 3. Oceanography--Research--Law and legislation--Congresses. 4. Marine sciences--Congresses. 5. Marine engineering--Congresses.

I. Alexander, Lewis M., 1921- . II. University of Rhode Island. Center for Ocean Management Studies. III. Title.
K3484.6 1988 333.91'6416 89-12446
ISBN 0-911189-20-3

This book may be ordered from:
The Law of the Sea Institute
William S. Richardson School of Law
University of Hawaii at Manoa
2515 Dole Street, Room 208
Honolulu, Hawaii 96822
Phone (808) 948-6750 or 941-8500
Telex 7431895 (ITT) SEALAW
FAX (808) 948-6402

Cite as 22 L. Sea Inst. Proc. [page numbers] (1989)

TABLE OF CONTENTS

OPENING CEREMONIES

Lewis M. Alexander 3
Edward D. Eddy 3
Ambassador Satya Nandan 6

PART I:
NEW DIRECTIONS IN MARINE SCIENCE AND TECHNOLOGY AND THE NATURE OF THEIR POTENTIAL IMPACTS

Introduction 15
Robert Duce

A New Dimension of International and 17
Interdisciplinary Cooperation
Thomas Malone

Discussion 25

Marine Science in the 1990s: Global Change and 27
Its Implications
Robert Corell

Discussion 34

Technology and the Law of the Sea (A Twenty Year Reprise) 36
John P. Craven

Discussion 50

PART II:
IMPACTS OF NEW DEVELOPMENTS ON THE EXPLOITATION AND MANAGEMENT OF NONLIVING MARINE RESOURCES

Introduction 55
Tullio Treves

Trends in the Exploitation of Deep Seabed Minerals 57
Conrad Welling

Political and Technological Changes Affecting Oil 61
and Gas Development in the Canadian Arctic
R.A.W. Hoos

Political and Technological Aspects of Change in 71
the Arctic - The Oil and Gas Industry
Roger Herrera

Discussion 77

Historical and Archeological Treasures 80
The *Titanic*: A Case Study
Technical Implications
Dana Yoerger

Commentary 84
Brian Hoyle

Discussion 89

PART III:
IMPACTS OF NEW DEVELOPMENTS ON THE EXPLOITATION AND MANAGEMENT OF LIVING MARINE RESOURCES

Introduction 95
Edward Wolfe

Large Marine Ecosystems: A Case Study 97
Kenneth Sherman

Marine Ecosystem Model: The Law of the Sea's Mandate 115
for Comprehensive Management
Martin H. Belsky

Commentary 135
Joseph R. Morgan

The Convention on the Construction of Antarctic 138
Marine Living Resources: A Case Study
R. Tucker Scully

Discussion 148

Law Enforcement Capabilities in EEZs: Australia and 150
the South Pacific Island States
Peter Varghese

New Technology in Surveillance and Enforcement and 153
Appropriate Development in the Pacific Islands
Don Aldous

Fisheries Law Enforcement Programs, Practices 171
and Problems in Malaysia
Jahara Yahaya

Commentary 191
Jon Sutinen

Discussion 194

PART IV:
IMPACTS ON NEW DEVELOPMENTS ON NON-RESOURCE USES OF THE OCEAN

Introduction 199
Alastair Couper

International and the New Law of the Sea: New Directions 200
For a Traditional Use?
Edgar Gold

Commentary 214
Awni Behnam

New Legal Issues Resulting from the U.S. Global Military 229
Commitment: A Naval Perspective of the Persian Gulf Tanker War
Richard J. Grunawalt

Discussion 234

An Overview of New Developments 237
D. James Baker

Commentary 242
Ralph Chipman

Subseabed Disposal of High-Level Radioactive Wastes; 245
Transition from a Hare-Brained Idea to a Feasible Technology
Kenneth Hinga

Legal Perspectives 271
Clifton Curtis

DINNER SPEECH

A Practicum in Marine Technology 285
James J. Griffin

PART V:
SCIENTIFIC ISSUES: LOSC AND ACCESS; TECHNOLOGY AND DATA MANAGEMENT

Introduction 291
John Knauss

Freedom of Scientific Research 293
Alfred Soons

Marine Scientific Research: U.S. Perspective 308
on Jurisdiction and International Cooperation
David Ross
Judith Fenwick

Discussion 319

Opportunities in Oceanographic Science Offered by New Advances in Data Management 322
Gregory W. Withee
Douglas R. Hamilton

Maximizing the Benefits from the New Technologies of Oceanographic Data Gathering and Management 333
The ICSU Perspective
S.I. Rasool

Developing Technologies within the Oceanographic Component of the World Climate Research Program 337
Raymond H. Godin

Management of Oceanographic Data and International Cooperation in China 342
Dai Ruguang

Technology and Data Management: U.S. Science Community Views 345
Ferris Webster

Discussion 352

PANEL VI A:
OCEAN MANAGEMENT CONCERNS OF SPECIAL INTEREST

Introduction 359
Lee Kimball

The State of the Environment 361
Alasdair McIntyre

New Challenges for Coastal Area Management and Ocean Management in the 1990s 368
Stella Maris A. Vallejo

Coastal and Ocean Planning 388
Eric Carlson

Integrated Coastal Resources Management Program for Developing Countries 390
Stephen Olsen

Discussion 395

CONTRIBUTED PAPER

Some Questions of Implication of UNCLOS for Special Agreements on Prevention of Marine Pollution 405
Valery I. Andrianov
Viktor A. Kiselev

PART VI B:
SPECIAL SESSION ON TRENDS IN THE LAW OF MARITIME BOUNDARY DELIMITATIONS

Introduction 411
Lewis M. Alexander

The Sources of Law of Maritime Delimitation 412
Philippe Cahier

The Content of the Law of Maritime Delimitation 418
Jean-Pierre Queneudec

Commentary 423
Francisco Orrego Vicuna

Discussion 430

PANEL VII:
IS THE LOS CONVENTION ADDRESSING TODAY'S CHANGING MARINE SCIENTIFIC, TECHNOLOGICAL, ECONOMIC, LEGAL, AND POLITICAL ISSUES?

Introduction 441
Thomas Clingan, Jr.

The Military Perspective 442
Geoffrey Greiveldinger

The Shipping Perspective 448
Thomas Mensah

The Fishing Perspective 460
Lee Anderson

Deep Seabed Mining: Environmental Monitoring Site Proposals . . . 466
Implementation of the Stable Reference Area Concept
Step One
Richard Greenwald

The Administration Perspective 481
Brian Hoyle

Discussion 485

BANQUET SPEECH

Preparing for UNCLOS IV? 491
Edward Miles

LIST OF PARTICIPANTS 505

INDEX 513

PREFACE

This conference required the efforts of numerous individuals, all of whom we thank, some of whom we will specifically mention.

Without the help of the planning committee and the session chairs the conference would not have addressed as much nor run as smoothly as it did. Many thanks. Without the presentations by the speakers there would have been nothing to put in print. Critically important to any meeting are the funding sources. For this meeting we were fortunate to have funding from: The Department of the Interior, Minerals Management Service, the National Science Foundation, and the Graduate School of Oceanography at the University of Rhode Island.

We of the staff of the Center for Ocean Management Studies at the University of Rhode Island, (COMS) were responsible, as co-sponsors, for the conference arrangements. We would like to thank the persons on whom much of the brunt of the work fell, Carol Dryfoos Hunter, COMS Coordinator, and Peggy Cooney, Secretary. Evie Henderson, URI Conference Coordinator, earned our gratitude for the many arrangements she handled for the conference. And finally, a number of students from the graduate and undergraduate programs in marine affairs helped with driving and various other duties. Without their willing and energetic hands, this conference would have ground to a halt. They are: Lynne Hinckey, Carlos Castro, Enid Kumin, Lisa Bonitati, Susan Ware, Peter Drury, and Gretchen Honan.

Professor Lewis Alexander, Director
Lynne Carter Hanson, Executive Director
Center for Ocean Management Studies
University of Rhode Island

PREFACE

This, the 22nd conference of the Law of the Sea Institute, was the first such conference to be held at the Institute's birthplace since its departure for the warmer climes of Hawaii in 1976. Indeed, two of the three founders (Lewis M. Alexander and John Knauss) were still at the University of Rhode Island, and the third (Dale C. Krause) came from Paris to be present.

With the return of the Institute to Rhode Island, the distinctive intellectual mark of the Institute's first Director, Lewis Alexander, returns again as well. Lawyers are once again challenged to sound the philosophical depths of the scientific and technological imperative and to understand why this Institute, the concerns of which they may consider to lie wholly within their own discipline, could be founded and spend its first twelve years at a university which did not then and does not now possess a school of law. Oceanographers see again that science, liberally defined, encompasses the rules for its application and that the unspoken and unproven partner of ocean science and technology is ocean policy.

We wish as well to acknowledge the Institute's staff at the University of Hawaii whose concerted efforts made both the conference and the volume which records its deliberations possible. In particular, we thank Ms. Elizabeth Ng, who carefully prepared the manuscript for publication.

John P. Craven
Director
Law of the Sea Institute

ACKNOWLEDGEMENTS

We gratefully acknowledge the generous support of the following organizations in providing funds for the conference and for the publication of this book:

The Andrew W. Mellon Foundation

Exxon Corporation

The Ford Foundation

Graduate School of Oceanography, University of Rhode Island

National Science Foundation

U.S. Department of Commerce

U.S. Department of Defense

U.S. Department of the Interior, Minerals Management Service

The University of Hawaii Foundation

The University of Hawaii Sea Grant Program

William S. Richardson School of Law, University of Hawaii

OPENING CEREMONIES

Lewis Alexander: Good morning, Ladies and Gentlemen, and welcome to this, the 22nd Annual Law of the Sea Institute Conference. It has been a long twelve years since the Law of the Sea Institute was last here, a long time for the Institute and a long time for the law of the sea. I was recently looking at the Proceedings of the 1976 conference, which was the last one held here, and I noticed one topic on "U.S. Policy and the Ocean Mining Industry" in which it was stated that the mining industry was asking the federal government to provide it with an insurance policy against the international uncertainties which could prevail with or without an international agreement on the seabed.

That sounds like a long time ago. Later in the conference Arvid Pardo, reviewing the then recently completed Revised Single Negotiating Text, lamented the fact that the proposed International Seabed Authority, under the new text, no longer had competence over all activities in the area beyond the limits of national jurisdiction, but only those relating to resource development. He considered that a very poor move to make. He was further shocked that such resource development, according to the revised text, could be conducted both by the Authority and by States Parties. He thought that was pretty bad, too. As I say, it's been a long 12 years since then.

Let me acknowledge two people in the audience, who, along with me, were responsible for organizing the Law of the Sea Institute here back in mid-1960s: John Knauss, who recently ended 25 years as the Dean of the Graduate School of Oceanography, and who is co-programming chairman with me at this conference; and Dale Krause, who was a professor here and now heads the Division of Marine Sciences at UNESCO in Paris.

To welcome us we are pleased to have the President of the University of Rhode Island, Ted Eddy. He came here five years ago and started a new era at the University. The number of applications has gone up considerably, which means we're getting better students as well as more students. Private giving has gone up. We are in the middle of a $50 million building program. It is an exciting new time.

Ted Eddy: It is a great pleasure to welcome you to the 22nd Annual Law of the Sea Institute conference. This is the first one to be held at the University of Rhode Island since 1976, and so in a very real sense we welcome you back home. The Institute has grown considerably over the past 12 years. When Lew asked me to take part in this program this morning he -- being his usual blunt self -- said, "Now make it brief because we've got a lot more important things to do than listen to a university president talk for this period of time."

One of the great advantages of having a commencement is having honorary degrees to give, and one of the great advantages of having honorary degrees is getting fresh stories from the honorary degree recipients. Two weeks ago we held our commencement. We gave an honorary degree to Irving R. Levine, the NBC Chief Economic Correspondent, who passed along a story about a Congressman who was asked to give a speech. He was told that it should be a very brief speech, no longer than 15 minutes. He told his aide, "Now, I want a speech which is exactly 15 minutes and no longer." The aide wrote the speech for him, handed him the folder, and the Congressman took off to give the speech, which took exactly 30 minutes. The Congressman was dismayed when his order had been

changed in such an obvious fashion. He called the aide in and said, "I told you I wanted a 15 minute speech and that was all." The aide said, "Sir, I *wrote* a 15 minute speech. It was exactly 15 minutes. Just before I gave it to you I timed it and it came out to 15 minutes. I put it in the folder and I gave you two copies." [laughter]

Well, Lew was helpful in giving me some background on your conference. Let me share it with you. The LSI was founded at this University in 1966 at a relatively slow time in the Law of the Sea and before the LOS convention, adopted in 1958, had progressed very far. The second conference had failed to reach agreement, and the forces which would impel the world community in preparing for and convening a third conference were barely perceptible. But movement was taking place. In his opening remarks at the first LSI conference, Rhode Island's Senator Claiborne Pell expressed the hope that the Institute would help bring about a new law of the sea conference. This was nearly a year and a half before Ambassador Pardo's well-known address to the United Nations on the common heritage of mankind and the need for a new law of the sea perspective. Also at that first LSI conference Bart Eichleberger of the Committee to Study the Organization of Peace suggested that the mineral resources of the deep seabed should be placed under international control, a kind of a forerunner of Ambassador Pardo's initiative. Later, as the U.N. Seabed Committee was organized and began operations, the Institute tracked its activities through the annual LSI meetings as well as special workshops. This focus continued during the Third LOS conference as well.

Now we're in a new phase of the law of the sea, one of implementation of the 1982 Convention in the light of developing scientific, technological, economic, and other trends. Certainly your program for this conference represents a good survey of those trends. Ocean policies and politics change more slowly now than they did in those early days of sudden spurts and starts at the LOS conference, but we still have to be aware of evolving trends and of subtle pressures which could, in a few years, have strong and often negative impacts on ocean affairs. I think that cloud hangs over this conference as much as anything. That is why we are fortunate to have organizations such as the Law of the Sea Institute to keep watch on changing conditions and to provide early identification of courses which may help to shape the future of the ocean environment and its uses.

We are particularly glad at the University of Rhode Island to have you here. We've tried to guarantee weather which would be cool inside and warm outside, and always sunny, of course. You have a big job ahead and we're delighted that you came to the University so that we could provide the right setting for your work, as you sit on this campus and look out at the actual water that you're talking about. So enjoy yourselves, come back often, and have some fun while you're here. Thank you very much.

Lewis Alexander: Thank you, President Eddy. I should like to thank the program committee, particularly Lynne Carter Hanson who, with John Knauss, did much of the work.

The opening address will be delivered by Satya Nandan, Under-Secretary General of the United Nations and Special Representative of the Secretary-General for the Law of the Sea in the Office of Ocean Affairs and the Law of the Sea.

The session chair for Part I of the program is Robert Duce, who is ending his first year as the new Dean of the Graduate School of Oceano-

graphy, is also Vice-Provost for Marine Programs here at the University, and is also our boss at the Center for Ocean Management Studies.

OPENING REMARKS

The Relationship Between the United Nations Convention on the Law of the Sea and Developments in Science and Technology

Satya Nandan
Under-Secretary General
Office of Ocean Affairs and the Law of the Sea
United Nations

Mr. Chairman, I am indeed very honored to be invited to speak at this opening meeting of the Law of the Sea Institute. I'm particularly pleased, because it was here at Rhode Island that I was first introduced to the proceedings of the Institute in June 1971. The subject of discussion at that time was "The Law of the Sea: A New Geneva Conference". When I look back at that meeting I remember how full of anticipation and enthusiasm we all were for a new regime for the oceans which would take into account the political and economic realities of the day, as well as the results of scientific developments and technological advances over the recent decades. No one at that time could have foreseen the monumental task that lay ahead of us, and the inordinate length of the conference upon which we were about to embark. What is important to observe, however, is that now, after seventeen years, the enthusiasm and interest which were displayed by the participants at that meeting of the Law of the Sea Institute have not waned. And here we are today meeting once again to continue our discussion on matters relating to law of the sea.

When I was invited to address this meeting I was told that I should speak on the subject of the 1982 United Nations Convention of the Law of the Sea and its responses to the advances in science and technology in our time. I was also told that I could speak on any other matter relating to law of the sea. I decided to take full advantage of this generous invitation. Accordingly, I wish to address the subject of the Convention and its responses to scientific and technological developments, and also to address some of the problems that have been raised with Part XI of the Convention dealing with deep seabed mining.

I. The Convention: Responses to Scientific and Technical Developments

The United Nations Convention on the Law of the Sea was adopted in 1982. As of the last date for signature, December 9th, 1984, 159 signatures were appended. It is now 1988. Where do we stand today? Some of the progress can be quantified. The Convention, which requires 60 ratifications to enter into force, has now received 35 ratifications. As regards its implementation, there has been dramatic convergence towards the 12 mile territorial sea regime to the Convention. Today, 104 States have territorial seas of 12 nautical miles and 18 States have territorial seas of less than 12 miles. Only 21 States have territorial seas greater than 12 miles and many of these are signatories to the Convention. The emerging consensus towards 12 mile territorial sea is vastly different from the chaotic situation with multiple variables, that existed prior to the adoption of the Convention.

There are, today, 89 States which have exclusive economic zones or exclusive fisheries zones of 200 miles.

In other areas, progress is not so easy to quantify, but has been marked by events. The Preparatory Commission for the International Seabed Authority and for the International Tribunal for Law of the Sea has held five and one-half sessions with the participation of about two-thirds of the signatories and most of the nonsignatories. Given that participation means sending a delegation to meetings for a full two months of the year, this in itself is a significant signal that States continue to be seriously committed to the Convention. The Preparatory Commission has recently registered India, France, Japan, and the Soviet Union as pioneer investors, each of them now holding the exclusive right to international seabed areas for the purpose of seabed mining. The registration unanimously of this first group of pioneer investors is of major importance as it brings into force, provisionally, the deep seabed mining regime of the Convention.

Looking at the Convention as a whole it would be apparent that it is not only a direct result of the political and economic needs of the international community, but it is also a response to advances to science and technology. It is well known that after World War II, changes in maritime law were stimulated by scientific and technological advances such as offshore drilling, increased tanker traffic and the size, and larger scale and more efficient means of fishing. Technology for the harnessing of other resources of the oceans was also developing. This created possibilities for the exploitation of resources which were previously inaccessible and used another area of uncertainty into maritime law, that States began to expand their jurisdiction to accommodate the possibilities that new technologies had created.

Two early examples of responses to the advances in science and technology are: the Truman Declaration of 1945, which established the sovereign rights of the United States over the natural resources on its continental shelf; and the Santiago Declaration of 1952 which established a territorial sea of 200 miles for three Andean States which were later joined by others. In other parts of the world also, there were a number of States which claimed territorial seas of varying breadths, from three miles to two hundred, and the tendency toward creeping jurisdiction over marine pollution zones, fishery zones, and the continental shelf was attracting attention. Thus the question of what the limits of national jurisdiction are became a major international issue.

Added to these developments, by the late 1960s, it became apparent that technology to harness the mineral resources of the deep ocean was advancing rapidly. As early as 1966, President Lyndon Johnson, at the launching of a research vessel, stated:

> We must be careful to avoid a race to grab and hold onto the land under the high seas. We must ensure that the deep seabeds and the ocean bottoms are and remain the legacy of all human beings.

It was this very same spirit which led the United Nations to take measures to ensure that the resources of the deep sea-bed should not become the subject of competition and conflict among States. States were concerned that there should not be a repeat of the type of colonization that had occurred in the 18th and 19th centuries with respect to land territories.

Thus, there was a need to establish an equitable system for the administration and development of these resources which would benefit the entire international community instead of favoring only a few. By

1970, therefore, the General Assembly of the United Nations had adopted a Declaration that stated that the resources of the deep seabed were the common heritage of mankind, and that these resources should be developed under an international regime for the benefit of mankind as a whole.

There are also other areas where the United Nations Convention on the Law of the Sea has responded to marine scientific and technological developments. Let me mention a few examples.

a) *Continental Shelf*

The search for and subsequent exploitation of offshore hydrocarbons lead to claims extending jurisdiction over the continental shelf. This development is reflected in the 1982 Convention, where the continental shelf is referred to as extending to the outer edge of the continental margin or to 200 miles from the territorial sea baselines, while more distant shelf areas may be claimed by the coastal State in certain circumstances. The new definition clearly reflected the substantially improved technical feasibility to explore and exploit mineral resources in coastal waters. This new definition of the continental shelf is based on technical criteria and is a further challenge to science and technology. States would need to undertake scientific surveys of continental margins in order to obtain geophysical and geological data necessary for the delimitation of the outer limits of the continental shelf.

b) *Exclusive Economic Zone*

The evolution of the concept of the exclusive economic zone is a consequence of developments in science and technology in the field of fisheries. Technological advances enabled distant water fishing fleets to operate for long periods of time at great distances. It also enabled these fleets to engage in large-scale fishing in coastal areas of other States. The impact on developing countries, particularly the Latin American countries, watching these distant water fishing fleets operate off their coasts was the seminal event responsible for the extension of jurisdiction over living resources. As coastal States strove to protect these resources, proposals were made at the Conference, ranging from a territorialist position to that of the establishment of preferential rights for coastal States. The exclusive economic zone concept as it finally emerged from the Conference is a tribute to creativity, compromise and co-operation.

c) *Marine Scientific Research*

At the time of the Conference, a consent regime for scientific research concerning the continental shelf was already contained in the 1958 Geneva Convention on the Continental Shelf. The regime now embodied in the 1982 Convention on the Law of the Sea has clearly extended the scope of the consent regime for marine scientific research in the exclusive economic zone and on the continental shelf. Under the 1958 Geneva Convention consent of the coastal State was required for all scientific research. It was only in the case of qualified institutions that such consent could not normally be withheld (Article 5(8)). The 1982 Convention has maintained the consent regime with respect to the exclusive economic zone and the continental shelf. It has, however, introduced an important change in favour of the scientific community in that the coastal State may not normally withhold consent from anyone wishing to conduct research except on a few specific grounds which are detailed in the Convention (Article 246(5)).

From an examination of legislation for the exclusive economic zone and the continental shelf, we now estimate that 85 States have specifically declared jurisdiction over marine scientific research in those zones. However, only about 15 States have enacted regulations or adopted

procedures which would assist researching States in obtaining consent. An examination of the problems concerning the implementation of the regime for marine scientific research suggests that many are essentially of a practical nature. I have no doubt that improved communication, clear procedures and rational discussion would help to solve those problems. The United Nations is ready to help in this process. We plan to convene next year a Group of Experts to consider the practical implementation of the provisions of the Convention in this area and to provide a set of guidelines which is hoped will be of assistance to States as well as to the scientific community.

I would like to take this opportunity to invite the scientific community to let us know of the problems they are encountering in obtaining consent for the conduct of scientific research in the exclusive economic zone and on the continental shelf and also to provide us with any ideas that they may have for overcoming some of the practical problems.

The 1982 Convention places great importance on marine science and technology. In addition to references throughout the Convention, Parts XIII and XIV are devoted to these two subjects. Part XIII on marine scientific research has provisions on international co-operation in this field and on the conduct and promotion of marine scientific research in general. Part XIV deals with development and transfer of marine technology. It also calls for international co-operation in this field and for the establishment of national and regional marine scientific and technology centers in order to stimulate and advance the conduct of marine scientific research and to enhance the national capabilities of States to benefit from the resources of the oceans.

d) *The International Seabed Regime*

No other part of the Convention reflects so significantly the advances in science and technology as Part XI, which governs the development of deep seabed mineral resources beyond national jurisdiction. Without the scientific discoveries of the 1960s and the subsequent development of seabed mining technology, there would be no regime for deep seabed mining.

The deep seabed mining part of the Convention is based on the principle of the common heritage of mankind. This cardinal principle establishes that the resources of the deep seabed and the ocean floor are the common heritage of mankind and should be developed for the benefit of all humanity. The machinery for the administration and the development of deep seabed resources is based on the parallel system -- a system which was proposed by the United States as a compromise and which guarantees private companies and State-sponsored enterprises the right to undertake mining operations side by side with those of the Enterprise -- the mining arm of the Authority. Everyone at the Conference agreed on the principle of the common heritage of mankind and on the mechanism provided by the parallel system.

During the conference, exaggerated claims about the economic potential of manganese nodules as a mineral bonanza certainly drove the negotiations at a pace that perhaps accounts for some of the difficulties we are now encountering with certain provisions of Part XI. The developing countries, which, generally, lack the means for exploiting deep seabed minerals, were motivated in part by the fear that once again they would have no part to play, and derive no benefit from, a new industrial development. They, therefore, sought to obtain full participation and maximum benefit from deep seabed mining activities. The countries with the capability to carry out seabed mining, in order to

protect their interests, demanded such a level of detail in the Convention that some of the assumptions on which they based their positions now seem somewhat short-sighted and unwarranted.

In these circumstances, it is not surprising that some differences should remain on certain provisions of the Convention. The final round of negotiations to settle these outstanding issues never really took place. The reason for this was the arrival of a new administration in the United States which was determined to re-open issues many of which were already considered settled.

Be that as it may, it is recognized that there are outstanding issues which need to be addressed. The problem is one of identifying the real practical issues and distinguishing them from those that are imagined or based on purely ideological considerations.

II. The Convention: The Regime for Deep Seabed Resources

The existence of some problems, however, should not lead to the conclusion that Part XI as a whole should be revised and that such revision would call for another Conference. The changes and clarifications that are necessary can be substantially dealt with in the framework of the Preparatory Commission, which has already demonstrated a pragmatic and flexible approach towards resolving a number of problems that have arisen thus far. The Law of the Sea community has never been bereft of ideas for creating informal fora and mechanisms for working out solutions to problems.

We should never forget that the Convention is a package of carefully negotiated compromises. Over 90 percent of this package deals with matters other than deep seabed minerals. The opening of one component of such a package would automatically open up all others and thus destroy the overall balance of rights and obligations of States which was the crowning achievement of the Convention. We could, however, very realistically focus on the few provisions which seem to be of concern to the most vocal critics of Part XI.

For example, the provisions on transfer of technology assumed that seabed mining technology would not be available on the open market. Therefore, it was of paramount importance that there should be rules to ensure that the Enterprise be able to obtain the technology necessary to keep pace with the first seabed mining operations under the parallel system. Thus, it was felt necessary to include compulsory transfer of technology provisions which would take effect under certain circumstances. Today, we find that seabed mining technology is for the most part, so far as it has been developed, available on the open market and it is highly unlikely that those provisions will need to be invoked. In any case, the obligations can only be invoked as a last resort and are limited in time to the first 10 years of commercial production of the Enterprise. The transfer of technology provisions are part and parcel of the parallel system. They are specific and limited in scope and time. These provisions are not of general application.

The issue of transfer of technology would certainly be minimized and probably become irrelevant if all State enterprises, consortia and the international Enterprise would find a way to jointly explore and exploit the first mine-site reserved for the Authority. This could become a common pilot project. It would also resolve a number of other issues related to financing and other aspects of the first operation of the Enterprise.

A second issue is the production policy. Does the Convention guarantee access to every qualified applicant? The answer is "Yes."

Every applicant is entitled to a contract and to a production authorization. Is the contractor then affected negatively by the production policy? The formula for production authorization is a function of statistics. Its purpose is to integrate the metals produced from seabed mining into the existing metal market with the least disruption to both the market and to the economies of land based producers.

While the formula may not be perfect, it may also not be well understood. There is a belief that the production formula must provide an allocation for every contractor at the same moment for the optimum amount of minerals each proposes to produce eventually. In practice, this will not happen because the contractors will be staggered in their start-up dates and they will not operate at full capacity in the first years.

For instance, based on today's statistics of a 1.73 percent growth rate in nickel consumption, which is historically very low, in the year 2000, there should be production capacity for four 3-million-tons-per-year operations running at full capacity. In the year 2005, there will be room for six such operations and in the year 2010, there will be room for eight. In addition, if we take into account the phasing in of operations, there can be even more mines operating since all will not be operating at full capacity. And of course, if the growth rate increases, there will be room for even more operations. Even so, it should not be too difficult to reach some understanding which would provide the production policy formula with the necessary flexibility to take into account unforeseen circumstances and to remove any misgivings that might exist.

A third issue is the Review Conference which again was a proposal by the United States as part of the compromise on the parallel system. It was meant to enable States to review how the system is working and to determine whether or not adjustments are necessary.

Unfortunately, this very plausible provision has become controversial because of the procedure that may be used for adopting the decision on any adjustments to the system should there be no consensus. The present procedure calls for a three-quarters majority and this the industrialized countries believe is not sufficient. They use constitutional arguments to support their position, stating that a decision of this kind would remove the prerogatives of their national legislatures.

One possible solution to the difficulties some see in the application of Article 155, which deals with the Review Conference, is that all States agree not to invoke the article and apply the normal amendment procedures prescribed in the Convention which requires ratification by two-thirds of States Parties for changes.

We must understand that order in the oceans is in the interest of all. No one State or group of States of whatever persuasion should feel that they alone have the right answers, or that their interest is the only one to be protected. I have identified a few well-known issues and suggested some possible approaches towards reaching some broad understanding on them. But the first step is that everyone must participate in the dialogue that is now going on in the Preparatory Commission.

In this connection, it is important to take note of the maturity and realism shown by the Preparatory Commission in dealing with the drafting of the mining rules and regulations for the Authority and the manner in which it proceeded with the registration of the first four pioneer investors. It is worth mentioning that in the latter case, it dealt not only with the problems of those who applied for registration, but also agreed to give equal advantages to those who are potential

pioneer investors, a group which includes consortia from non-signatory States, namely the Federal Republic of Germany, the United Kingdom and the United States. The practical and realistic approach taken in these instances should reassure all those who have feared an extreme politization of this body. It also augurs well for the resolution of other issues.

Mr. Chairman, let me refer back to where I started. When looking at the relationship between science and technology and the Convention on the Law of the Sea, one cannot but conclude that to a large extent the Convention gives appropriate legal answers to a number of questions raised by the tremendous increase in our knowledge of oceans and technical capabilities in the first half of this century. There is no doubt that as we approach the twenty-first century, more and more attention will be paid to the uses of the ocean and the exploitation of its resources. It is important, therefore, that we approach these developments within an accepted legal framework. There must be certainty about the rights and obligations of all States so that the general atmosphere is conducive to rational multiple uses of the seas without conflicts. I hope that we can all agree that that framework is the United Nations Convention on the Law of the Sea.

PART I

NEW DIRECTIONS IN MARINE SCIENCE AND TECHNOLOGY AND THE NATURE OF POTENTIAL IMPACTS

PANEL I

INTRODUCTION

Robert Duce: I want to welcome all of you, as Lew has and as President Eddy has, to the University of Rhode Island, and in particular to the Narragansett Bay campus. We hope you have a very enjoyable and profitable week. It is also a great pleasure, of course, to welcome back the Law of the Sea Institute, which as you know, left the university about 12 years ago. It is a particular pleasure for me to welcome the people who actually work in the Law of the Sea Institute at the University of Hawaii. I came here myself from the University of Hawaii about 18 years ago, so I know that place and love it very much.

Marine sciences and natural sciences, in general, are on the threshhold of new ways of perceiving and proceeding our sciences - the way we understand what the earth is all about. We are going to hear some of these new approaches. I would like to put in historical perspective how natural sciences, and in particular, marine sciences have developed over the last 40 years. We will see that where we have been, where we are now and where we're going next are part of a very logical progression.

The period just after the war, in the 1940s and 1950s, was a time of exploration, in a sense. In the funding agencies, the National Science Foundation, the Office of Naval Research (ONR), etc., which were formed shortly after the war, there was a recognition that the federal government really had a role to play in science.

In those terms whatever measurements you made in marine science were new. Finding out what was there was a major step forward. Relatively little thought was given to time and space scales. A few data centers were established, including the initiation of one of the most important data sets that we've ever gathered; that was the beginning of the measurement of carbon dioxide at Mauna Loa in the 1950s. That has been, of course, an extremely important data set, relative to our concerns about climate change.

The 1960s was a period in which marine scientists began to undertake process related studies. We tried to better understand the details of what was happening. Technology began to make an impact on the science through new instrumentation. Of course, this was the period that followed the SPUTNIK era, and considerable additional science funding was available during that time. However, marine science was still concerned with small space scales and short time scales, with studies carried out primarily by single investigators and graduate students. Models were beginning to be developed, but they were still rather crude.

The 1970s and the early 1980s were characterized by multi-investigator and multi-national programs. At this point there was a recognition of the need to bring different parts of individual disciplines together. The international aspect became important. In ocean sciences it was the period of the International Decade of Ocean Exploration, which transformed the way we approached marine science. At this time we were concerned with regional space scales and seasonal time scales in our attempts to understand the earth system, and the modelers and measurers began to work together. Models began to be used in an experimental mode, and truly interdisciplinary programs were initiated during this time period.

Now, in the late 1980s and the 1990s, the next logical step is to recognize the need for individual scientists in the various disciplines, to work much more closely together to understand the earth as an entire system. No longer is it possible for atmospheric scientists to work only in their own area, and marine scientists, earth scientists, etc. The earth is an integral system, and technology has now developed to the point that we can attempt to understand this system. This is the major new direction we are taking, the new threshold we are approaching. The talks this morning will be about the science and the technology that will allow us to take these next steps, and the directions these steps will take us. We are obviously concerned with global space scales, inter-annual time scales, and interactive modelling and observing systems.

A New Dimension of International and Interdisciplinary Cooperation

Thomas F. Malone
St. Joseph's College
W. Hartford, Connecticut

The message I am priviledged to bring to you today is that we stand on the threshold of a renaissance in the sciences concerned with Planet Earth, including the fauna, flora, and the humans who call it their home. A conceptual framework is emerging in which it is recognized that the terrestrial and marine environments and the diverse forms of life inhabiting them constitute an integrated system of interacting parts. No single part -- oceans, atmosphere, or biota -- can be understood in isolation with sufficient depth to anticipate its changes. Nor can any geographic segment be analyzed satisfactorily as a sequestered entity. A deeper understanding of the structure and metabolism of the total earth system is within reach. To capture it will require breaking new ground in international and interdisciplinary research.

This renaissance is intimately interrelated with the explosive development in marine science and technology now gathering momentum after a gestation period of some four decades. Its origin -- in no small part -- goes back to the visionary deliberations in the 1950s of the Committee on Oceanography of the National Academy of Sciences. Harrison Brown, Roger Revelle and Columbus Iselin and their colleagues put in motion a sequence of international expeditions and studies that set the stage for the array of progress that support and elaborate, for example, the World Ocean Circulation Experiment. Meanwhile, the Academy's Committee on Meterology, led by the imaginative Lloyd Berkner, Carl Eckart, Hugh Dryden and Jule Charney, was laying plans that led to the Global Atmosphere Research Program and the World Climate Research Program. Collaboration between oceanographers and atmospheric scientists is now an accepted research mode. It has come a long way from that first encounter in the late 1950s in the Members' Room of the academy when the two committees met to explore cooperation. We never did sit down, but circled warily around, eyeing each other somewhat suspiciously. From that inauspicious beginning, however, cooperation of profound significance emerged. The scientific evidence of an ocean-atmosphere linkage triumphed over human fallibility!

Another element in the origin of this renaissance was the International Biological Program of the 1960s. It transformed the classical mode of individual scholarly investigation of the world's flora. Led in this country by the quintessentially renaissance man, Roger Revelle, the horizons it explored laid the groundwork for linking the physical and life sciences.

The roots of this renaissance go back to the writing in this century of the Soviet geochemist, Academician Vernadsky, who recognized the inextricable link between life and its surrounding energetic and material structure through photosynthesis, transpiration and nutrition.[1] The philosophical basis was set forth with admirable clarity by Dr. Herbert Friedman in 1983, in these prophetic words:

> The real connections that link the geosphere and biosphere to each other are subtle, complex, and often synergistic; their study transcends the bounds of specialized, scientific disciplines and the scope of limited, national scientific endeavors. For these reasons progress in fundamental areas of ocean-atmosphere interactions, biogeochemical cycles, and solar-terrestrial relationships has come far more slowly than in specialized fields, in spite of the obvious practical importance in such studies. If, however, we could launch a cooperative interdisciplinary program in the earth sciences, on an international scale, we might hope to take a major step toward revealing the physical, chemical, and biological workings of the Sun-Earth system and the mysteries of the origins and survival of life in the biosphere. The concept of an International Geosphere-Biosphere Program (IGBP) ... calls for this sort of bold, 'holistic' venture in organized research -- the study of whole systems of interdisciplinary science in an effort to understand global change in the terrestial environment and its living systems.[2]

Powerful motivation for taking action on Friedman's vision was provided by Richard Goody and has colleagues in a report on the human habitality of Planet Earth:

> The human race lives on a planet characterized by change --- This is a unique time, when one species, humanity, has developed his ability to alter its environment on the largest (global) scale and to do so within the lifetime of a single species member.[3]

These two seminal ideas prompted the International Council of Scientific Unions in 1983 to initiate exploration of parctical steps to act on their implications. Preliminary meetings around the world in 1984 culminated in a symposium on global change in September, in Ottawa, Canada, sponsored by the International Council of Scientific Unions (ICSU).[4] The recognition evolving from that meeting that "a deepened understanding of anthropogenically induced global change is becoming a imperative of contemporary society" led ICSU to commission a two-year study leading to the establishment of *The International Geosphere-Biosphere Program: A Study in Global Change in 1986.*[5] The objective of the program is:

> To describe and understand the interactive physical, chemical, and biological processes that regulate the total Earth system, the unique environment it provides for life, the changes that are occurring in that system, and the manner by which these changes are influenced by human actions.

The ultimate intellectual scope of IGBP linked conditions in the interior of the Earth with those in the interior of the sun. Both observational and analytical, the nature of the program will require observations of parameters not now being measured and will necessitate an innovative style of interdisciplinary analysis. The most challenging aspect of the proposal is the intent to illuminate linkage between the physical sciences and the life sciences. The viewpoint is holistic and global.

The rationale for IGBP is fivefold:

1. Maturation in understanding the processes in the several domains of geophysics -- atmosphere, oceans, lithosphere, mantle and core, solar-terrestrial physics -- and in the study of ecological systems -- has brought us to the point at which it is possible to cast these processes in quantitative form -- mathematical models. An array of international programs over the past two decades has made it abundantly clear that interactions among the several domains are so important that issues in geophysics and ecology must be addressed in a unified manner.

2. It turns out that a vital part of that linkage is found in the biogeochemical cycling of both major and trace chemicals. These cycles have been elucidated during the last decade or so and are now the object of intensive study.[6] New dimensions of global observations combining *in situ* and remote-sensing measurement are required.

3. Major advances in remote-sensing sensor and detector technology have been made since TIROS was launched in April 1980. Active remote-sensing techniques are under development to add to the current passive remote-sensing capabilities.[7] These techniques give promise of providing 3-dimensional properties of the dynamic, thermodynamic, chemical, and biological processes in the Earth system. Explosive growth in the processing power of computers is making possible mathematical modeling that was only a dream a decade ago. Advances in telecommunications, data storage, access, and retrieval are transforming the traditional data-archiving function into a sophisticated information system that is an integral part of research, permitting real-time interaction by individual researchers.

4. A powerful motivating force is the realization that population growth and the agricultural and industrial activity in our generation that transforms natural resources into the goods and services to meet the human needs of a growing world population is altering the environment of our small and tightly knit planet in unprecedented ways. These changes have consequences for future generations that we cannot as yet comprehend. The greenhouse gas issue, depletion of the stratospheric ozone layer, desertification, deforestration, and species extinction are issues that have sky-rocketed into public consciousness.

5. Apart from providing the knowledge base to anticipate and avoid traumatic, anthropogenically induced environmental perturbations, motivation is emerging to lay the scientific basis for achieving *sustainable development of the biosphere* (living off the yield of natural resources without depleting the resource capital itself). This issue is looming ever larger in the thinking within developing countries, where population pressure will be greatest as we cross the threshold into the twenty-first century. The unity of ecology and economics has now been generally accepted, following publication of the report of the World Commission on Environment and Development[8] (commonly known as the Brundtland Report after its Chair, Gro Brundtland, Prime Minister of Norway).

The structure of the program is now being developed by the Special Committee of ICSU chaired by Professor James McCarthy of Harvard University. It has a secretariat headed by Professor Thomas Rosswall at the Royal Swedish Academy of Sciences in Stockholm. Close consultation is maintained with national IGBP committees and with the groups overseeing international programs such as the world climate research program and programs addressed to the study of the oceans, the solid earth, and solar-terrestrial physics. The Special Committee will hold a major con-

sultative conference in Stockholm in late October. That occasion will provide an opportunity to develop further the linkage between this initiative and other ongoing or planned programs.

Intensive planning and program design will continue for the balance of this decade. The observational mode will commence in the 1990s, with full-scale operations probably coinciding with the planned initiation of the Earth Observing System in the mid-1990s.

Initial program activities will include:

1. Process studies -- The flux of energy, water, and chemicals at the ocean-atmosphere and the land-atmosphere interfaces -- the response of the atmosphere to fluctuations in the several spectral domains of the solar radiance -- the biological processes that influence biogenic emissions from the vegetation and from the euphotic zone of the ocean.

2. Observations -- An internationally sponsored Earth-observing system is required. It will include standardized and calibrated remote-sensed observations from geostationary and polar-orbiting satellites as well as an Earth-based network to provide observational time series as well as spatial resolution and validation for the satellite measurements. New ground must be broken in measuring biological and chemical processes.

A promising development was an unprecedented meeting of top officials of 17 space agencies from around the world in Durham, New Hampshire, last April under the rubric of "Mission to Planet Earth," in connection with the International Space Year planned for 1992. The conference explored the role of space science and technology in the IGBP/Global Change undertaking -- a precursor to the comprehensive study of the earth as a system, proposed by the NASA Earth Systems Science Committee.[9] The seeds were planted for a new era for multilateral cooperation in space.

3. An information system -- An integral part of this observational system and of the study of processes will be the design and development of a sophisticated scientific information system responsive to the needs of research while fulfilling an archival function. Intimate interaction is necessary between a dynamic research program and data collection.

4. Modeling -- Theory, as well as information gained from process studies and the observational system, will guide the development of conceptual and quantitative representation of those processes and their interactions. The models, in turn, will feed back to the design of observational systems and the elucidation of processes. Models are the principal tools for anticipating natural change and discriminating between it and anthropogenic perturbations. A hierarchy of models is envisioned that reach across domains and link the relevant physical, chemical, and biological processes.

5. Recovery of environmental records -- "Proxy" indicators, or records, of prehistoric environmental changes -- such as global ice volume, tree-ring widths, ice cores, isotope and chemical ratios in lake and ocean sediments, ice caps, and coral reefs. The stage is now set for a more intensive study of the dynamic significance of these indicators within the context of a set of highly interactive processes that make up the total Earth system.

Priority is being given to key interactions that may lead to significant global change on time scales of decades to centuries; that most affect the biosphere; that are most susceptible to human activity; and that will most likely lead to a useful predictive capability.

Early attention is likely to be directed toward the biogeochemical cycling of those chemical substances that constitute the vital linkage among the atmosphere, oceans and terrestrial and marine ecosystems. Moreover, anthropogenic perturbations in these cycles are the principal cause of the kind of global change to which Goody drew attention. The Global Change Committee of the National Academy of Sciences has included exchange processes involving the euphotic zone of the ocean among topics especially attractive for study now.

This session is dedicated to discussion of the implications of global change with respect to new directions in marine science and technology. Several issues appear to merit considerations:

a. Is it time to bring together, in a unified manner, the linkages among the physical and chemical processes in the ocean and the biological processes -- and to integrate these with the corresponding processes over the other one-third of Planet Earth? How interwoven within these processes are the anthropogenic perturbations? Is the marine science and technological community prepared to overcome the institutional barriers to a truly interdisciplinary effort? This is more than integrating the contributions of individual disciplines addressed to components of an overall problem. It means that the search for solutions takes precedence over traditional boundaries. It means combining disciplinary accuracy and interdisciplinary originality in that search as argued by Schneider.[10]

b. How imminent is anthropogenically induced global change in the ocean? Does it matter, since climate change resulting from human activity cannot be analyzed and anticipated without including the oceans? It was the possibility of human intervention in climate that prompted President Kennedy to include reference to atmospheric research in his 1961 U.N. address. The Global Atmospheric Research Program and the World Climate Research Program followed. Will the unequivocal commitment "to promote broad international and bilateral cooperation in the increasingly important area of global climate and environmental change" by Messrs. Gorbachev and Reagan[11] last December have similar consequences?

c. To what extent is it desirable to integrate major international programs in marine science into the emerging activity known variously today as Global Change, the International Geosphere-Biosphere Program, Earth System or Mission to Planet Earth? Would a unified, interdisciplinary effort advance the interests of the marine sciences more effectively -- or less effectively -- than a stand-alone program? More than pragmatic, programmatic autonomy is involved. Are the intellectual and scientific imperatives persuasive? If the answer is in the affirmative, a strategy and timetable need articulation.

d. The research enterprise in this country is clearly entering a new era in which attractive research opportunities exceed support possibilities. The distinctions between "big" science and small science are becoming blurred. Institutional innovation and shared facilities are increasingly common. The boundaries between basic and applied research are eroding. Overhanging all like a dark cloud is the Bipartisan Budget Agreement, designed to avert fiscal disaster as a consequence of unprecedented budget deficits and negative balances of payments. In its present form, it limits increases in nondefense discretionary spending to two percent per year. The implication is clear.

We face several years of fiscal austerity during which the setting of research priorities will be the order of the day. In the best of all

worlds, these will be determined through action in concert by the scientific community and the executive and legislative branches of the government.[12] But they will be set. A persuasive case and a unified constituency acting in statesmanlike fashion will be important.

e. One feature that global change and marine science and technology share in common is that both are inherently international. Are there yet new vistas of international cooperation, coordination, sharing of facilities and funding that should be imaginatively explored to overcome the constraints that affect every nation in one fashion or another? Marine science and technology have a proud tradition of international activity as a basis to explore new dimensions of international cooperation.

f. A second feature shared in common is the importance of space science and technology. Research with remote-sensing has demonstrated great potential in the capability to measure critical ocean variables. Observations from space are a fundamental aspect of global change studies. Here, in particular, enhanced international cooperation could permit application of new observational tools more rapidly than an array of independent national efforts. Fertilization is needed of the seeds of cooperation planted at the ISY Conference in New Hampshire in April where high priority was accorded to focussing the potential power of space science and technology over the next decade on illuminating the physical, chemical and biological process on Planet Earth.[13] A more intimate interaction among investigators of global change, research oceanographers and space science and technology is inevitable if the progress now within reach is to be achieved. The development of a new regime in the space domain can profit from the experience of the oceanographic community in seeking to establish the Law of the Sea. A judicious blend of nongovernmental and intergovernmental institution will be required, as well as balance between national programs and an integrated international effort. All nations should be involved to ensure access to observation in coastal areas.

g. The design of the end-to-end data system for TOPEX is a precursor of the information system that will be required for the operational phase of global change.[14]

h. Implementation of the global change concept which crosses national and disciplinary boundaries as well as agency domains, while merging science and technology will almost certainly necessitate re-examination of institutional arrangements at the international level -- and perhaps at the national level.[15] The scientific community has a stake in this endeavor to assure a productive partnership between the scientific community and the intergovernmental infrastructure. Undue concentration of authority and bureaucratic paralysis must be avoided in an efficient dynamic research program.

This is a sampling of the issues that merit consideration in exploring new directions of marine science and technology.

In summary, will this program take off? A quarter of a century of involvement in international scientific cooperation left me unprepared for the enthusiasm and support the concept of global change is receiving. This is found in the scientific community here and abroad, in the executive and legislative branches of the government and among the general public. The encouragement is exhilerating; the responsibility is sobering.

If all the dreams and aspirations of the world scientific community are realized, five generic issues will have to be confronted:

a. data access and exchange;
b. technology transfer (especially with respect to space technology);
c. scale - balance between designing a program too large to manage against one too small to be effective;
d. integration of social and behavioral sciences with the natural sciences; and
e. the timing of policy responses to the threat of irreversible anthropogenic global changes - balancing the impetuousness of activists against the traditional caution of the scientists.

Finally, is it possible that science and technology can develop the knowledge base upon which the power of world opinion operating through government will demand a path with attractive vistas instead of one that places in jeopardy so many of the values that humankind treasures? Cannot the coming together of scientists from many disciplines and many nations to ensure a productive global life support system for future generations offer an example of a mode of thinking that might well be reflected by diverse national governments as they address the management of world affairs?

NOTES

1. V.I. Vernadsky, "The Biosphere and the Noosphere," *American Scientists* 33, (1945); pp. 1-12.
2. H. Friedman, "The Science of Global Change -- An Overview," in *Global Change*, T. F. Malone and J. G. Roederer (eds.), (Cambridge and New York: Cambridge University Press, 1985), pp. 20-52.
3. R. Goody (Chmn.), *Global Change: Impact on Habitability, A Scientific Assessment*, (Jet Propulsion Laboratory, JPL 0-95, C.I.T., 1982).
4. T.F. Malone and J.G. Roederer (eds.), *Global Change* (Cambridge and New York: Cambridge University Press, 1985), p. 510.
5. See T.F. Malone, "Mission to Planet Earth," *ENVIRONMENT* 38, No. 8, (October 1986), pp. 6-12.
6. B. Bolin and R.B. Cook (eds.), *The Major Biogeochemical Cycles and Their Interactions*, SCOPE 21, (Chichester and New York: John Wiley & Sons, 1983).
7. NASA and NOAA, *Space-Based Remote Sensing of the Earth. A Report to Congress*, (Washington, D.C., Superintendent of Documents, September 1987).
8. World Commission on Environment and Development, *Our Common Future*, (Oxford and New York: Oxford University Press, 1987), p. 400.
9. F. Bretherton, *Earth System Science: A Program on Global Change -- A Closer View*, (NASA, Washington, D.C., January 1988).
10. S.H. Schneider, "The Whole Earth Dialogue," *ISSUES* in Science and Technology IV, No. 3 (Spring 1988), pp. 93-99.
11. See letter to the editor, *N.Y. Times*, January 12, 1988.
12. F.P. Press, "The Dilemma of the Golden Age," Presidential Address to the 125th Annual Meeting of the National Academy of Sciences, April 29, 1988.

13. H. Meyerson (ed.), *Report of the ISY Mission to Planet Earth Conference*, 29 April-1 May, Durham, N.H., U.S.-ISY Association, Washington, D.C.
14. R. Kahn, "Coping With All the Earth Science Data," EOS, 69 (1988); pp. 609 and 612.
15. U.S. GOSP Interagency Working Group, *The U.S. Global Ocean Science Program: A Strategy for Understanding the Role of the Ocean in Global Change*, (Joint Oceanographic Institutions, Inc., Washington, D.C., October, 1987).

Megan Ballliff: You mentioned that due to the limited funding available relative to the scope of the problems we are facing, there is a need to set priorities; I wondered if you had an opinion on how best to proceed in setting those priorities, who's responsibility is it to set them and/or what type of cooperation do you feel will be necessary?

Thomas Malone: Frank Press, in his address to the National Academy in April, 1988, has set forth a point of departure for the discussion of priorities. Not everyone agrees with his thesis, on his list of priorities. I have indicated the priorities within the program; that does not respond to the priorities within all of science. My own thinking is not yet clear. I think it is hasty to try and set a blueprint. I would say this, though, that not only is it priorities within the scientific enterprise but it is really priorities within the discretionary part of the total budget. We cannot argue for a larger retained share of that segment unless we have priorities in our own little part of that segment. Frank's notion was very good. It needs to be expanded to embrace the other sectors in the discretionary portion of the budget. We've got to get our own house in order before we take on that larger task. It must not be a self-serving task. There must be a persuasive case for the role of scientific and technological progress in societal affairs.

I haven't answered your question exactly. I have indicated that a point of departure has been established and we should build on that.

Jack Botzum: A few years ago in Virginia -- I won't further identify the site -- I attended a meeting and after a set of remarks somewhat similar to yours the gentleman who had been dozing in the front row woke up and said, "But what about the mosquitos?" Your point of linkage between the natural sciences and social sciences should not be forgotten. I would only emphasize, who are we saving the planet for? How many people can the planet support? What kind of people? And I don't want an answer to the question. [laughter]

John Knauss: My impression is that this planning has been done primarily by ICSU [International Council of Scientific Unions] type organizations to date. At what point, if ever, do you see involvement of the United Nations-type apparatus, the World Meterological Organization, UNESCO, IOC and FAO? Do you see the organization developing primarily through the non-governmental groups with which scientists are more comfortable to work, or do you see a role for the United Nations operations in this development?

Thomas Malone: We must have both. When we set up the Global Atmospheric Research Program the basic idea came out of the non-governmental scientific community. We recognized early that it had to be done with and through governments, so we worked out a treaty between intergovernmental WMO and the nongovernmental ICSU. Then we got into climate change and we had to work out a treaty between UNESCO and ICSU. I participated in those treaties and I shudder at the thought of trying to set up a whole set of treaties, but we must involve the intergovernmental organizations.

It may be that UNESCO in its reincarnation will be that, I'm not sure. It remains to be seen what Dr. Mayor and company will do there.

To answer your question, you simply have to bring together the intergovernmental organizations and the nongovernmental organizations. The intergovernmental organizations have a logistical capability, a stability that the slender reed of nongovernmental organizations do not have. That is, in my mind, one of the big challenges and I refer you again to the little book by Mr. Gro Brundtland and the World Commission on Environment and Development which very astutely addressed the deficiencies of international organizations, both intergovernmental and nongovernmental. They primarily are sectoral, and disciplinary, and that is why I insist that a high priority is the examination of the international institutional structure. You have got to have governments involved. How are you going to get data out of the developing countries unless they feel they have some voice in it? So, yes, you've got to have both and it's a tough problem. And it is one that the scientists don't naturally cotton up to. They are not interested in those things, but without it you're not going to get the science.

Roger Herrera: I think you just gave me the answer to my question. You talked of the necessity of a balance between impulsiveness of the activist and the caution of the scientist. I was going to ask you where you put the governments in that equation.

Thomas Malone: Right in the middle. As we witnessed in the Montreal Protocol, unless the governments get together on these global issues you're not going to get any action -- the activists shout from the rooftops, the scientists say we're not ready yet, we need more information, and nothing is going to happen until your governments get involved. That is another reason to underscore Johnny Knauss' point that unless the governments are involved with this program in the development of the knowledge base they're not going to be able to make the decisions. And the policy decisions are going to be made by governments in this era of national governments. Does that answer your question?

Thomas Malone: A drought is one manifestation of the kind of perturbation either natural or anthropogenic. The kind of international cooperation which the oceanographers, the meteorologists, the biologists with an IBP program, the judicious blending of intergovernmental and nongovernmental efforts in these major programs, I think offer a pattern of how we can do this. It is more difficult to bring in the space dimension because, sure, there is a COSPAR but that's a nongovernmental thing. There is a tendency to fashion bilaterals to handle space technology and sciences. In my opinion that is not enough. The drought is one manisfestion of environmental perturbations which exacerbate the pressures on the global life support system which has to support more people, more agriculture, and more industry. That is what we've got to address, and I think that the Brunotland report is important. It was a U.N. driven report but funded outside of U.N. sources. It is a superb document, and I think it nailed down once and for all the inextricable link among economy, ecology, and international security.

Marine Science in the 1990s: Global Change and Its Implications

Robert Corell
National Science Foundation
Washington, D.C.

Introduction

It is a pleasure to be here and an honor to share this platform with Dr. Thomas Malone.

Our planet clearly is changing. Its environment is changing in ways that we do not understand, and yet I, like Tom, hold a very optimistic view that we stand on the threshold of an unprecedented opportunity to understand the far-reaching implications of not only the natural processes that dominate global change, but how we humans who live upon the face of the earth contribute to its changing environmental condition. So from a National Science Foundation (NSF) perspective a comprehensive study is truly within our grasp. I wanted to share with you some of the perspectives that I had gained in the last years as we looked together at the Washington scene and throughout universities at this question.

The Evidence for Global Change

Two very remarkable things have happened. First, global scale and environmental changes are clearly evident, and they are observable. As a result we scientists continue to ask ourselves: "Is the evidence demanding?" The evidence, in some cases, is. We recently held a conference at NSF that allows us a better understanding of some of the biological implications of the ozone hole, and for that matter some suggestion of what ozone depletions in the upper atmosphere of the northern hemisphere already documented hold for the future. We also learned that there is now evidence of mounting development in the Arctic for somewhat smaller changes. We know and have studied the El Nino, the southern oscillation. That is unquestionably documented. We are beginning to get some understanding of the process of the El Nino. There is a marvelous paper in a recent issue of *Science* that begins to get a handle on what are the underlying physical and chemical phenomena that create the El Nino. Plate tectonics and ridge-crest processes dominate the ridge axes of the ocean and contribute significantly to its water chemistry and to its heat balance, and certainly to new and exciting discoveries about the nature of life.

The greenhouse effect is clearly a dominant factor of life in the Washington scene. We certainly know that CO_2 is rising, as Bob Duce mentioned earlier. We have the record at Mauna Loa. We have similar records of methane concentration increases. Theoretically we know that the greenhouse effect is likely to contribute to global warming. On the other hand, the direct evidence of global warming is somewhat further from our grasp. There are some data sets that suggest that the sea surface temperature is rising. Theoretical models strongly suggest that is likely under the conditions we see. So the evidence is coming. On the issue of sea level rise I recommend you read a recent report by the National Research Council (NRC) on Sea Level Rise. It is a marvelous document that tells you what some of the implications are likely to be for the society in which we live.

From a scientific perspective, the evidence is mounting. The list is long and we are likely to see more. In my view, there will be more ozone holes over the Antarctic. They will have different names. They will cover different regions but we are likely to see more of those kinds of developments as the complex mixture of natural and anthropogenic processes work together to change the character of the earth on which we live. We are likely to see climate changes, changes in the nature of the protective environment, of the envelope of atmosphere in which we live. We will see redistributions in coastal regions as sea levels rise and fall. It is likely in time scales of generations that productivity in agricultural areas will be shifted. In short, the mounting evidence is there.

The Magnificent Convergence

At the very same time that these global scale processes are becoming more evident and more dominant in the environment in which we live, science has matured to the point where we can be so presumptuous as to think we might tackle the problems. Particularly our sciences of oceanography, atmospheric and earth science, have matured dramatically, over the last two decades, not only in the infrastructure of the intellect that we are able to bring to the problem, but also in the tools at our disposal. We now have pervasive observational capacities, i.e., satellites and super computers. I would also add the personal computer to that list. Most of you have upon your desk a personal computer that has changed the character of the way you do science and even type letters. With these and other advanced sensing systems we are able to get a larger scale understanding of the nature of the globe, including the three dimensional character of both the atmosphere and the ocean. These things have come together at what is likely to be a fortunate time for all of us when we need to be able to address the mounting evidence that there is global change taking place. So as the sciences mature we have a mature scholarly framework within which to work. We have worked out new methodologies that have been proven and we have advanced tools to tackle the problem.

There is a second convergence that is also occurring in my mind; that is the joining together of the science community with those who have to deal with policy questions that affect the very nature of the societies in which we live. It is no longer a convergence of convenience where it would be nice if policy and science worked together to include the social sciences in the policy framework. It is no longer a convenience of convergence but a necessary convergence. It is imperative that these two communities work together. From a policy perspective legislators, political leaders, and governments are taking action. The World Climate Research Program was established and supported through the Intergovernmental Oceanographic Commission (IOC) and other mechanisms to undertake things like the World Ocean Circulation (WOC) experiment in the Tropical Ocean-Global Atmosphere Program (TOGA). The U.S. has established the National Climate Program. A Global Climate Protection Act was passed in December 1987, in which words like stabilize, mitigate, i.e., do something about the changes that are occurring in the climate, were found. One of my colleagues at the National Oceanic and Atmospheric Administration (NOAA) asks "Stabilize? Control the climate?" Those are the words in the Act, and whether you like the words or not there is great concern on the part of our political leaders that we address these kinds of questions. If we look to the international scene we certainly can make a comment about the scientific input into the

Montreal Protocol for the reduction of chlorofluorocarbons (CFCs). It is an important convergence that science now has the capacity to address global scale problems and policy needs of government and institutions to address those concerns. There are high expectations for the science community as well as great demands coming from the policy sector.

The study of global climate is now a process that is being undertaken more aggressively by the World Meteorological Organization (WMO) and the United Nations Environment Program (UNEP). Some of you know that a governmental panel is in the process of being established among the nations of the world through WMO and UNEP to do an assessment, much like what was done for the CFC/ozone problem, on a more pervasive scale. Two or three years from now there will be a report that will give us a better scientific understanding of what the global patterns in the decades ahead are likely to be. In short, the policy demands are current and science is expected to move aggressively to address the scientific questions, so that a fuller predictive capability becomes a way of life in our environmental sciences.

Implications of Action

What are the implications? I think there are profound implications for those of us from the academic community. We are going to see changes in the very culture and the way in which we do science. The questions of interest are no longer at the central heart of any one discipline but lie at the boundaries of the interfaces between disciplines, at places where we have not yet developed the language to even begin to understand each other's way of thinking. Some of us grew up in deductive disciplines, others in inductive disciplines, and still others describe the world taxonomically. Those disciplines need to come together so that action will create a cultural change in our institutions, particularly our universities and research laboratories. That coming together will make some changes in the institutional frameworks within which we support science. It is no accident that oceanography exists here on Narragansett Bay. It was cultured and nurtured, bringing together physicists and biologists, and chemists, and geologists, in a framework that allows them to look in a more comprehensive way at this total arrangement called the ocean. The expansion of that idea, borne here and elsewhere in this country in oceanography, is going to find its way where we bring the ocean in contact with the atmospheric sciences and solid earth science. Much of what we are interested in occurs at the boundaries between ocean and atmosphere, between ocean and land, and between land and atmosphere. In fact, to use this institution as an example: the Dean of this institution is an active participant and scholar in the field of atmospheric chemistry. His leading an institution of oceanography is a hallmark of the future.

On the policy side, the caldron within which policy is developed is going to be expanded to require a much broader role of the scientific community. Dr. Malone suggested that we, the science community, could no longer escape the responsibility of participating actively and aggressively in science policy development. I hope to suggest later in this talk that that is not just a theory but is already beginning to happen in this country and elsewhere. Changes in our international institutional infrastructure are going to take place. Think about it. We want to study the globe, but let's take the ocean for an example. We want to study seven percent of this ocean and understand how the ocean circulates, i.e., the world ocean circulation and experiment.

How do we accomplish that? NSF, NOAA and a few others could put some dollars and ships on the table, but that won't begin to address the magnitude of the problem. We have to join forces with our brother and sister nations in bringing the resources to bear. It is hard enough to get the U.S. Congress to work at the same time as the budget is developed here to get a job done, never mind reach across international boundaries. Yet, I think it is going to happen. It is slow, it is tedious, it is difficult, but I remain very optimistic about our capacity to pull it together because the driving force is now understood by virtually all of us, in both the science and the governmental communities. We no longer have the luxury of wanting to do it, we have the responsibility that we must do it. Those actions will introduce some changes in the infrastructure of how policy is developed.

The National and International Agendas: Science and Policy

Let me take you on an adventure through what is happening in Washington. Someone asked me if I wrote my speech last night and I said yes and the reason for that is that some things are happening on the time scale of days that I thought you'd be interested in hearing about. Also, because it bears directly upon this issue of how the United States is one of many who are going to work together to address the question of understanding global change. The International Council of Scientific Unions (ICSU) established the leadership in the science community by creating the International Geosphere/Biosphere Program (IGBP) in 1976; however, the seeds of the global change program within the U.S. had long since been planted and were growing in the National Academy of Sciences and within the agencies. For example, at the same time ICSU was bringing IGBP to the international scene, the National Science Foundation was bringing into existence its global geoscience program which was designed to put the funding into the hands of U.S. investigators to address the problems of global change.

In the spring of 1987, the National Academy of Sciences of the United States appointed a committee on global change to serve two purposes: both to be the U.S. expression of the IGBP program and participate from that perspective in a larger international interest, but at the same time to help the United States define the key scientific questions that were going to drive a global change program in the United States. In parallel with that the President's Science Advisor appointed a Committee on Earth Sciences (CES), a committee whose job it was to bring together the 12 federal agencies who were concerned with the U.S. global change programs. It is called the Committee on Earth Sciences simply because it was the only name that encompassed all the environmental sciences: earth, ocean, atmosphere, and solar-terrestrial interactions. Federal programs were being built and put in the budgets. As a result there has been a ferment over the last couple of years of developing activities, guidance mechanisms, coordinating bodies that would allow, somehow, the United States' science community and federal agencies to work together and produce an effective effort.

However, it wasn't until the spring of 1988 that we started to look seriously at how we were going to accomplish that goal of coordinated work. We soon learned that we had some language problems. We were calling it a global change program, we were calling it IGBP, we were calling it an earth system science program, and so on. The agency heads got together and agreed that a common language was needed as well as some common definitions, and set out to develop them. On the 23rd of June, 1988 we will put forth a document toward that end that has been

approved and endorsed by the National Academy's Committee on Global Change, the Committee on Earth Sciences, the Office of Management and Budget (OMB) and all 12 federal agencies which are going to use a common framework for the program in global change.

Let me give you some of its ingredients. First, there is an overarching definition and I assure you that getting endorsement by federal agencies and OMB of an ICSU document that describes global change was no simple task. It included seven elements to describe the scientific content of the global change program in the U.S. For example: to learn about the geochemical dynamics one must include the study of sources, sinks, and the interaction between mobile biogeochemical constituents within the earth system with a particular focus on water, oxygen and other key elements including carbon, nitrogen, sulfur, phosphorus, and the halogens. For each of those seven elements there is an extensive definitional framework to outline what are the scientific ingredients that when coupled together form the U.S. global change program. We have defined a basic research program as one that not only concerns a major long term observational effort, but also includes a program to address data management. I use data management here in the largest sense, from the quality control of its acquisition to its archiving in a fashion that is easily accessible by the science community. That document will go forth very shortly to set the working framework for the U.S. global change program.

That isn't all, as you well know. WMO and UNEP are working on the development of a global climate intergovernmental panel arrangement so that that program can move forward. IOC has already had its discussion of this matter and at its next meeting in March, 1989, will move very aggressively on a number of fronts relating to the global change program. Other nations share one concern about how we put together this type of international program in a rational and effective way. What are the budgeting strictures? How do we coordinate things like ships, computers, satellites? There was a meeting in New Hampshire a few weeks ago on an international satellite program that was remarkable. Seventeen nations got together to talk about a global-earth observing system. You are going to see more and more of this type of cooperation. Those nations with strong scientific interests are addressing this question seriously. We will see more of the WOCE/TOGA type programs put together by the science committee integrated with the intergovernmental framework within governmental frameworks so that we can address a number of those questions that I suggest in this list of seven that have not yet been fully explored.

I'd like to mention some of the types of scientific questions that are included in the document. Some of the science policy questions that will drive the interagency arrangements on global change on the timescales of decades to centuries are: what activities do we need to pursue to improve our understanding of global climate change, that is, global warming, ozone depletion, drought, interactions between the oceans and the atmosphere, uptake of heat by the ocean, variation in sea-ice clouds, land-sea vegetation, etc.? There are a whole host of these types of questions that then underpin each of those seven areas. We can now get to the question, "How do we begin to sort out the priorities?"

The science will help us do that. We in the science community believe that the scientific issues have to drive the priority questions for the simple reason that there are some pieces of science that are absolutely essential to unravelling the onion of understanding, and

those that can be must be addressed first. There are others that we can't yet tackle.

I would like to share with you a broader discussion of that scientific framework. What do we expect to come out of this interagency effort? Let me just point out a few things. Planning will be done on a joint basis. We now have a definitional framework. We are already developing coordinating plans, like the U.S. Global Ocean Science Program which was documented and circulated last fall. Documents of that nature will be produced in time. The document on groundwater is under preparation and others are being planned. There will be joint implementation strategies. We already have the beginnings of those for the World Ocean Circulation Experiment for TOGA and others will follow for both international and national programs. Coordinating mechanisms at various levels, from program officers to agency heads are now being established to mount the federal effort to plan and execute this program. We are going to undertake, across agencies, the joint assessments necessary to underpin science-policy requirements such as under the Global Climate Protection Act, to achieve a thorough understanding before starting the mitigation process.

I suspect, before the turn of the year 2000, that we will clearly have protocols of the Montreal-type involving other areas of the global climate issue. I doubt whether we will be able to handle the global climate in one pervasive Global Climate protocol, but I think elements of it will fall in place around such things as CO_2 or methane or any number of integrating ideas. We are also doing budget planning. We have all the budget examiners for the 12 agencies working together (quite a feat) so that when we go forth with our budget initiatives they have some meaning, some understanding about how NOAA, NSF, National Aeronautics and Space Administration (NASA), Environmental Protection Agency (EPA), Department of Energy (DOE), and so forth work together. This allows our requests for budgets to have some meaning in comparison to the others. As a result, we are going to have fully coordinated OMB cross-cuts including coordinated budget plans.

And finally, a word or two about policy issues. We are in the final phases of putting together a set of national machinery to deal with the global climate policy problem. It is too early to give you exactly what the framework will be but two principles have already been agreed to by all the parties. The first is that the science will be connected but separate from the policy issue in the sense that it can be driven by the science itself and not be driven by the political aspects often underpinning policy questions, and yet so well connected that policy will be a natural evolution of the scientific assessment. That science will be linked through things like the Committee on Earth Sciences, the National Academy, the President's Science Advisor and the Office of Science and Technology Policy (OSTP), etc. Put simply, the machinery of this nation from the Academy to the troops who do science in American universities and laboratories around this country are all going to be linked into that process.

The other principle is that the policy side will similarly be linked to the policy machinery, i.e. from the Office of the President, things like the Domestic Policy Council, and other sets of machinery that are established by this administration or others to handle policy development issues will be coordinated through OMB, and again OSTP, and so forth. In a few months, maybe a few weeks, we will be able to prepare some new flow diagrams that show exactly how it will be done. It will have much of the flavor that we, in the science side of the house, have

evolved for ourselves where we have brought policy and science together in some fashion to allow us to put forth reasonable policy directives.

Relationship to the Law of the Sea

"What does all this have to do with the Law of the Sea (LOS)?" one might ask. I think it has a tremendous relationship to the agenda that this body has addressed itself to in all its years of existence. First, it is an appropriate environment in which we can think together about the problems that we are going to face in the years ahead. It is a marvelous intellectual framework because it brings science and policy and international affairs together in a rich environment of discussion and discourse. More specifically, however, the freedoms of the seas for scientific research are clearly an issue. I'll call it the 28th percent profit. Everybody talks about the 200 mile zones covering some 40 percent of the oceans. I like to think of it as about a little more than a quarter of the surface of the earth are within the jurisdictional arrangements and the proclamations of Coastal States. To understand global processes we clearly can't leave out 25 percent of the face of the earth. More importantly, some of the richer energetics that occur in global processes occur where land and sea and atmosphere interact. I need not remind you that the great Gulf Stream and other major currents in the ocean are almost all within those jurisdictional boundaries. Much of the productivity that the world knows about occurs within those boundaries, so getting to the heart of scientific questions clearly is going to be done within those margins to a large measure. Also, working across international boundaries will be extraordinarily important to this issue. Those problems are not all resolved as Ambassador Nandan indicated, but I think this kind of scientific and international policy agenda will make it easier for us to address those issues of jurisdictional arrangements for scientific research, particularly because the imperative is there. All of us need to understand the nature of the changing globe. Therefore, I think the 28 percent problem is going to, if not disappear, become less of a problem. In the short year that I have had in this office, I have already seen good signs to suggest that jurisdictional problems are going to be reduced as we work together on the global change agenda.

Conclusion

I conclude by saying that the LOS is one of several caldrons, within which we can think together, nurture our ideas and stimulate the considerations of how we deal with global change. It is likely that there will be conferences in addition to those on the Law of the Sea, perhaps conferences on the Law of Global Environmental Issues or the like. I suspect it is the only way we are going to be able to get at some of the policy matters that will derive from our scientific understanding. The patterns of cooperation are here. The time for doing it is not far off and I suspect that we, who have long had an interest in the ocean, are going to be joining our earth and atmospheric science friends in trying to address this larger issue of global change.

Dale Krause: I would like to make a statement. I found the talk very interesting. It seems to me that the kind of framework that you have discussed -- let us say it is a natural evolutionary step from what has been going on, but it is a major evolutionary step. It frames the question about international jurisdiction, about international cooperation, particularly about the relationship of science and policy in a different way than it was, as you say, a year ago or six months ago, when I listened to discussions in the U.N. and between the various agencies on regional seas conventions and so on. This is a very good way of thinking about them and it is a natural step in the process. We just had a meeting last week in UNESCO looking at the future of marine science. All the participants pointed out the gap between scientists and decision makers, scientists and policy. We are going to look forward to this document with a great deal of interest because I think this kind of approach is very badly needed all over the world.

Jack Botzum: You are of course very optimistic this morning. You get all your OMB examiners into one room and indeed it's something that is unique. There is a danger in that, Bob.

Robert Corell: Oh, amen.

Jack Botzum: Aren't these guys -- and aren't you helping them -- going to suck up all the money that's available for these grandiose programs? Where is the small scientist, the guy who has a particular project that he wants to work on and he would like to be left alone to do it, fit into your picture?

Robert Corell: There are maybe two answers. First of all, at NSF -- and I can really only speak for them -- we are committed to an adherence to that philosophy which you are asking about. Science really grows in the minds of individuals and when we structure programs we keep that foremost in our minds. NSF funding, as we project over the next five years, and we have done this projection -- will increase both in real dollars and in percentage of its support to individual investigators. The second observation I would make, which is really a turn on the same idea, is that many of these programs really have at their very heart individual scientists because we operate at NSF and elsewhere in this country in a competitive grants arena. How do we get at the methane coming out of the marshlands? It is usually an individual scientist and two or three of his students going out and really understanding that process that becomes the molecule out of which we make the larger projections about how things happen. It's a danger; we're worried about it, we think about it, it is inherent in our planning. With respect to OMB, I said "amen," and there are dangers and they're real. But when we took a good hard look at it the down sides were significantly worse in our minds. By working together building a team of those who manage the budget, those who establish overall U.S. science policy, and that's a very complex process even if you agree there is one, we think that we may have a chance to treat this in a rational and reasonable sort of way. I am impressed by the commitment at all of these levels of our federal government to try and be rational and reasonable about it. I haven't

seen it -- getting those examiners I thought was really going to be a very unusual scene. It was really a remarkable experience. I had the privilege of making the presentation to them and they had very very good questions, as good questions as you'd find asked by any of our scientific audience. Some of those folks are extraordinarily well trained in science and ask even more difficult questions than we ask of ourselves.

David Ross: Perhaps it is premature to ask the question, Bob, but in the wiring diagram everything is so closed on itself. I was curious what your perceptions or feelings are: who's going to run this thing? Where is the leadership going to come from? Who is going to coordinate it?

Robert Corell: There is a great sense of shared leadership. Each of us sees increasingly the role we play in that diagram, and I think your observation of a certain circularity is correct when it comes to doing a science assessment. Right now we are talking about how we are going to do the global climate assessment, which we have to do on the time scale of eighteen months by law. We're bringing together the best of the scientists from government, NCAR, and individual laboratories. And out of that emerges an individual who will lead that effort. There is a cadre of a half a dozen folks in D.C. who have agreed that there is no lead agency but we all must lead together. I suspect, David, you are going to see people popping out who will play various leadership roles. It will be a conscious effort to be certain that that happens, but together it is going to be managed through these pieces of machinery. Dallas Peck will be very visible because he is chairman of CPS on occasion. Hal Mooney will be very visible because he is chairman of the Academy Committee, and so forth. But it's a good question, David, and we have thought long and hard about it because there is a propensity to want to create a kind of a lead agency or lead effort, and we are trying to avoid that because we think it's going to work a lot better the other way.

Technology and the Law of the Sea
(A Twenty Year Reprise)

John P. Craven
Law of the Sea Institute
University of Hawaii

The author has been pontificating in public since 1958 and in print since 1966 about the effect of technology on the Law of the Sea. The time scale of these predictions was unlike those of Nostradamus and as a result these predictions and those of his colleagues have already come home to roost. Rationalization now suggests that the technologists of that decade were not altogether wrong even though the legal community seized upon technical mis-predictions and misconceptions as the basis for negotiation of substantial elements of the law of the sea. At the first annual meeting of the Law of the Sea Institute, Willard Bascomb stated,

> I should perhaps note that in our search for underseas minerals we began at the top of the scale with diamonds and then we descended through platinum and gold, tungsten, tin and we are getting down to the lower levels now. I think we may never get down to manganese nodules.

At the second annual conference of the Institute John Mero (he of deep seabed minerals fame) gave equal prominence to ocean thermal energy (and its associated artificial upwelling) and the manganese nodules. He predicted economic viability for one or both in from "ten to twenty years" (i.e., 1976 - 1986). Students of fact and logic will agree that it is correct to say that both were right.

The community prediction, however, focused on manganese nodules and disregarded deep ocean water as the major resource of the open ocean. The legal effect of this mis-prediction is thoroughly discussed in a previous paper[1] and is not relevant here except as it sets the stage from which we can courageously and rashly make another attempt at predicting the future of the law of the sea on the basis of the technology of the sea. Our point of departure, the current status of the law, is as clear and well defined as international law has ever been. For one reason or another nearly every nation of the world, including the United States, acknowledges that with the exception of Part XI, the words of the UNCLOS III text are a definitive statement of the international law of the sea. Indeed, such anomalies as the current United States position on tuna is argued as being in conformance with Part V, Article 64, of the Convention. If it is true, as this paper hypothesizes, that much of this nearly universal consensus code is incompatible with the technology of today and of the near future, then it would not be rash to suggest that this universal text will require revision. If so, it is most appropriate, then, to examine the current state of technology and the developments in technology in light of the rights and duties which are enumerated in the text, and in particular, the enforcement of these rights and duties.

The Territorial Sea and Straits Passage

The primary issues having a technological component in Sections 1 and 2 (Limits of the Territorial Sea and Innocent Passage in the Territorial Sea) are those which are related to warships, submarines, nuclear powered ships and ships carrying nuclear or other inherently dangerous substances. The driving international factor is in the evolution of techniques for arms control of strategic nuclear weapons. The recently concluded INF (Intermediate Range Nuclear Forces) Treaty provides for continuous inspection by teams of the USSR and the United States in each other's territory. The technological need for inspection stems from the technological fact that the readiness state of strategic nuclear weapons is essentially instantaneous and there is no credible way (short of deployment beyond verifiable range) to provide assurances that a strike first posture is not intended. There is still a significant factor of range dependence and in particular if some form of "thin shield" ballistic missile defense and cruise missile defense is deployed by a threatened nation. Thus a ballistic missile or cruise missile defense is completely nullified by nuclear capable ships or submarines operating within or just outside the territorial sea or beyond the 200 mile EEZ (which by Article 88 is reserved entirely for peaceful purposes). We must conclude that bilateral or multilateral agreements will be concluded in the near future which will include as a component inspection and range control of nuclear capable ships and submarines. Coastal States which are not parties to such agreement will feel threatened unless they can participate in the monitoring and enforcement of such arms control agreements.

On first inspection it would appear that coastal States do not have such a right under the terms of UNCLOS III. As the record of UNCLOS III shows, the maritime nations maintained as a highest priority item the right of innocent passage of warships, nuclear powered ships, and ships carrying nuclear or other inherently dangerous or noxious substances and transit passage through straits for ships aircraft and submarines. On its face the Treaty appears to accord the maritime nations that right. But Article 19, para. 2 cites twelve conditions which are prejudicial to the peace, good order and security of the coastal State of which at least five, (a) (b) (c) (d) and (i), are subject to interpretation by the coastal State, or may require inspection by the coastal State or other authority. Chen Zhizhong of the Peoples Republic of China has stated:

> On the second point, (exercise or practice with weapons of any kind) it is immaterial whether the water is territorial sea or not. It all depends upon whether the exercise gives rise to a threat to the coastal State. With modern military technology a threat to a coastal State can occur no matter the distance of the ship from the shore, within 12 miles or beyond 12 miles. Even if a warship passes through the EEZ it can also give the rise to a threat to the coastal State, under the modern technology of the military. So in this case I think the situation may require change. If the coastal State is strong enough to control the security along its coast they can allow passage, but can ask for notification.

In other words any modern military warship automatically falls in the category of a ship engaged in the exercise or practice with weapons of any kind unless some assurance is provided in the form of inspection or notice.

What are the technological conditions which reinforce these notions on the part of coastal States? First, the maritime States have, on a number of documented and publicized instances, employed submersibles in violation of international law to enter the territorial sea of coastal States for the purposes of collecting military intelligence. The technological difficulties associated with detection and surveillance of such craft are such as to lead to the belief that only a small number of such violations of territorial sovereignty have been detected, and to lead to frustration with respect to enforcement when the intruder has successfully evaded the detector. Second, the readiness condition of modern weaponry is such that it is virtually impossible to ascertain if the warship is posing a threat of use of force or is engaging in "any exercise or practice with weapons of any kind." Third, the doctrine of strategic deterrence is one which has been enunciated by a number of the maritime nations. "Showing the flag" takes on a new meaning when the warship is known to be nuclear capable, and in particular, when it possesses a nuclear cruise missile capability (non-existent at the time that UNCLOS was negotiated). Is the mere transit of a territorial sea which is not required for a warship to conveniently transit from its port of embarkation to its next port of call, thereby an "act of propaganda aimed at affecting the defence or security of the coastal State?"[2]

Quite obviously, it is the coastal State which makes the determination that the foreign ship is engaging in one of the prohibited activities, and if that determination is legally correct, then the coastal State "may take the necessary steps in its territorial sea to prevent passage which is not innocent".[3] Quite obviously the law as now written is fraught with the potential for incidents such as that experienced in the Black Sea or in the Gulf of Sidra. This is particularly true in the territorial sea where warship immunity is suspended when engaging in any of the prohibited activities of Article 19 or when not in compliance with the laws and regulations of the coastal State made pursuant to the Treaty as stipulated in Article 30.

Two other aspects of passage through the territorial sea which will become increasingly vexatious and unacceptable to the coastal States are the transit of commercial ships which are nuclear-powered or which are carrying nuclear materials, and the transit of warships which are carrying nuclear missiles and which are otherwise the subject of arms limitation and arms control agreements. Two treaties in existence which establish nuclear free zones - the Treaty of Tlatelolco and the Treaty of Rarotonga - do allow transit through the territorial sea by nuclear-capable ships, but prohibit the entry into port of such ships by any of the contracting parties and, in the case of the Treaty of Tlateloco, by any of the signers of the Protocols.

In any event, it is suggested that requirements of arms control will necessitate some form of inspection and notification requirement for ships and submarines which transit waters within some verifiable range parameter of the nuclear weaponry and that this range will, in general, be considerably larger than twelve miles. Non-military ships which are nuclear powered or which contain dangerous nuclear materials will similarly require monitoring and notification when traveling within ranges of the coastal State that are small as compared with the radius of toxic influence in the event of an accident.

The Contiguous Zone

Article 33 rests on the technological presumption that within a twenty-four mile margin of sea the coastal state is able to:

> Exercise the control necessary to a) prevent infringement of customs, fiscal immigration or sanitary laws and regulations within its territory or territorial seas.

Even without utilization of modern marine technology the prevention of the illegal import of illicit substances and persons has not been successful. The profit from these operations has been sufficiently great that smugglers of drugs have had no hesitancy in employing high-speed watercraft, aircraft and other sophisticated transport equipment, even at the cost of abandonment of these transport vehicles after a single successful voyage. The inability of a nation as powerful as the United States to cope with the seaborne traffic within the context of the contiguous zone is such that the intercept, search, and arrest of foreign flag ships takes place at distances from the coast of eighty or more miles. Court decisions have uniformly supported the authority of the Coast Guard in such searches and seizures under authority of 14 U.S.C. sec. 89(a) and 19 U.S.C. sec. 1581(a). Most recently, frustration has resulted in the age old practice of taking "prize" on the basis of technical violation, presumably as a deterrent to more serious violations of the law.

While these techniques may prove effective for such innocents as the Woods Hole Oceanographic Institution or Souse Brothers Interisland Tug and Barge, professional smugglers will not be deterred and have only just begun to employ modern marine technology. High speed "wave piercing" surface craft are currently in use and have required the enforcing authorities to acquire similar craft for the purpose of chase. The first entry into the realm of underwater technology has been uncovered in the use of canisters with transponder beacons which are jettisoned in locations known to the smuggling team and which are retrieved by coded signal. Unsophisticated interisland and coastal sea transports of illicit substances take place routinely in Hawaii via canoe, and with swimmers aided with swimmer-support craft (sail boards, surf boards, Hobie cats, etc). The new technology of remotely-operated unmanned vehicles has just arrived on the commercial scene. It is only a matter of time (a short time) before the underwater delivery of illicit substances in unmanned submerged vehicles is technically and economically feasible. Legitimate uses of small commercial submersibles are already appearing in the form of tourist submersibles, work submersibles, and research submersibles. The intermingling of these legitimate transports and illicit transports will make enforcement impossible unless there is a readily available means of distinguishing between authorized and licensed underwater vehicles and unauthorized vehicles. Although it has long been thought that it has not been technologically feasible for submersibles to fly a flag and to give proof of documentation the technology of low-cost pingers and transponders is well developed. One can confidently predict with little fear of contradiction that in the near future underwater vehicles will require licensing and will be required to carry license-coded pingers. One can predict with some fear of contradiction that unlicensed and non-acoustic responding submersibles will be assimilated to the class of ships without nationality. One who has studied the history of technology and the law of the sea can confidently predict with the absolute assurance of emotional contradiction that nations will

soon weary of costly ineffectual intercept, search, and seizure of documented vessels on the high seas, and will readopt the principles of the Treaty of Paris that free ships makes free goods, and, as in the past, port state enforcement in the port, hot pursuit in the territorial sea and contiguous zone, and suppression of piracy on the high seas will be the residual remedies for the interdiction of illicit cargoes.

The Exclusive Economic Zone

It is in the Exclusive Economic Zone that technology will play the most dramatic role in the modification of the nature of the envisioned regime. Drafters of the convention believed, with good reason, that the primary resource of the EEZ was fish, and that the regulation of conventional fishing, conservation and allocation of resources was the primary substance of the regime. It was the perception of Dr. Alastair Johnson of the Marconi Corporation to note that the primary resource of the ocean is the deep ocean water itself and it has been the perception of the Japanese as expressed by Dr. Kenji Okamura that an equally important resource is ocean space and ocean space utilization. (It was suggested that the author moderate his views on these technologies - this is analogous to asking General Billy Mitchell to speak on the role of airpower as a means of delivering the mail).

The primary resource characteristic of deep ocean water is that it is cold. Of nearly equal importance is that it is rich in nutrients and that it is biologically pure (only a few diatoms). To understand the fundamental significance of the value of cold we should understand the fundamental nature of natural productivity in any given micro climate. Each sub-region of the earth operates as a heat engine, with transports of heat coming from solar irradiation, convection through the transports of fluids such as the gases of the atmosphere and of the water in the form of atmospheric moisture, river flow, and oceanic transport. At any moment in time, however, the efficiency of this heat engine is given by the Carnot efficiency $T_1 - T_2 / T_1$. In desert regions where the air and ground are at the same temperature $T_1 - T_2$ is very small and the region is unproductive. In the temperate zones in the springtime when the warm spring sunshine interacts with the cold runoff from the mountain snows $T_1 - T_2$ is large and as a result there is evaporation, condensation and rain, and of equal importance is the photosynthetic process, which generates sugars as well as starch and proteins when the root zone is cold and the leaves are warm. Similar periods of productivity are associated with autumn. In the low tropical islands exposed to trade winds the surface of the ocean water is a cold plate and as a result the temperature of the atmosphere does not decrease until an altitude of about 10,000 feet is reached. The resulting inversion layer prevents the formation of rain. The isothermal character of the land mass and the adjacent fluids (land and water) is such that there is little natural productivity. When there are high islands and winds, such as trade winds, the moist atmosphere is lifted into colder regions and "orographic" rain is produced. The production of rain is a mechanical process in which the heat energy of the environment is converted to mechanical energy to raise the water from the ocean to the top of the mountain. Once again $T_1 - T_2$ is large as a result of the vertical transport of the moist atmosphere.

If now we produce artificial upwelling from the deep ocean to the surface, we dramatically change the temperature differences available to the natural heat engine. In regions where the water has upwelled, the natural productive efficiency of a low island is increased by factors of

four or more, on the high islands the leeward coasts are similarly benefitted and in the open sea, where there is no natural upwelling, an environmental energy potential exists in what is now a vast tropical oceanic desert. The energy required to bring the water to the surface is, of course, minimal, requiring only the energy associated with the density difference resulting from the difference in temperature and salinity between the deep ocean and the surface of the sea. (Indeed the primary energy cost is in the positioning of the deep water in header tanks and reservoirs from which it may flow by gravity to the various facilities).

This realization of the fundamental change in productivity is the cumulative understanding of a wide variety of deep ocean water developments that are taking place at the Natural Energy Laboratory in Keahole Point, Hawaii. We now understand that, with intelligent intervention, it is possible to achieve the natural benefits of eternal spring in the tropical oceanic regions. This means the year-round production of spring crops such as strawberries, lettuce, asparagus, alpine ornamental flowers, etc., the year-round production at maximum growth rates of seaweeds such as nori and ogo, of shell fish such as opihi, oysters, shrimp, and lobster, the year-round production of kelp, abalone, trout, salmon, sea urchins, the year-round high volume production of sophisticated algae such as spirulina, and dunalsetta, and icosopentane. It is possible to achieve the generation of closed cycle electrical energy, without risk of biofouling, with the use of low cost aluminum heat exchangers; the flash evaporation of surface water and condensation with the use of deep ocean water to produce fresh water as a by-product of the open cycle process, the low-cost, non-heat producing air-conditioning of buildings; and the elimination of chill water generators and cooling devices in industrial production. Many of these processes can employ deep ocean water which has already been used or which is yet to be used.

This technology is being followed closely in Japan, Europe, Britain, and Canada. We can confidently predict that various forms of energy and aquaculture plants will be available for the tropical islands in the near future. But the major significance of these developments is the hastening of the transition from fishing to aquafarming and ranching. This transition is occurring most rapidly in Japan where aquaculture now provides about twenty-five percent of their marine protein. The construction of artificial reefs is continuing at a high rate and projects for fertilizing these reefs with deep ocean water are on the drawing boards. The cage culture of salmon in the Norwegian fjords is already a major element in the world's supply of salmon. The ability to produce marine protein continuously, throughout the year, under controlled conditions equivalent to those used in the production of chicken and beef, and at a cost comparable to the cost of animal protein of comparable quality, will displace the competitive fished product, which is the victim of seasonal and annual variations, of the uncertainty of the hunt, of illegal competitors, of the cost of regulation, of the economics of quotas and all of the international encumbrances which make fishing such an interesting and non-profitable operation.

Of greatest significance to the law of the sea is the elimination of the need to patrol large areas of the EEZ for the regulation of the industry. The only fish which has not yet been demonstrated as amenable to aquaculture is tuna. The American love affair with the tunafish sandwich is not likely to be assuaged by a different species no matter how carefully marinated in mayonnaise, but the first marine biologist who solves the problem of tuna spawn in captivity will be on his or her

way to fame as the Marine McDonald (unless, of course, his or her research was sponsored by Sea Grant). It is equally true that the successful deep ocean water mariculture operations will take place in the EEZ. The ranching of bottom fish (or slow growing animals such as lobster) will be most economically conducted in a natural environment enhanced by artificial reefs and habitats. Enforcement in these local areas will not be dissimilar to enforcement on the land ranch.

In any event, proximity to islands for logistic support, for processing, and for transport will be an economic necessity, as will be the need for an Exclusive Economic Zone for the management of these ocean farms. It is in the regime of islands that the Law of the Sea failed to anticipate the rapid pace of technology. In the 1958 Convention on the Continental Shelf, the width of the shelf was defined by that famous phrase "to a depth of 200 meters or to a depth which admits of practicable exploitation". The ink was hardly dry before technology made the depth of practicable exploitation the bottom of the sea. In a similar manner a soon to be equally famous phrase of Article 121 states that, "Rocks which cannot sustain human habitation or economic life of their own shall have no exclusive economic zone or continental shelf."[4] Just as the Continental shelf phrase was suggestive of a depth limit of 200 meters associated with the then existing technology of oil drilling and the limit of economically significant demersal fisheries, so the "economic life" provision suggests a minimum size of rock associated with the technical feasibility of extracting economic income from a remote location in the middle of the sea. Lawyers, no doubt, have had extensive experience since the middle of the 19th century with the legal status of "guano islands." Here the low cost per unit cube of this valuable, for its time, high-tech commodity of modern agriculture suggests a rock like Nauru which has an area of eight square miles. Nature was not so instructive to the lawyers as to produce a diamond-generating volcanic cone which produces Hope diamonds on the top of a ten square foot pinnacle, but technology will be.

The most recent development in this regard is the island of Okinotorishima. This island, which has been described as a "king-sized bed" rock sitting on a two kilometer by five kilometer reef, is located in a portion of the South Pacific not yet covered by an EEZ. The Japanese government has sent an expedition of planners to this island to determine the manner in which it could be developed for economic purposes. The expressed intent is to include this island when it declares its 200-mile economic zone.[5] A primary element of the analysis is the generation of an activity to be conducted on the rock which will qualify as "capable of sustaining economic life of its own." For the past few months the rock has been the locus for a remotely-operated weather station. Other possibilities are as a transfer and repeater station for fibre optic oceanic cables, or as a communications, command and control center for operations in the EEZ. The development of a fishery associated with an artificial reef together with an ocean thermal energy station are other possibilities under investigation. In any event, the Japanese intend to make a considerable capital investment and to act in a manner which they deem consistent with the treaty for the establishment of an exclusive economic zone.

The motivation for this forced development of an accident of nature is another technological anachronism of the treaty Article 60, para. 8, states "Artificial islands, installations and structure do not possess the status of islands. They have no territorial sea of their own and

their presence does not affect the delineation of the territorial sea, the exclusive economic zone or the continental shelf."

The technology for the creation of artificial islands which are geophysically indistinguishable from natural islands is now well developed. A major portion of the Netherlands consists of lands reclaimed from the sea including artificial islands in the North Sea. The stabilization of the Bangladesh delta will require similar developments in the process of which artificial and natural islands will be created by man and by nature as a result of the works of man. These islands will, for environmental, social, cultural and economic reasons, utilize the ocean space surrounding them at distances in excess of those required as a safety zone. Although the current scale of technology will rarely suggest that this zone of ocean space utilization will be as large as 200 miles, there are many current examples (the siting of ocean thermal energy facilities, scientific stations like project DUMAND, artificial reefs for fish habitats, underwater parks, etc.) in which the distances from the port island are of the order of ten to fifty miles. But ocean space utilization does not require the building of an artificial island as its central urban city. The study of stable ocean platforms for urban systems is now more than fifty years old (Armstrong Seadrome 1932, Mulberry Harbors 1942, Triton City 1965, Aquapolis 1974, Ocean Information City 1985). The initial realization is that of Australia's Barrier Reef Hotel. This is a major hotel complex which is based on floating barges above the barrier reef some 30 kilometers beyond the territorial sea in Australia's exclusive economic zone. Located in a reef lagoon, the natural protection against sea states which is thus afforded permits the use of barge construction for the facilities. These include recreational tennis courts mounted on a separate barge facility and a flotilla of recreational craft to carry visitors to the coral reef sites of the Great Barrier Reef Park. Although the concept of a resident population has not yet been established for this community, legislation which provides for municipal governance has already been enacted. The first embryonic elements of other recreational complexes are now appearing in the form of an underwater hotel in the Caribbean and in the proliferation of tourist submersibles in the Caribbean and in Hawaii. Appropriate sites for these submersibles are currently within the territorial sea, but many underwater sites of interest are located well outside of this zone.

This concept of ocean space utilization is being most actively pursued in Japan under both private and governmental auspices. Competition exists between the "Artificial Islands" community and the "Floating Platform" community. The latter is evolving from the stable ship concept. The SWATH (Small Waterplane Twin Hull) or SSP (Semi-submerged Platform) ship has been conceptually available since the mid-fifties but for many years was realized only in the form of the Congressionally unauthorized *Kaimalino*, which achieved legal status as an experimental mobile platform, and not as a ship of the United States Navy.

Its offspring have been slow in gestation due to cultural lag on the part of rugged seagoing oceanographers and naval mariners who relish the challenge of man against the sea. Nonetheless the Japanese have successfully developed and commercialized a 400-passenger ferry, an oceanographic ship, an ocean engineering development and submersible support ship and an executive yacht. The chase boat for the America's Cup trials was a San Diego SWATH (originally the *Soave Lineo*). At long last the United States Navy and the Coast Guard have SWATH ships under

construction and a sophisticated tourist SWATH ship for Hawaii is presently under construction.

This steady, unspectacular, but continuous progress in the development of stable transportation and stable platforms for ocean space utilization virtually assures the existence of a number of floating communities with significant resident populations in the next two decades. For purposes of taxation, regulation of commerce and trade, participation in the political process of the flag state, suppression of illegal activities, public health and safety, the full emoluments of governance must exist for these communities on the platforms and in the area of ocean space which is to be utilized. The generation of oases of municipal sovereignty, which include areas of ocean space in the Exclusive Economic Zone, is a societal necessity of these technological advances. Concomitantly there will be a retreat from the perceived necessity to control the full area of the Exclusive Economic Zone, and large parts of these legally defined areas of the ocean will return to the status or continue in the status of *res nullius de facto*.

The Continental Shelf

The regime and resources of the continental shelf have been established by the precedent set by the Truman Declaration and the Outer Continental Shelf Lands Act. The principal resource of the shelf has been, is and will continue to be oil. The world geopolitics of oil has produced artificial gluts through the suppression of opportunities for demand, has created military confrontations in politically unstable regions of the world, has created poverty and bankruptcy in the oil-rich Gulf of Mexico where there should be affluence, and has brought the development of marine technology in the oil patch to a virtual standstill.

This situation, like war, will prove to be a minor transient in the demographics of world energy. The increase in world population and the leveling out of the per capita demand for energy (reduction of demand in the affluent nations and increase in per capita demand in the developing and underdeveloped nations) will result in world-wide energy shortages at the turn of the century or at the latest by the year 2010. Current world demand for energy has remained constant at about 300 quads[6] per year but will be at least double or perhaps triple that amount by the time of the shortage. If this demand is to be met, all forms of base load energy must be developed (oil, coal, nuclear, ocean thermal). There are many oil-bearing provinces in the ocean which are yet to be exploited. Many of these are at depths of from 600 to 6,000 feet and a large potential exists under ice in the Antarctic.

Previous attempts to develop underwater installations which are completely decoupled from the surface have proved uneconomic and technologically difficult. But recent advances in application of modern information machines and techniques to the underwater regime suggest dramatic breakthroughs. A number of dramatic developments can be cited, not the least of which is acoustic tomography, which will provide the clarity of underwater imaging to overcome the range limitations on underwater optical techniques.

The development of artificial intelligence techniques for the preprogrammed mission control of unmanned, untethered vehicles is well underway. The use of new materials for manned and unmanned underwater vehicles has been pioneered in the development of acrylic (most notably in the United States) and titanium hulls (most notably in the United States research community and in the Soviet military community). The

author is delighted to follow this conference with a meeting which will examine the revival of glass as a low-cost structural material for deep submersibles - a highly promising technology which has lain dormant for more than twenty years.

We are thus at the threshold of the development of new techniques for the recovery of deep ocean oil. The legal regime appears to be effectively in place for all but the Antarctic. Once again the international development of the regime for the Antarctic is proceeding on a misperception of the nature of underwater technology and the presumption that the under-ice exploitation of deep ocean oil provinces is a capability of the distant future. It is the challenge prediction of this paper that the 2008 meeting of the Law of the Sea Institute will be focusing on the time critical problem of the allocation and development of the oil provinces of this region of the world.

The Area

This paper is relatively silent with respect to the hard mineral resources of the legal continental shelf. Politically this is a subject of immediate interest and concern to the Law of the Sea community, but an honest and objective examination of the technology and economics of the hard minerals industry leads to the conclusion that the extraction of hard minerals from the seabed for other than political reasons will not be economically feasible in the time scale of this paper (the next two decades).

This paper cannot be silent with respect to the effect of technology on the regime of the Area. The development of this regime was based on the technological misperception that manganese nodules were the primary resource of the area. Excellent progress has been made on the allocation of mining sites among pioneer investors. These allocations have included informal but negotiated agreements with the United States as to the location of its own sites, as well as the sites of the Treaty participants. Certainly the technological advances which will be achieved by the marine community will have immediate application to the technology of mineral recovery, but the author's pessimism with respect to the development of this resource is related to the nature of the industry as a whole.

It is a curious and paradoxical result that the discovery of deep ocean geothermal vents has so increased our understanding of the geophysical location of these mineral rich anomalies that we can now locate new and previously undiscovered "mines of Cyprus"[7] in many uplifted oceanic sites on land. When the newly discovered and newly available land sites are measured against the changes in world demand for hard minerals which have been occasioned by the development of a phenomenal range of plastics and ceramics (high strength, high temperature, light weight, etc.) then the projected demand for deep ocean minerals will be non-existent unless and until the costs of extraction and processing these deep ocean materials is significantly less than the costs associated with any other method for producing these materials or their functional equivalent. The author's continuing faith in the fact that the deep ocean (below 200 feet) is the world's most benign environment for the conduct of industrial operations is tempered by his empirically developed understanding that cultural lag in the use of ocean technology innovation is, at a minimum, twenty years.

What then are the technological uses for the area? The answer has been available to technologists for many years. The ocean, and in particular, the deep ocean, is the ideal repository for the permanent

(in terms of human history) storage of toxic and hazardous wastes. Legitimate and understandable concern for the random and haphazard pollution of the ocean has generated an international metaphor that the ocean is easily polluted and is an inappropriate location for the disposal or storage of hazardous and toxic materials. The London Dumping Convention all but forbids the use of the ocean for this purpose. This unreal perception of the ocean cannot long be maintained. The alternative of land-based disposal is rapidly becoming more politically unacceptable. Pressure now exists for the export of toxic materials to remote islands. The development of these islands as ideal human habitations will soon make this alternative equally unacceptable. The proliferation of excess quantities of plutonium and other long-lived high level radioactive wastes continues as long as nuclear power plants are in operation. "Swimming pool" storage of spent nuclear fuel rods is already approaching an unacceptable limit.

As against these growing political realities are the studies by Hollister and others of the Woods Hole Oceanographic Institution which indicate that storage in stable oceanic tectonic plates is both technically feasible and reliable over many half lives (80,000 years) of the material to be stored.

The Environment and Scientific Research

This paper would be incomplete without discussing the implication of one of the most profound technological developments in ocean technology - that of underwater fibre optic cables. Ocean scientists and environmental monitors have drifted off into space for the simple reason that the transmission of information in the ocean environment has been band-width limited to a painful degree (a few kilohertz - roughly 10^3 bits per second) and that the penetration of the ocean by sensors of any description has been limited in range to virtually zero for normal electromagnetic radiation, a few feet for optical (a few hundred for sophisticated lasers), and a few miles for acoustic sensing. As a result oceanography and environmental monitoring has been one of sea surface measurement with information acquisition and dissemination in band widths of kilomegahertz (roughly 10^8 bits per second) cycles. The major problem for the ocean scientist has been "ground truth" or "sea surface" truth, much less water column or "seabed" truth.

Attempts have been made to resolve the problem through national data buoy systems. These are costly and expensive, require transducing of acoustic and other underwater sensor signals and a satellite link. The introduction of extensive networks of fiber optic systems will have a dramatic impact on the ability to monitor the ocean. The band width of fiber optics is in the optical spectrum (roughly $5x10^{14}$ or roughly one million times the bit rate associated with electromagnetics). The signal-to-noise ratio is also excellent. Transatlantic and transpacific communication fiber optic systems have already been installed at a cost far less than that of satellite installation. Oceanic cables are thus transformed from cables with about six channels to cables which are limited for convenience only to about 60,000 channels.

Initial applications to ocean science have been in Project DUMAND (Deep Underwater Muon and Neutrino Detectors). This project envisions a three-dimensional array of Cerenkov radiation detectors which will detect the photons generated by the interaction of high energy neutrinos and muons which originate in outer space. The determining of the energy and source of these emanations requires correlation of photon showers to determine direction and cone angle. This requires correlation measure-

ments of the order of nanoseconds and transmission to a shore based analytical facility. A single string of the DUMAND located some fifteen miles from shore (either in the U.S. EEZ or the Hawaiian Archipelagic waters, depending on interpretations of the Law of the Sea) has been tested and the capability of making such measurements in the deep ocean has thus been demonstrated. We may well project from these results a developing network and telephone booth concept of fiber optics laid on the ocean floor to provide permanent monitoring of the physical and chemical parameters of the ocean.

Although the current law of the sea authorizes and protects nations in the laying of underwater cables, nothing of the order of magnitude that portends for fiber optics was contemplated. The security of these optical nets will be a prime target for saboteurs and intelligence gatherers. Needless to say, the information gleaned will be of great value in ocean resource utilization, and, needless to say, it will be of great value to the world community if these networks extended into the Exclusive Economic Zones. As fixed installations they will run afoul of Article 246, para. 5 of the 1982 Convention, which gives coastal states the right to withhold consent for installations which are encompassed by Articles 60 and 80 pertaining to "artificial islands, installations and structures in the exclusive economic zone and on the continental shelf". Some sort of international treaty or agreement, not dissimilar to that which authorizes the World Weather Watch will undoubtedly be required if these fiber optic networks are to meet their potential for the transmission of information in and about the ocean.

Dispute Settlement

Although it is not immediately obvious that the technology of the sea has an effect on dispute settlement the events of the past few years suggest otherwise. The imaginative and multi-variate dispute settlement provisions of the Treaty appear to provide all of the options needed for the peaceful resolution of disputes about the law of the sea. With the exception of the jurisdiction of the Sea-Bed chamber, with respect to States Parties conducting operations in the Area, the employment of any of these mechanisms is optional. There remains in the treaty a number of situations where nations are authorized, by implication at least, to employ force in the enforcement of their perception of the law of the sea. Article 30 authorizes a coastal state to "require" a warship to leave the territorial sea when it does not comply with the laws and regulations of a coastal state concerning passage through the territorial sea." Article 95 provides warship immunity for ships on the High Seas and Article 58 incorporates the gravamen of that immunity into operations in the Exclusive Economic Zone. Implicit in that immunity is the right of self-defense. When two nations have differing views as to the breadth of the territorial sea, as in the Gulf of Sidra dispute or as to the conditions under which passage is innocent as in the case of the February 11, 1988 U.S. - USSR Black Sea Incident, then the article authorizes the coastal State to use force, if necessary, to compel the warship to leave the territorial sea and, on the assumption that its interpretation of the law is correct, the navigating State may engage in self-defense to preserve its right of passage. Pending further legal resolution of the dispute both sides are free to engage in proportionate reprisal for any damage incurred. This is but one example of a conflict escalating potential which is built into the current structure of the dispute settlement provisions of the treaty. The exponentiation of these conflicts is a function of the sophistication of technology available to

both parties. The tragic incident of the *Stark* is demonstration of the vulnerability of sophisticated warships to relatively unsophisticated missiles unless they are in a state of continuous readiness. The rapid and continuing advance of sophisticated information and sensor technology and their ubiquitous availability in the commercial market is a guarantee that future confrontations and incidents with relatively unsophisticated nations have the potential for militarily effective hair trigger response and counter response. When the issue is a judicially determinable difference in the interpretation of the law of the sea, then the world community should provide a mechanism for compulsory dispute settlement, or in the alternative to eliminate the right of coastal nations to employ force in the enforcement of boundary disputes and to establish substitute mechanisms such as the award of punitive damages against nations who refuse to employ any of the dispute settlement mechanisms in the resolution of disputes over interpretation.

Summary 1968-1988

In summary, the technology of the sea has made and will make dramatic changes in the form of applications of information systems, in the use of fiber optics, in the development of sea based arms control and arms limitation systems, in the application and use of superstable ships and superstable platforms, in the development of deep ocean water as an energy, fresh water and protein production resource, in the development of low-cost deep ocean technology. The net result will be a dramatic change in the use of the sea from that of a navigation and resource extraction regime to one of space utilization and occupation. As a result of these developments artificial boundaries in the sea will become increasingly enforceable and of little interest to the coastal states and the maritime community, the result of a non-functional, non-geophysical technologically irrelevant width of the territorial sea; a non-functional, non-geophysical technologically irrelevant contiguous zone; a non-functional, non-geophysical technologically irrelevant legally defined continental shelf; and a non-functional, non-geophysical technologically irrelevant 200-mile exclusive economic zone.

In lieu thereof, nations States will concentrate on oases of jurisdiction associated with aquafarms, ocean thermal energy installations, oil fields, floating recreational communities and cities, artificial islands, scientific installations, communication networks, etc. The remainder of the ocean will return to the status of a free sea, with a seabed which is almost entirely *res nullius de facto*, with unchallenged freedom of navigation by documented ships and submarines flying optical or acoustic flags. Curiously enough there is no requirement for immediate major modification of UNCLOS since the boundaries specified in the treaty and the uses of the seabed can erode from non-enforcement and disuse to be replaced by the more localized regimes.

NOTES

1. Craven, J.P., *Technology and the Law of the Sea: The Effect of Prediction and Misprediction*, in Louisiana Law Review, Vol. 45, July, 1985, No. 6, pp. 1143-1159
2. Article 19(2)(d), 1982 Convention.
3. Article 25-1.
4. 1982 Convention, Article 121.

5. Nabauchi, Kiyofami, *Japan's Ocean Affairs*, Law of the Sea Institute-Japan, 1988, p. 4.
6. One quad is 10^{15} BTU (British Thermal Units) (1,000,000,000,000,000 BTU).
7. This name refers to metallic ore deposits of oceanic origin, lifted above the ocean through tectonic action.

Burdick Brittin: John, how soon is it going to happen?

John Craven: Oh, this -- I'm glad you asked that question. The last prediction was 20 years ago, and at that time I made a 20 year prediction and this is a 20 year prediction, and I hope to come back here 20 years from now and give a third talk. [laughter] But the ubiquitous use of the deep ocean as an economic resource will clearly be here in 10 years, no question about that. That's mostly for agriculture, but for power, that's more like 15 to 20 years, extensive use as power source, energy source, and that sort of thing.

Unknown Male: When can we taste the strawberries?

John Craven: Commercially, at Ke'ahole Point, we start first proving the product, then we move it into a small commercial phase and then we have the science and technology department as the second phase. The strawberries are just about to move into the first commercial phase and all our initial production is gobbled up by the hotels on the Kona Coast of Hawaii. I will predict that two years from now you can get strawberries from the Mauna Kea or the Maunalani Hotel at very exalted prices. We are also making arrangements with American Airlines to provide the strawberries for their breakfast flights that originate from Hawaii, so fly American. [laughter]

Bill Brewer: John, putting on your lawyer's hat now, what do you think we ought to do about a law of the sea convention that contains so many anachronisms?

John Craven: I don't think we can do anything about that, but what we should do is we have got to take in our country a brand new approach to the Lowry bill and to the EEZ. We are treating our EEZ as though it were a purely resource regime and as though it were a regime that was Federal. No, the EEZ is going to be occupied space. There are going to be communities that are in it. They are going to have political jurisdiction and the founding fathers never intended that the Federal Government generate large, large numbers of Washington, D.C.s in an area which is larger than the entire continent of the United States, larger than the land-based territory of the U.S., so we have to start looking at a political jurisdiction as well as resource jurisdiction in the EEZ.

Edward Miles: John, I had this incredible feeling of *deja vu* [laughter]. Twenty-one years ago when Bill Burke brought us all together in Columbus, Ohio, that great coastal state, [laughter] you were pontificating about technology and the future law of the sea.

John Craven: Yes.

Edward Miles: And a lot of people believed you and believed other people like you and this led -- I'm skipping a lot -- to the great manganese nodule scam. [laughter]

John Craven: [laughter] Ask the question, I'll give you an answer. [laughter].

Edward Miles: This experience over the last 21 years suggests to me that I will treat all such predictions as Sunday supplement trivia unless and until I see some fairly systematic economic analysis accompanying the predictions. The economic analysis must include the time scales within which utilization is predicted. If the economic analysis does not accompany the prediction then I am just going to say ho, hum and walk away.

John Craven: Well, a) you are absolutely right in making that statement. I do want to point out that you will never see, never have seen, never will see a prediction in any paper I have ever written that the manganese nodules are a viable resource of the deep ocean. Never have made that statement, never will make that statement. And, I didn't make it 20 years ago. Twenty years ago we didn't know very much about the deep ocean waters' resource and we didn't make any predictions about that. The only way you really study is to use deep ocean water, and we now have established industries that are making money. The abalone farm is making money, the algae farmer is making money, and these two guys are expanding as fast as they can expand. The abalone farmer has got a four-acre lake of deep ocean cold water and he is starting to construct three others so that very shortly he will have 16 acres of deep ocean cold water. We have 15 acres of algal growth with deep ocean cold water, and we are now starting to construct 40 more acres of alga ponds. The abalone farmer is producing not only abalone but salmon, sea urchins, and oysters. Both have orders for all of their production over the next three to four years. That is the only kind of economic analysis I know, Ed. I don't believe any paper economic analysis, good or bad or indifferent. There is only one kind of economic analysis that I know, and that is, cash in and cash out. When the cash flow in exceeds the cash flow out, you've got something that is economical.

PART II

IMPACTS OF NEW DEVELOPMENTS ON THE EXPLOITATION AND MANAGEMENT OF NONLIVING MARINE RESOURCES

PANEL II

INTRODUCTION

Lynne Carter Hanson: It gives me great pleasure to introduce Tullio Treves. He is a Professor of International Law at the University of Milano, Italy, and is currently Legal Adviser to the Permanent Mission of Italy to the U.N. in New York.

Tullio Treves: The reports we are going to listen to this afternoon cover a rather mixed bag of subjects. One group corresponds fully to the given title of this session, "Impacts of New Developments on the Exploitation and Management of Nonliving Marine Resources" -- they will consider questions on oil and gas development and on deep seabed minerals.

The other group of papers concerns the case of the *Titanic*. It is obvious that it corresponds less easily to the general title of the session, because, among other things, it would be difficult to consider wrecks, or even archeological finds, as "resources" within the current meaning of the term.

There certainly is an objective interest in studying these subjects, both of which seem extremely exciting and there certainly are time constraints that made it impossible to have separate panels for the two groups of papers just mentioned. Having both sets of papers together this afternoon may be a good idea because there are at least two aspects they have in common, and to which I would like to draw your attention.

The first is that both sets of problems concern activities in which new technologies - or the extension of existing technologies to new environments - are involved.

The second is that both sets of problems fit with some difficulty within the framework of the traditional rules of the law of the sea and also within that of the 1982 Law of the Sea Convention.

When the 1982 Law of the Sea Convention was being negotiated, deep seabed minerals were considered as one of the topics of utmost importance. Polymetallic nodules were seen as the most relevant among such minerals: so much so that an extremely elaborate as well as controversial set of rules and institutions for the exploration for and the exploitation of these minerals was included in the Convention. Six years have elapsed since the end of the negotiations. Are the nodules still as important? Are there other minerals of some interest in the deep seabed? Are the reasons for supporting and for opposing the rules on the exploration and exploitation of deep seabed minerals still valid? These are some of the questions which we look forward to hearing from such an experienced industrialist and negotiator as Conrad Welling.

Offshore oil and gas development is perhaps the utilization of the resources of the seas that States consider as the most crucial for economic as well as for strategic reasons. The basic international law rules concerning such development have not changed much since the 1958 Geneva Convention on the Continental Shelf. Practice in the last decades has seen, however, many new problems emerge as far as accommodation between this and other uses of the oceans is concerned, as well as concerning the impacts of this use of the sea on the environment. Particularly severe conditions such as those prevailing in the Arctic create new challenges to the technology as well as to the law, especially

if particularly high environmental standards are sought. We will hear on this from the Canadian and from the United States' perspectives as regarding oil and gas developments in the Arctic by two experienced practitioners, Mr. Rick Hoos and Mr. Roger Herrera.

Trends in the Exploitation of Deep Seabed Minerals

Conrad G. Welling
Ocean Minerals Company
Mountain View, California

Seawater has proven to be a difficult medium for the flow of information. Except for cables, sound is the basic method of communications because seawater is essentially opaque to electromagnetic energy. Sound travels very slowly in water at approximately 4,000 ft. per second. Electromagnetic energy, light and radio waves travel at 186,000 miles per second in air and space. This is over 200,000 times more than sound in water. Furthermore, the bandwidth with electromagnetic energy can be a million, billion or more times that of sound. The result is an information rate of sound in many orders of magnitude lower than with electromagnetic energy.

The scientific community and ocean explorers have shown great ingenuity in developing tools and methods to circumvent the opaqueness and density of seawater. Because of this characteristic of seawater, ocean exploration can be judged highly inefficient, when compared with dry land or space exploration. The combination of high costs and low utilization of exploration ships at sea relative to land has extremely limited our knowledge of the ocean floor as well as the location of any hard rock minerals.

One of the reasons petroleum exploration at sea has been so successful is that seismic exploration uses sound, and seawater does a respectable job of transmitting the sound signals to the subsea floor. The resulting seismic reflections reveal geologic formations that could contain petroleum deposits.

One of the most successful mineral exploration operations at sea, other than petroleum, has been that associated with the manganese nodules. The reason for the success is that manganese nodules are a unique deposit. They are two dimensional, existing right on the ocean floor and cover thousands of square kilometers. It would be difficult to miss them. At the present time with the limited capabilities of available exploration tools, other hard rock minerals are difficult to find, and in many cases will most probably be found only by chance.

Two recent developments are having a profound effect on ocean exploration. One is based upon a better use of sound, and is exemplified by devices such as Sea Beam, Sea Mark and Gloria. They are basically side scan sonar systems giving a greatly increased resolution topographic map of the ocean floor. Prior to the development of these devices, precision depth sonar used a single vertical beam that produced a single line depth chart along its course. The new devices produce a very wide picture, or accurate chart, up to a kilometer or more along the ship's course. As a result, one pass by these new devices will provide the same information as a hundred or more passes that would be necessary by precision depth sonar. Thus for the first time marine explorers are able to map vast areas of the ocean floor with relatively great accuracy, in a relatively short time. In the case of Sea Beam, the chart is produced in real time. This capability is possible by the use of a properly programmed computer.

The second development is navigation accuracy worldwide. Since World War II many radio systems have been developed, such as Loran. Their accuracy varies greatly, but generally the navigation accuracy is proportional to the distance the ship is from the shore station. The forthcoming Global Positioning System (GPS) will provide accuracy in the order of meters, i.e., less than the dimension of the survey ship's, is not dependent upon distance from shore, is far more accurate than the existing satellite navigation system, and will require much less time by the operator. Furthermore, it is designed to be available world-wide with the same accuracy. It also has the potential of providing elevation in relation to the established geoid to an accuracy of a centimeter or so. GPS can be used to determine the subsidence of an offshore oil platform as an example. Because of the great accuracy obtainable, horizontally and vertically world-wide, the full potential of GPS can only be imagined at the present time.

However, as important as these two developments are, there remains much more to be done. It is believed that utilization of some emerging technologies may be able to provide new equipment development that will enable greatly improved utilization of expensive exploration ships.

In the past two decades the ocean scientists have made some significant discoveries of the ocean floor characteristics. The basic new geological discovery was that of plate tectonics. The sulfides of copper, zinc, lead, nickel and other metals are associated with the hot spots along the ocean ridge where new ocean floor is being formed. From information obtained to date, these so-called "massive" sulfide deposits take perhaps a century or so to form. At the present time we have very little information on the commercial potential of these deposits. It is reasonable to assume that the spreading ocean floor has carried away from the ridges deposits that were formed millions of years ago. In addition, the increasing sedimentation with time has covered whatever deposits were formed. Because of this it is virtually impossible to find the deposits. What is needed are indirect methods of exploration, systems that can be rapidly deployed and moved over the ocean floor and indirectly indicate the presence of a mineral deposit such as is done on land. Such systems could measure electrical potential, magnetic, gravity or chemical variations associated with mineral deposits.

One such method is known as Induced Polarization or IP for short. On land the device employs electrodes inserted in the ground as much as tens of meters apart. An electrical charge is then placed on the electrodes and the resistance of the ground or rock is measured. The resistance is different for many ore deposits than it is for non-mineral bearing rock. This method was tried at sea by the U.S. Geological Survey with enough success to indicate it has potential use. It was previously thought that the seawater would short out the electrodes in a horizontal path above the sea floor. However, to the contrary, the seawater formed a good conductor path to the ocean floor. Therefore the electrodes did not have to be inserted in the sea floor but could be towed over the bottom. I would like to point out that insufficient work has been done at this time to know just how effective this approach could be. There is a possibility that IP could be far more effective at sea than on land, simply because of the time not wasted in inserting the electrodes into the soil, as required on land. There are many other technologies, such as magnetics, gravity or chemistry, that may provide the necessary indirect means to ocean exploration.

Another possibility is the use of satellites. Last year the Norwegians reported that they detected from Satellite Radar Data a few

centimeters' change in the surface of the ocean above seventy to eighty percent of the known oil deposits in the area off Norway. The gravity deflection is the result of the lighter weight petroleum, which provides a slight depression in the sea surface over the petroleum deposits. The measurements were possible because of the use of a computer program that was able to effectively reduce the noise caused by sea surface variations resulting from waves and tides.

The important factor here is that this approach works only at sea and not on land. Perhaps a refinement of this approach could provide us with a much better picture of the geology and morphology of the ocean floor. I have the feeling that a continuing review of not only existing technologies, but emerging technologies, could provide the path to a great increase in ocean exploration efficiency.

Other recent developments are in fiber optic sensors. As reported in the technical journals, these new developments have the potential of greatly increasing the information rate, accuracy and utilization in oceanographic research and exploration. New developments in sensors, based upon fiber optics technology, are allowing greatly reduced size and increased reliability and accuracy. These new sensors will be able to take measurements in such areas as static pressure, temperature, flow, liquid level, acoustic signals, rate of rotation, magnetic fields, electric fields, strain, acceleration, chemical composition, and displacement.

There are important technical features to the use of fiber optics that will greatly increase the information rate so necessary for increased ocean exploration efficiency. One of the problems associated with electronic systems is electromagnetic interference or static. This is not present with fiber optics. Other advantages are no electronics at the sensor and remote placement of the sensor.

Other areas that require further development are sampling tools and auxiliary vessels and submersibles that carry them. In the sampling tool area, the remote corer has had limited development to date. The primary reason is that the limited market for these specialized devices discourages many industrial activists from spending the capital to develop them. However, the technology exists to greatly improve their performance and utlization.

Since we know very little about the mineral resources of the ocean floor it would be difficult, if not impossible, to manage them. Take the example of the manganese nodule deposits. With the exception of petroleum deposits, we know far more about them than any other mineral occurrence. However, detailed knowledge about the topography of the ocean floor where these deposits occur does not exist. Yet this knowledge must be known before serious commerical operation begins. The existing equipment, such as Sea Mark or Sea Beam, must be further refined before the information can be obtained.

In summary, the basic technology and knowledge exist that are required to develop greatly improved ocean exploration tools. I believe that without the new exploration tools that can greatly enhance our knowledge of the ocean floor it would require a century or more to gain the same knowledge as could otherwise be gained in a decade or two.

Therefore, a national or perhaps international program involving interagency cooperation among government, academia, and industry is necessary to support an ocean exploration development program. Over the years I have heard countless discussions of the ocean floor based upon little or no knowledge even among the so-called experts. Many legal and political decisions have been made on assumptions that have little or no

foundation in fact. Improved knowledge of two-thirds of the surface of the world could be of great assistance in the development of policy, both national and international, on the oceans.

Political and Technological Changes Affecting Oil and Gas Development in the Canadian Arctic

R.A.W. Hoos
Dome Petroleum Limited
Calgary, Alberta, Canada

Introduction

The Canadian Arctic generally, and the Beaufort Sea-Mackenzie Delta region in particular, has undergone tremendous social, economic, political and technological changes over a relatively short period of time.

In less than a century the northern native population has evolved from an essentially nomadic, almost stone-age culture, through to the micro-chip society of the twentieth century, with all the latest of technological advances and innovations available to other North Americans. Politically, the north has evolved from a time when there was no government, through to government by the Hudson Bay Company, to the Federal and Territorial governments and, most recently, to some measure of self-government through the settlement of native land claims.

Technologically, over the last 100 years, the north has experienced explorers, the whaling industry, the fur trade, the introduction of government and northern defense, and over the last 20 years, the oil and gas industry amongst others. The oil and gas industry, in turn, has evolved from 1960's southern onshore drilling technology to 1980's offshore Arctic drilling and support systems technology which have now clearly demonstrated the feasibility of operations on a year-round basis in the Arctic offshore.

This paper attempts to highlight some of the major social, political and technological changes that have occurred in the Canadian Beaufort Sea-Mackenzie Delta region over the last century which now places this region in an advanced state of preparedness for major hydrocarbon and transportation projects as the world approaches the twenty-first century.

Economic, Social and Political Change

People have been living in the Beaufort Sea region for at least 4,000 years. However, only over the past 100 years has there been intensive contact between native and non-native people, a process which has required tremendous adjustments and adaptations. This process had led to the growth of native groups, communities and northern government with unique remembrances of the past and perceptions of the present. It is out of their past and present that these interest-holders now face a future that will increasingly be shared with oil and gas development.

There have been several eras of major change in the post-contact history of the Western Arctic. The present era, in which the search for oil and gas has been significant, was preceded by periods when fur and baleen were major staples, and later, by others when government and continental defense were extended into the Arctic. Each such era has had major effects on the people of the region, changing their culture, customs and economic base. Each has brought new people, many of whom

stayed as permanent residents, thereby adding to the ethnic complexity of the region.

Early Contact

The earliest contact between the native population of the Mackenzie Delta-Beaufort Sea region and the outside world occurred as a result of expeditions led by explorers like Hearne (to Coppermine in 1769), Mackenzie (to Garry Island in the Mackenzie Delta in 1789), and Franklin (1825). Such voyages had a major bearing on the subsequent history of the Arctic, but they had little impact on the largely nomadic native people of the day.

Whaling

The first major era involved the southern whalers who had gradually moved northward in their search for whales during the latter part of the 19th century, entering the Beaufort Sea by about 1890. Because of the need for harbors, Herschel Island and Baillie Island became the two focal points of whaling activity. The commodity of interest to the whaling fleets was baleen, obtained from the bowhead whale. Estimates indicate that a season's take may have averaged $1 million, a large sum at the time. The whaling era lasted nearly 20 years, and when it ended, the Arctic bowhead population was on the verge of extinction.

The whalers quickly introduced the Eskimos to the fur trade, succeeding where previous inland trading posts had failed. In return for furs and caribou meat, Eskimo families received goods from San Francisco that were much cheaper and more varied than the goods that Hudson Bay traders brought into the region via the Mackenzie River.

While it lasted, the whaling era was a period of prosperity, learning, and change. For about 15 years, Eskimo families were in continuous contact with American whalers and Americanized Eskimos that that had accompanied them from Alaska. They learned the English language, acquired new customs and technology, and learned much about non-native values.

Yet, contact with the whalers ultimately proved disastrous. The introduction of liquor by the whalers led to physical violence and loss of life. Much more important was the effect of diseases to which Eskimos had not previously been exposed. Smallpox killed many people, but an outbreak of measles in 1900 and 1902 proved even more serious. By the time the whaling era ended in 1909, there were only about 250 Mackenzie Eskimos, or some 10 percent of the original population, left between Barter Island and the Bathurst Peninsula.

Fur Trade

The collapse of whaling had serious economic consequences for all coastal Eskimo populations. With caribou and bowhead populations greatly depleted, and with a new dependence on non-native goods and technology, one of the few recourses left to these people was to develop the fur trade which the whalers had introduced. Disease had depopulated the lands of the northern Yukon and then the Mackenzie Delta, and Eskimos from Point Barrow and other parts of northern and western Alaska moved eastward to occupy these fur-rich lands. The population along the Beaufort coast of Canada began to rise again so that, by 1923, an estimated 400 people occupied the Mackenzie Delta and adjacent coastal regions. Some three-quarters of these people had come from Alaska.

The era in which fur was the main staple, roughly 1910 to 1950, witnessed a substantial increase in the Eskimo population of the delta

and adjacent coasts. The 1941 census reported over 700 Eskimos in the area, over half of whom lived in the delta. By 1951, the total population had risen to over 1,000 and had now become two distinct groups, one located in the delta, mainly at Aklavik, the other at or near Tuktoyaktuk. The delta people tended to trap the lower delta and the Arctic coast westward to the Alaska border, while the Tuktoyaktuk group trapped the outer delta, the Tuktoyaktuk Peninsula and eastward to Cape Bathurst.

The fur era came to an end shortly after World War II. Fur prices had fallen to levels which could no longer sustain either the expectations that the native people had developed out of prolonged exposure to non-native goods, or the basically sedentary way of life that had developed in the communities.

A return to a more nomadic, hunting way of life, which may still have been possible at the time of the whalers, or even at the beginning of the fur era, was no longer a serious possibility. In terms of material culture and their knowledge of the outside world, the trappers in this region had now moved too far from their aboriginal past. Matters had also become complex socially and culturally as many of the major groups of the region, Indians, Eskimos and whites, had intermarried. Missionaries had come from France, Belgium and England, traders from the Hebrides and Shetlands, and whalers turned traders from California.

Government and Defense

Shortly after the decline of the fur trade two very large projects firmly introduced the wage economy to the people of the region. These were the construction of Inuvik, which especially affected the Mackenzie Delta, and the building of the DEW line, which markedly influenced native populations from Alaska to the eastern Canadian Arctic.

The years immediately following World War II saw a major expansion of government services throughout the Arctic, including the Beaufort Sea region. In December 1953, the federal government decided to build Inuvik as its western Arctic administrative center up until that time, was considered inadequate for future needs and allowed little scope for expansion. By the summer of 1954, the present site of Inuvik had been chosen. Construction began in earnest in 1957. Local people who had received considerable vocational training during the preceding three years provided the core of the construction labor force, working as carpenters, painters, mechanics, and drivers. By the time construction was completed in 1960 some native people had moved into the wage economy permanently. Others had come to depend on wages from casual and seasonal labor to purchase goods that the traditional economy could no longer provide.

Construction of the DEW line proceeded concurrently with the building of Inuvik. The sheer scale of the project meant that many people, from all regions of the Arctic coast and even from inland areas, became employed. Families relocated and lived in tents near DEW line stations so that they could be close to the job site. When construction finished, many of these families did not return to where they had come from but either remained near the site, where family members continued to work, or moved to one of the larger and then rapidly growing northern communities.

In combination, employment in building Inuvik and the DEW line had a profound impact on the native people of the Western Arctic. People had learned new skills and attitudes, had relocated to take jobs, and had in some cases, earned enough money to set themselves up in trapping or

business after the wage jobs were over. Social status systems based on hunting and trapping were displaced by systems organized around wages and employment, and around an increasingly urban lifestyle.

Oil and Natural Gas

Much of the change that has occurred in the northern society, particularly with respect to economic conditions in the Beaufort Sea region during the past two decades, has been associated in one way or another with the activities of the oil and gas industry. Although this industry has been active in the area since the early 1960s, the first real boom in exploration did not begin until 1970, immediately after the 1969 discovery of the major oil field at Prudhoe Bay, Alaska. The prospects of making a major oil discovery in the delta were further heightened in 1970 when Imperial Oil Limited struck oil at Atkinson Point, northeast of Tuktoyaktuk.

The longer term exploration programs begun by several of the majors in the 1960s were quickly expanded and accelerated. Other companies moved into the area and began active exploration programs. The first wells were all drilled on land. However, as time went on, the industry began to believe that the greatest potential for finding oil in the area was offshore beneath the waters of the Beaufort Sea. In 1973 Esso pioneered the technique of utilizing artificial islands in the nearshore Beaufort Sea as temporary drilling platforms. By 1986 Dome, through its subsidiary Canadian Marine Drilling Limited (Canmar), extended the exploration effort into deeper offshore waters by bringing in two ice-strengthened drillships. The Dome-Canmar fleet has since expanded to a total of four drillships and a bottom-founded drilling barge (SSDC). In addition, Gulf reactivated its interest in 1983 by bringing in one floating and one bottom-founded unit.

The increased exploration activity that began in 1970 had a variety of effects on the communities of the Beaufort Sea region. Inuvik quickly took on the appearance of a mini-boom town as geophysical and drilling service companies, headquartered in southern Canada, expanded their northern facilities or opened new ones. Most located in or near Inuvik because of the community's transportation, communications and service facilities. Some oil and gas companies leased office space and moved additional administrative and supervisory personnel northward. Tuktoyaktuk, Aklavik, and Fort McPherson also experienced significant effects as residents sought and obtained work with oil and gas companies or contractors.

The early 1970s was also a period of much planning, anticipation, concern, and debate about pipelines in the region. The Arctic Gas project was the best known of the pipeline proposals. In the years immediately following the Prudhoe Bay oil discovery there was considerable news coverage about a possible overland oil pipeline via the Mackenzie Valley to link the North Slope with midwestern markets in the United States. As this possibility faded following American congressional approval for a Trans-Alaskan oil pipeline, and exploration in the delta continued to yield more gas than oil, everyone's attention turned instead to the prospects for a large diameter gas pipeline to link North Slope and delta gas reserves to southern markets via the Mackenzie Valley. Two consortia soon had competing pipeline proposals under development and a host of engineering, environmental and socio-economic programs were launched.

The consortia soon merged to form Canadian Arctic Gas Study Limited and the research effort in the region accelerated in response to federal

government guidelines for information required as part of the application to build a pipeline. All of the research and planning activity on the part of industry and government, and the heightened concern in both Canada and the United States about the adequacy of North American energy supplies following the Arab oil embargo of late 1973, led many people in the north and elsewhere in Canada to believe that a pipeline along the Mackenzie Valley was highly likely in the near future.

Thus, by the time Arctic Gas submitted the initial parts of its application to build and operate a gas pipeline in early 1974, many northern residents had already made commitments in the expectation that the pipeline would be built. Native organizations were growing increasingly opposed to its construction and were preparing arguments to delay construction until after land claims were settled. Many people, including native people, were preparing for employment with the pipeline industry by participating in oil industry courses and trainee employment at various points in southern Canada. A small number of residents, primarily a mix of long-term residents and recent arrivals in the Inuvik business community, were making investments in facilities and services that would only pay off if the pipeline were constructed.

The Mackenzie Valley Pipeline Inquiry (the Berger Commission) was established in 1974 in response to the Arctic Gas application and submitted its report to government three years later. During this time, many northern residents were caught up in a running debate among various groups concerning the potential environmental, economic, and social effects of the proposed pipeline. Community hearings were held in settlements from Old Crow in the Yukon, east to Holman Island and southward along the Mackenzie Valley.

The Berger Commission report recommended that the pipeline be postponed for at least ten years in order to permit the settlement of land claims and time to better prepare northerners for future development. This precipitated the dissolution of the Arctic Gas consortium and many of the immediate socio-economic benefits anticipated for the region. With the pressure off, native groups in the delta and valley actually lost one of their main levers for achieving early land claims agreements from the government. Residents employed by the oil and gas industry or those participating in industry sponsored training programs suddenly found their future employment prospects much less certain and, in a number of cases, non-existent.

The impacts of the perceived "no pipeline" decision were particularly acute in Inuvik. As various companies pulled out of the area or sharply reduced their northern exploration programs in the months following the pipeline decision, employment and business activity in Inuvik slumped. Some businessmen went bankrupt, others sold out at a loss and some simply pulled out. The community's population dropped nearly 10 percent within a year.

However, the impact could have been worse. Some companies did not pull out. Imperial reduced its activities in the region but remained committed to a long-term program of offshore exploration using artificial islands. Esso's island building and drilling activities provided continuing employment for some residents and on-going business for northern food, transportation, and construction enterprises.

Dome's exploration program in the deeper waters of the Beaufort Sea was also maintained. Dome's drilling subsidiary, Canmar, continued to expand its drilling support base at Tuktoyaktuk and to respond to community and regional desires for employment, training, and local business opportunities. Canmar's activities in the period 1976 through 1985 and

Gulf's reactivation commencing in 1983 have provided a considerable stimulus to the economies of Tuktoyaktuk and Inuvik, and the other Beaufort rim communities.

Largely because of encourging discoveries and considerable "hands-on" involvement on the part of the northerners, by the early 1980s the prospect of hydrocarbon development and associated transportation systems was again becoming a matter of increased discussion in many Beaufort Sea communities.

In 1981, the subject of Beaufort Sea-Mackenzie Delta development (including the range of production and transportation issues) was directed by the federal government through an extensive public hearing process under the banner of the Federal Environmental Assessment and Review Office (FEARO). In 1984, after three years of detailed study and a comprehensive set of public hearings, the Beaufort Environmental Assessment Panel concluded that Arctic oil and gas production, and transportation could proceed, subject to stringent conditions designed to protect the environment and to mitigate impacts on northern society. This basic conclusion and the detailed set of accompanying recommendations was generally well-received by the northern public, governments and the industry alike. Western Arctic northerners signalled that they were now much more prepared to accept and deal with the major energy projects envisaged for the area.

Concurrently with the major public hearing for the Beaufort and delta area, a 12-inch oil pipeline was being built to transport oil from Norman Wells, halfway between the delta and southern pipelines. The successful completion of this project and the maximization of northern benefits associated with it further stimulated the northern public's and government's desires to proceed with Beaufort development. In addition, another major milestone, the Western Arctic Land Claim involving the Inuvialuit people of the Beaufort Sea-Mackenzie Delta area was settled in 1984. Lastly, Gulf discovered the Amauligak oil and gas field in the Beaufort Sea, presently estimated to contain about 500 million barrels of recoverable oil.

The time seemed to be right for development to begin! However, even as Amauligak was being delineated, other conditions were changing. In particular, the world price of oil plummeted in 1986, and has not yet recovered to the values needed to justify commercial development of these frontier oil and gas resources. Since the mid-1980s Arctic exploration has slowed down considerably. Nevertheless, the public, governments, and industry continue to prepare themselves for the future.

The Dene-Metis Land Claim down the remainder of the Mackenzie Valley corridor may be imminently settled. The federal government has been devolving some of its regulatory powers to the Provinces and Territories. There is, currently, considerable activity and discussion over the development of a Northern Accord which, if achieved, would effectively transfer much of the authority for regulating oil and gas activities in the north to the Northwest Territories.

Northerners, native groups and the Government of the Northwest Territories are indicating clearly that they are committed to development, provided they have a significant say in managing their resources, and an active role to play in the future development of their lands. For its part, the oil and gas industry is prepared to work cooperatively with all the key players to make Beaufort Sea hydrocarbon development happen as soon as project economics permit.

Oil and Gas Exploration

Exploration for oil and gas in the Beaufort Sea-Mackenzie Delta region has been underway since the mid-1960s and was spurred on by the Prudhoe Bay Alaska oil discovery in 1968. The first well, *Reindeer, D-27*, was drilled on land in the delta in 1965 by Gulf, Esso, and Shell. That well was dry but since then various operators have drilled more than 100 wells onshore, resulting in several small oil discoveries and two major gas fields.

Artificial Islands

In 1973 the industry turned its attention to the offshore Beaufort Sea with the drilling of the first well from an artificial island built by Esso in water 10 feet deep. This island, known as Immerk, has been followed by more than two dozen other temporary exploration islands, many of which were built in progressively deeper waters, with the deepest to date being a caisson system located at Uviluk in a water depth of 100 feet.

The two primary factors to be considered in offshore island construction have been water depth and ice floes. In the shallow, nearshore waters, out to a depth of approximately 65 feet, it has been cost effective to build sacrificial beach-type islands. These islands have also been designed to withstand the relatively minimal ice forces found in this area. The general oceanographic situation in the nearshore areas is that each year sea ice forms in the late fall; it rapidly becomes anchored to the shoreline and the sea floor, forming an area of landfast ice, where ice movement and therefore ice forces are lower than those found further offshore.

Mobile Bottom-Founded Drilling Systems

To build islands economically in the deeper water beyond the edge of the landfast ice into the so-called transition (moving ice) zone required major changes in design philosophy. The first new step was the building by Dome of a caisson-retained island at Tarsiut in 1981, located in 70 feet of water. This was the first island to use caissons and a subsea berm with steep sideslopes instead of a sacrificial beach at the waterline. The technological and design advances incorporated into the Tarsiut island allowed it to be constructed in only one season, using about 1.3 million cubic yards of sand for a sacrificial beach island in a similiar water depth. Two delineation wells were successfully drilled at this location during the winter and summer of 1982. The Tarsiut island thus became the first island capable of year-round operation in the Arctic offshore. This island has now been dismantled, after successfully withstanding the ice and wave environment of the offshore Beaufort for two years.

Experience gained by the company at Tarsiut resulted in the development of a new bottom-founded drilling structures was prompted by drilling opportunities offshore in Alaska. Largely because of poor sea floor foundations and the absence of sand, the SSDC required modifications such that the unit could be set down on an unaltered sea floor in up to 80 feet of water. To accomplish this, a submersible steel barge 715 feet by 360 feet and weighing 31,493 tons was constructed to serve as a subsea platform on which to set down the SSDC. The structure was built in Japan beginning in the fall of 1983. Upon completion in June, 1986, the MAT (as it was called) was towed to the Alaskan Beaufort Sea where it was ballasted down to the sea floor. The SSDC was floated over the submerged barge and the two structures mated in a period of eight

hours. The system has since been moved to a second location by debal-lasting both the SSDC and MAT and towing the unit to the new location. Since there has not been a submerged berm to ground a rubble field at these Alaskan locations, the SSDC has been exposed to moving ice for two winters without any rubble field protection.

Another new caisson unit named Molikpaq was mobilized to the Arctic by Gulf in 1984. This caisson does not require a berm in water depths less than 70 feet and uses sandfill to achieve the required sliding resistance. It is floated into position, ballasted to the bottom and the inner core filled with sand. Molikpaq is also highly instrumented and has now worked on several subsea berm locations, where it has obtained significant data on ice forces. Molikpaq drilled the discovery well for Gulf's Amauligak field in the Beaufort Sea. Amauligak appears to be the first world class oil discovery, containing about 500 million barrels of oil. Molikpaq is currently engaged in delineation drilling on the Amauligak structure.

Floating Drilling Systems

As island-building technology for shallow water drilling was progressing, in 1976 Dome mobilized three ice-reinforced drillships to begin drilling in the deeper waters. During the first year of drilling, the season length achieved was approximately 70 days. The company now has four ice strengthened drillships operating in the area and has been able to extend the season considerably with the aid of an ice management system based on a combination of specially developed drilling and operating procedures, icebreaker support, and an ice surveillance and prediction program. Although the drillships operate on a seasonal basis only, the ice management approach has allowed drilling operations to proceed well into the freeze-up period in the presence of up to two feet of first-year ice. In an effort to further extend the drilling season capabilities of floating systems, Gulf brought a Conical Drilling Unit (Kulluk) into the Beaufort Sea in 1983. Through a combination of the icebreaking capabilities of the unit itself, together with supporting icebreakers, this system has been able to extend the season to about six months.

Exploration drilling from floating systems will likely continue to be carried out on a seasonal basis, because drilling operations later into the winter can only be achieved at progressively higher incremental operating costs caused by the requirement for extensive ice management and support systems. The role and capability of floating systems for exploration drilling in the Beaufort Sea is well established, however, and they will remain as one of the principal exploration tools in water depths beyond 100 feet.

In terms of drilling results relative to the offshore program, roughly 44 wells have now been completed, resulting in about 18 oil and/or gas discoveries, including, most significantly, the Amauligak oil field, as well as other substantial oil discoveries at Tarsiut, Adlartok, and Issungnak.

Future Development

The progression of exploration systems used in the Beaufort Sea has facilitated the development of the technology required for year-round production operations. The enlargement and redesign of bottom-founded exploration systems such as the SSDC and Molikpaq will provide suitable platforms for year-round drilling and production facilities. Experience with the existing exploration systems has enabled the industry to refine

the environmental design criteria and to significantly lower the costs of future production facilities. With Amauligak, the Canadian Beaufort is now clearly on the threshold of going into production. In total the industry has now confirmed approximately 1.6 billion barrels of recoverable oil in the offshore.

What is required now is a more predictable and stable world oil market. Just a few years ago, it was thought that oil prices would have to be in the $35 to $40/barrel range in order to justify development. With the tremendous advances in technology and understanding of the physical environment, the industry is now confident that development of the Amauligak field could be justified on the basis of about $22 per barrel of oil.

Production Facilities

The nature of the production platforms will vary depending on the location of the prospective fields. At onshore sites, production facilities would be placed on standard sand or gravel pads comparable to, but larger than, those currently employed for exploration drilling. In the shallower waters of the offshore area production islands would again be similar to those used now, but they would be larger, have a higher freeboard and be reinforced to accommodate safe, year-round and long-term production activities.

For the development of deeper fields offshore, single or multiple caisson systems similar to but larger than those presently being employed in the exploration phase will be used. For smaller fields, or for early production purposes, single caisson systems containing all necessary components for producing, processing, and storing limited quantities of oil have been designed. For the Amauligak oil field, Gulf has completed extensive evaluation of a number of caisson options and has selected a multiple caisson system which can be installed in phases while the field is being developed, and as it grows to the projected design operating capacity of 150,000 barrels per day. The anticipated structural concept for development is a caisson retained island using two large barges constructed either with reinforced concrete or composite steel and concrete walls. The barges would be 525 feet in length and 150 feet wide.

They would sit on a prepared subsea berm and provide a freeboard of 45 feet. Once positioned, the ends would be closed off with additional caissons and the center of the core area would be filled with granular material. The present plan also calls for early production to commence with seasonal shipments of oil out of the region via tankers until such time as the appropriately-sized pipeline (20 inches) is installed and becomes operational.

With respect to year-round tanker operations for fields further offshore, successful experiences with the SSDC and Molikpaq, supported by the findings of several engineering and research projects carried out over the last decade, have demonstrated that year-round tanker loading in the lee of a structure is very feasible on the basis of both operations and safety considerations. The SSDC and Molikpaq have successfully resisted the moving ice throughout the winter and confirmed an anticipated phenomenon. The moving ice, in combination with the caisson, creates an open water wake in the ice field on the lee side of the island. This wake persists for a substantial distance, and the width and regularity of the wake is such that tankers and icebreakers would be able to use this wake to access the caisson on a regular basis. The wake is predictable in its behavior, and with periods of no movement, the

refrozen wake consists of uniform and relatively thin ice through which the vessels can move without difficulty. This approach eliminates the requirement for costly enclosed harbors or protective barriers.

Further engineering work is now being carried out to optimize caisson systems for several of the locations where discoveries have been made. Present results indicate that significant improvements can be achieved in the overall economics of a development, or conversely, in the economic threshold level of specific reservoirs needed to support a commercial development.

Transportation Systems

Both pipelines and tankers have been evaluated by the industry and both have been assessed to be economically and operationally feasible systems to carry Beaufort Sea oil to southern markets. The choice between the two will mainly to be a function of the water depth of a commercial discovery, discovery size, production rate, and the availabilty of capital. From a cost perspective, the nearshore fields will most likely be served with a pipeline system, while tankers may be the best solution for fields located in the deeper waters offshore. Pipeline technology has been amply demonstrated by onshore and offshore projects around the world, and in particular, by the Alyeska pipeline form the North Slope to Valdez, and the smaller diameter buried pipeline from Norman Wells to northern Alberta.

Major advancements in icebreaking technology have occurred since 1979 with the proven experience of a number of new generation icebreakers. Marine operations have been carried out year-round in the Beaufort Sea, as required. Field data acquired through the operation of these icebreakers have contributed significantly to the development and design of future icebreaking tankers and has resulted in reduced power requirements and, hence, also a reduction in construction and operating costs of these tankers. International certification agencies have confirmed the view that icebreaking tankers can be built which will be able to transport oil safely through the Arctic on a year-round basis.

Conclusions

As reviewed in this paper, the north has been the focus for tremendous social, economic, political, and technological changes over the relatively short period of the last century and, in particular, over the past 20 years. Social and government institutions, the wants and desires of northerners, and the state of Arctic drilling, production, and transportation technologies have reached the point where all parties are poised to actively participate in and benefit from the development of the oil and gas resources of the Beaufort Sea-Mackenzie Delta region. Now all that is needed is the right price for oil, combined with a relatively stable and predictable environment in order to turn the dreams into reality.

Political and Technological Aspects of Change in the Arctic - The Oil and Gas Industry

Roger C. Herrera
Standard Alaska Production Company
Anchorage, Alaska

Abstract

The nature of the politics and practical reality of the search for and production of hydrocarbons in the Alaskan Arctic is investigated. Three controversial and linked aspects of Arctic oil development are discussed. Those are: the Outer Continental Shelf leasing and exploration program in the Alaska Beaufort Sea, the utilization of gravel-filled causeways for oil production close to shore, and the Congressional decision on the management of the coastal plain of the Arctic National Wildlife Refuge (ANWR) in northeastern Alaska.

The perceptions and realities - both scientific and political - of these three issues are examined, and it is concluded that the massive collection of environmental data in the Arctic is being inadequately analyzed and subverted by political perceptions to an extent that puts future oil development from the region in jeopardy.

Introduction

Three separate but related developments will be considered in this paper, all of which are specific to the Alaskan Arctic and all of which have become highly politicized and controversial. They are: oil and gas exploration on the Beaufort Sea Outer Continental Shelf adjacent to Alaska, the utilization of causeways in the nearshore region of the Beaufort Sea, and the political process, now ongoing, to determine the future management of the coastal plain of the Arctic National Wildlife Refuge, either as wilderness or as an area of active oil and gas leasing.

Outer Continental Shelf Leasing and Exploration: the Beaufort Sea

Despite a public perception that outer continental shelf leasing and development are fraught with risk and danger to the environment, the reality of the process offshore northern Alaska has become somewhat routine and benign. There are important reasons for this situation which was preceded by seven years of indecision, controversy and delay prior to the first joint federal-state lease sale in the Beaufort Sea in December 1979. Major among those reasons has been:

1) The establishment of a good working relationship between the oil industry operators and the local North Slope residents, the Inupiat Eskimos. This relationship has prospered because of intense educational programs aimed at explaining the technology and implications of offshore drilling and development. It has also benefitted from the deliberate creation of jobs for local residents, and from the fact that the massive economic changes induced in the area as a result of local taxation and income from the Prudhoe Bay Oil Field production, have had many positive effects. At the same time it has become increasingly clear that subsistence hunting and other cultural activities, including the seasonal hunt for Bowhead whales, were not being adversely impacted by oil

activities. From being initial opponents of Arctic development, the North Slope inhabitants are now cautious supporters of OCS oil activities and of the opening of the ANWR coastal plain;

2) Prior to the first Beaufort Sea lease sale, the Bowhead whale, an endangered species, was considered to be in extreme jeopardy. The total population was thought to number less than 1,000 animals, and the Eskimo subsistance take was being controlled and reduced by the International Whaling Commission. Since that time, the oil industry, the Eskimo Whaling Commission, the North Slope Borough and the involved federal agencies, have carried out over $30 million of research and population studies on the Bowhead whale and have ascertained that the population numbers now exceed 7,800 animals. Recently the allowed Eskimo harvest has been increased to 41 takes or 44 strikes. Equally important, regulations have been established to protect the whales during their fall migration from any impacts of offshore drilling operations. These procedures have been working successfully, as has cooperation and radio communication between the offshore operators and the Eskimo whalers. As a consequence of all these measures the Bowhead whale, while still protected by the Endangered Species Act, is not precluding active offshore oil and gas exploration;

3) Since 1979, six federal lease sales have taken place in the Beaufort Sea and eight State of Alaska lease sales in the nearshore waters within the three mile limit. They have become routine and have escaped litigation, itself an indication of the thoroughness of the administrative procedures and the social acceptance of the outcome. The permitting of exploration seismic or drilling activity after a lease sale has also become efficient and relatively fast. The Minerals Management Service and the operators are now familiar with the regulations and practical requirements for the region and administrative problems are no longer the norm;

4) The United States petroleum industry has benefitted greatly in the Arctic from the pioneering technology developed by its Canadian counterparts in the Canadian Beaufort Sea. With few exceptions, all the equipment and experience proven in the Canadian Beaufort has been used in Alaska. But for that advantage it is unlikely that much political progress would have been made towards an active exploration program in offshore Arctic Alaska; and

5) It is unfortunate that much of the lack of controversy surrounding Arctic OCS activity can be attributed to the lack of success resulting from the exploration drilling. In the Alaskan Beaufort Sea 18 wells have been drilled without any clear indications of a commercial discovery having been found. Within the offshore state acreage, only one major oil accumulation has been found from the 61 wells drilled. It is the Endicott Field, which produced approximately 100,000 barrels of oil per day from an area 20 miles northeast of Prudhoe Bay, about three miles offshore. The controversy associated with the permitting of that field confirms the thesis that any production scenario from the Beaufort Sea will involve political and agency conflict.

Since 1976, the U.S. oil industry has spent $6.9 billion on obtaining leases on the Alaskan OCS. It has spent at least a further $3 billion on exploration of those leases. The results have been largely disappointing. Nevertheless, the recent, May 25, 1988, Chukchi Sea OCS Sale, which received high bonus bids of $478 million, is indicative of continued industry interest.

It is quite reasonable to postulate that giant oil fields remain to be discovered offshore Arctic Alaska, and that the oil industry is still optimistic and willing to continue the search. The outcome will be influenced positively by the establishment of a practical national energy policy, and by an increase in the world price of oil. Given the increase in U.S. consumption of oil and the decrease in our domestic production, it is inevitable that our need to import foreign crude oil will continue to expand. That situation will quickly translate into price increases and possible shortages, both of which will help the search for new oil.

The chances of a viable energy policy being instigated are not good considering the fact that no Congress has faced up to that issue despite two severe energy crises in the past fifteen years. The Administration perceives it has an energy policy which is driven by the free market place. Unfortunately, the price of oil will soon not be set in a free market place but will be determined by the member countries of OPEC. It is therefore somewhat optimistic to expect much positive encouragement from government to aid the search for Arctic oil.

Causeways

Further complicating that search is the attitude of the U.S. Army Corps of Engineers and other federal agencies, such as the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, regarding the utilization and environment effects of causeways built into the nearshore Arctic marine environment. Two causeways are in existence, the West Dock and the Endicott Causeway. The West Dock Causeway is located on the western edge of Prudhoe Bay and is 14,400 feet long. It was built in several stages initially being constructed as a 4,400-foot dock in 1975. It was extended a further 5,000 feet in 1976 as a result of the annual sea-lift of equipment and production modules being prevented from reaching the dock face for unloading due to extreme ice conditions. The third extension was added in 1980 to reach water depths sufficient to site the Prudhoe Bay Waterflood Facility at its far end. One 50 foot breach was included at that time to facilitate fish passage. The effects of the causeway on the physical marine conditions and on the marine biology have been extensively monitored and studied since 1980 as part of the terms of the permit.

The Endicott Causeway was completed as an access and pipeline route to and from the Endicott oil field in 1986. Its north-south extension is approximately 10,000 feet long and contains two breaches, 500 feet and 200 feet wide for fish passage. It too has been subject to extensive monitoring both pre- and post-construction.

A third causeway, the Niakuk Causeway, situated between the other two on the eastern fringe of Prudhoe Bay, has been the subject of a permit application which has not yet been processed. It would be utilized to develop and produce a small, marginal oil field located 6,600 feet offshore in water depths of 4 1/2 feet. The perception exists that additional causeways may be needed adjacent to ANWR, either as docks or to develop nearshore oil fields in the offshore state acreage. No such fields have yet been discovered and water depths in the area are much greater than further west, but if a field is located in a geographical area suitable for a causeway, oil production using a pipeline located on a gravel causeway is obviously preferable to a subsea buried pipeline which cannot be visually monitored and would be difficult to repair. Such a safety and environmental consideration should not be ignored.

The controversy associated with the two existing causeways is largely a function of the fact that they have induced physical changes in the local marine environments. Both temperature and salinity of the sea water has been marginally changed over small areas, although the changes were predicted prior to construction. Furthermore, the marine environment in the region is perennially subject to massive natural changes induced by the seasonal influx of warmer, fresh, river water discharge, and wind induced current changes affecting both temperature and salinity. Monitoring of fish and other marine life has not shown any detectable change in migration patterns or population levels.

All these factors were considered by the Corps of Engineers prior to the permit issuance. For example, the Record of Decision for the final extension of the West Dock states, "Factors bearing on my review include conservation, economics, aesthetics, general environmental concerns, historic values, fish and wildlife values, flood damage prevention, land use, navigation, recreation, water supply, water quality, energy needs, safety, food production, and in general, the needs and welfare of the people" (U.S. Army Corps of Engineers, 1980). The decision went on to state that it "is based on thorough analysis and evaluation of the various factors enumerated above; that economic, human safety, and petroleum recovery considerations outweigh identified potential environmental effects, the bulk of which are reversible following project termination: that the proposed work is in the overall interest of the public as reflected in the comments of State and local agencies and the general public and the current energy policies of the United States; that the proposed work is deemed to comply with established State and local laws, regulations, and codes; that the issuance of this permit is consonant with national policy, statutes, and administrative directives; and that on balance, the total public interest should best be served by the issuance ....".

Given the balanced and careful nature of that decision and the fact that no adverse impacts to fish and wildlife have been identified by the extensive monitoring programs, it is difficult to comprehend the attitude of agencies that both these causeways should be retrofitted with extra breaching, and that no further causeways should be allowed in the Arctic. Three possible explanations for the agencies' apparent position can be postulated.

- One relates to the aesthetically derived assumption that any man-induced change to the environment is negative, irrespective of whether such changes are distinguishable from naturally occurring changes.
- Secondly, some agencies, U.S. Fish and Wildlife Service in particular, work on the assumption that habitat is a limiting factor to populations in the Arctic. This implies that the North Slope and the shallow waters of the Beaufort Sea would have to be at their biological carrying capacity, so that any elimination or change of habitat would result in reductions in populations. There is no evidence to support this assumption, with the possible exception of fish over-wintering habitats in unfrozen pools in rivers. However, such habitats are not affected by causeways.
- The third reason may be a concern that the cumulative impacts of causeways have not been adequately assessed and could be adverse. It is correct to state that the methodology and scientific acceptance of the measurement of cumulative impacts on biological systems is hardly developed due to its extreme complexity. Nevertheless, twenty years of fishery data have been collected from the Colville River, west of Prudhoe Bay, and eight years of post-causeway data are available from

the intensive biological monitoring programs in the area. None of the data show major fish population changes or other tell-tale indications of impacts due to the causeways. Obviously such things should be looked for, but their absence is good, not bad, news.

A good scientific solution to the causeway controversy should be available with the continued collection and responsible analysis of data. If the governmental agencies reach fundamentally different conclusions from industry scientists, the questions should be resolved by independent, disinterested scientists of repute, rather than be reached by litigation or a political solution. In the meantime the development of new Arctic oil at Niakuk and possibly adjacent and within ANWR is in jeopardy.

The Arctic National Wildlife Refuge

The ultimate fate, to be determined by Congress, of the 1.5 million acres of the coastal plain of the Arctic National Wildlife Refuge is northeastern Alaska probably will hinge not on a rational discussion of the capability of the oil industry to develop an oil field in the area without incurring environmental harm, nor on the aesthetics of wilderness and the benefits of adding to the 55 million acres of wilderness lands already in Alaska, but on the politics of Congressional re-election campaigns, and on the outcome of the Presidential election. That is not to suggest that adequate debate and consideration of the factual issues has not taken place. In fact, twenty-seven Congressional hearings have addressed ANWR since late April 1987 - the most on any issue before Congress. The results of those hearings, as measured by committee votes on ANWR bills both in the House and the Senate, strongly indicate bi-partisan support for leasing on the coastal plain with appropriate environmental protection mandated by legislation.

The political question has become, not whether ANWR will be opened to oil and gas leasing, but, when will it be opened? The timing of that decision will obviously be influenced by a general unwillingness of most politicians to make controversial votes immediately before an election. It may also be influenced by the "newness" of an incoming Administration. Factors such as the balance of payments deficit and the cost of increasing imports of foreign crude oil will impact the decision, as will the unpredictable happenings in the Persian Gulf. But most of all the decision will be made because people are comfortable with the ability and commitment of the oil companies to explore and develop the coastal plain in an environmentally responsible fashion. The rhetoric and exaggeration of the environmental organizations or the technical explanations of the oil industry have their place in this process, but the bottom line should be man's ability to utilize Arctic experience and scientific knowledge to operate compatibly in the Arctic environment without detriment to the wildlife or destruction of ecosystem balances. At the same time the ultimate decision on ANWR must be one which benefits the nation at large.

Conclusion

Alaska produces approximately 2.1 million barrels of oil per day which represents about 25 percent of the United States' domestic production, and the largest output of any state in the Union. In one year's time the production from the giant Prudhoe Bay field will start to decline, and by the year 2000 Alaska's Arctic production will probably be reduced to about 600,000 barrels of oil per day. One of the frustrations of an Arctic oil field is that it takes at least ten years

from the day of its discovery to initiate first production of oil to market. This time span is a function of regulatory procedures and the physical nature of the environment, and it cannot be appreciably shortened. The discovery of a major oil field would, itself, take two to five years of exploration drilling to find, and prior to that at least two years would be needed to organize and hold a lease sale after enactment of legislation allowing the sale to take place.

The ten to seventeen years needed to bring on-stream new oil from the Arctic OCS or from ANWR pinpoints the impossibility of significantly changing the decline in Alaskan oil production until the year 2000 or beyond. It also pinpoints the necessity of solving the controversial political and environmental problems and perceptions of Arctic oil development as quickly as possible. Irrespective of our national resolve to increase energy conservation or utilize alternative sources of energy, it is almost inevitable that our dependence on oil will have increased by the turn of the century as will our dependence on imported foreign oil. Neither of those circumstances is beneficial, and both can be ameliorated to some degree by sensible production of oil from new areas in Alaska. Unless environmental scientists, administrators, legislators and oil companies improve their record of impartial data analysis and decision making on Arctic matters, rational and safe development of the region will not be achieved.

BIBLIOGRAPHY

U.S. Army Corps of Engineers, Nunn, Lee R., Colonel, District Manager, Alaska. "Sections 10 and 404, Record of Decision, Prudhoe Bay West Dock", Dec. 19, 1980.

David Ross: I couldn't help but notice that Conrad Welling, talking about nodules, said that we need the technology to really see what is there. Mr. Hoos said we have the technology but we need the economics; and Mr. Herrera said we have the technology, the economics, and the science, but we need politics, which brings us back to Conrad Welling. What I want to ask of Mr. Welling is: are nodules really a realistic potential for economic development in the next ten, twenty or thirty years?

Conrad Welling: Actually this has been debated for years. I have been at it for 25 years, and that is too long from my point of view, but there are misconceptions. Manganese nodule mining is a nickel business and depends upon the nickel price and market. If the market is there ocean mining will come into existence. Recently, the nickel price has gone up considerably, but it will still take five years to see if the market will absorb the new production with the existing mines coming back on stream. So I would say that at a very minimum, with ten years of development time and five years of stabilized favorable market, it will be at least 15 years before operations begin. When we started 25 years ago the nickel market looked far better in the future than it did, say, ten years ago. The following nickel market placed the whole operation on back burner. Strictly the nickel market, and I have to say that over and over again, is a controlling factor. In any activity, just like offshore petroleum, if the technology exists and they know how to do it, you still have to have the market. One has to talk intelligently about the nickel market if you are going to talk intelligently about the management of the nodule industry.

Edward Miles: I wonder if I might throw this up, Connie. What is the relationship, as price increases, between laterite deposits on land and manganese nodules at sea?

Conrad Welling: We could not have obtained 130 million dollars of development money if we had not conducted a good economic study. The main result of the study was the realization that we could not compete with existing laterite mines but could compete with new nickel mines. If the price of nickel will stay in the 6 to 8 cents per pound range after all the existing land mines have been shut down or brought back into operation, then the prospects for manganese nodule mining will be good.

Howard Strauss: I was disappointed with the presentation of Mr. Herrera. I would have thought that after the experience of the last 20 or 30 years one would take the view, particularly in the Arctic, that unless one was sure that what one was doing would not upset the delicate environment in the area, one would not do it. I would have thought that if additional measures can protect the existing environment more than existing technology or existing efforts do, then unless one could show that those measures added nothing or added very little protection, one should make the effort and spend the money.

Second point, there was no recognition of protection of lifestyle of people in the area. One can speak of the economic value of the Arctic, but there is also a cultural and community environment that should be protected.

Roger Herrera: You are exactly right in both instances, of course, and the reason I can say that with a degree of confidence is that there is not much of a problem or controversy at the present time in Northern Alaska, because the natives are very comfortable with the situation. If they weren't, then we wouldn't be operating or at least we would have a real problem on our hands. The reason they are comfortable is two-fold, I think. One, they've had ten years experiencing what's happened at Prudhoe Bay. They have recognized it as not impacting their subsistence life style at all. They've recognized that, except to the extent, of course, that it has brought a huge social change and also environmental benefits. They tend to like the environmental benefits most of all and put up with the social change. The end result of this, though, is the natives are very supportive of offshore exploration and development on the Alaskan side of the border.

Your first point is totally valid also. The only reason I can criticize the suggestion that further breaching should be put in is that there is absolutely no rational scientific evidence to show that breaching will benefit anything. I don't mind protecting the environment. In fact I will go one further and tell you, as a fact, that the company I work for is the biggest producer of oil in the United States and has the most reserves of any oil company, including the mighty Exxon; and yet, our environmental department has more people in it than our exploration department at the present time, which is symptomatic, I would hope, of a certain positive attitude towards protecting the environment.

Richard Bilder: This is a question for either Mr. Hoos or Mr. Herrera, or both. It is my understanding there is a controversy between the United States and Canada, about the boundary on the Beaufort Sea. I was wondering whether either of you would happen to know and could tell us about how your companies are handling environmental problems in this situation. Is the dispute having the effect of inducing cooperation or getting in the way of a solution to environmental and other problems?

Rick Hoos: If I may begin to answer the question, I think that as a general statement, the oil and gas industry in Canada and in the U.S., particularly over the last six or eight years, have worked very closely together. Previously we were all so busy doing our own thing that we didn't communicate all that much. More recently, however, with issues such as the bowhead whale, and for that matter, the Cisco which emanates from the Mackenzie and moves over into Alaska, and the possibility of oil spills moving from Canada to the U.S., there has been a great deal of cooperation and interchange of ideas. I think we are now a team in that sense.

In terms of the "Beaufort Pie" as we call it, industry is simply the meat in the sandwich. Both governments have political and legal points to make, and both governments are quite prepared to permit leasing to occur in that disputed zone, and, in fact, I know that my company has land courtesy of the Canadian government in that disputed zone. But as far as I know, no oil company in their right mind is going to try and do anything in that area until such time as the dispute is resolved, and in fact I don't believe the governments are encouraging things beyond what they have done so far.

The same applies to the Georges Bank area on the east coast where we also had some leases which were, in essence, in moratorium. When a

decision was handed down and the land turned out to be on the U.S. side of the line, we just lost the rights, plain and simple.

Tullio Treves: At the Third U.N. Law of the Sea Conference the question of recovery of artifacts from the seabed was considered for the first time in a general codification conference. Two Articles - 149 and 303 - on "objects of an archeological and historical nature" have been included in the 1982 Convention. Among the numerous problems they give rise to, attention is to be drawn to the lack of a definition of the notion of "objects of an archeological and historical nature" and, even more so, to the fact that the two provisions consider such objects either in a 24-mile zone coterminous with the contiguous zone, or in the seabed beyond the limits of national jurisdiction. Nothing is said about such objects lying between the 24-mile line and the external limit of the continental shelf. Dana Yoerger will explain to us the technological developments that have led to the finding and recovery of the *Titanic*, and Brian Hoyle will comment on the legal-diplomatic aspects of this incident.

Historical and Archeological Treasures
The *Titanic*: A Case Study
Technical Implications

Dana Yoerger
Woods Hole Oceanographic Institution
Woods Hole, Massachusetts

Today I will speak about the technology that was used on the *Titanic* search and exploration.

The technologies that were used on the *Titanic* mission were, in almost every case, developed for other purposes. Our purpose at Woods Hole is, of course, scientific research. If you are studying the deepsea floor for geologists, geophysicists and biologists, there's a large component of commercial offshore technology that points this way; and, of course, a large amount of the technology that we developed in our shop was with Office of Naval Research money, so the naval influence was very strong. None of the real driving forces behind our technology were shipwreck searches or survey and salvage, or underwater archeology. However, I feel very strongly that these areas are going to be strongly affected.

The technologies for locating and exploiting shipwrecks are evolving due to these outside forces. At the same time, technologies for proper archeological treatment of these kinds of items is also developing rapidly. I believe the technology will not be the limiting factor in the choices that are going to have to be made. There will be the option to treat, let us say, a few-hundred year old ship as an archeological resource or strictly for its own intrinsic value. The technology will not lend us one choice or the other. We will be able to do proper archeology at full ocean depths, or we can just grab the items. It will be the job of a lot of the people in this room to make those choices.

I will review the technology that we used on the *Titanic*, and also present an update showing the progress that we've made in our technological systems since then. The original *Titanic* search mission was the first field trial of the *Argo-Jason* system, and particularly the *Argo* vehicle. It was a joint operation with the French agency IFREMER. The towed vehicle, *Argo*, has as its strong point wide area optical and acoustic survey.

The current phase of our program now is to integrate the search vehicle, *Argo*, with the smaller vehicle called *Jason*. Its job is to do closeup inspection. The second *Titanic* expedition, out of Woods Hole, was to test an earlier prototype of the *Jason* vehicle which was run off of the submersible, *Alvin*. Our current effort now is to build this entire integrated system to bring remotely-operated or unmanned technologies to bear on the study of the sea floor. We needed a good place to test it, and the *Titanic* seemed like a good place; that was one of the ingredients that led to the discovery of *Titanic*.

The mid-ocean ridge is the driving scientific setting for our work. The *Argo-Jason* system was conceived as a way of improving the efficiency of the exploration of the mid-ocean ridge. To put this problem in a nutshell, a very tiny fraction of this very interesting part of sea floor has been investigated scientifically. This technology can greatly improve scientific access to the sea floor. I think most people are

familiar with all the interesting attributes of the mid-ocean ridge. In particular, one spectacular aspect is the fact that there is hydrothermal activity: water seeps down, gets heated up, and this has tremendous ramifications on the terms of heat balance of the ocean and chemical balance of the ocean, and of course, the hot water and chemicals together provide a very good setting for a chemo-synthetic base, eco-systems which have proven to be a scientific bonanza. That is our perspective on this technology; that's why we developed it, and the *Titanic* was a spectacular test of the system.

The strategy was to use the IFREMER vessel with its towed sonar system to locate the wreck, and the Woods Hole vessel KNORR, using *Argo* to do a close-up optical/visual inspection. Unfortunately, due primarily to bad luck with weather, the French weren't able to find the ship with their sonar system. It was left to us with the KNORR to finish searching the remaining part of the search area where the ship was found. Had everything gone according to the original plan the French certainly would have been successful in locating the wreck.

The French-towed side scanning sonar system has a very high resolution, with extremely high image quality, with approximately a one kilometer swath. With this high of a resolution you can actually see a piece of data mosaic showing the so-called Titanic canyon (which is not where the *Titanic* is). Basically, the resolution of images and the scope of it is such that if it were the *Titanic* it would be so large that they never would have missed it had they been in the right spot. They searched about two thirds of the area and it was in the third that they did not have time to search.

The *Argo* vehicle, used in 1985, basically is a towed, unmanned camera sled. The TV camera is forward, light sources aft, both strobes and incandescent lights, telemetry, power system, and other systems like attitude and altitude, and a computer controller to tie then all together. There've been some very significant improvements in the *Argo* system since then.

The cable which we used on the *Titanic* in 1985 is a very important part of the system. It is about .6 inches in diameter, a little bigger around than your thumb, and has a 40,000 pound breakage strength. That's a very important restriction because electronically cables are a very skinny pipe. It is difficult to transmit data over long distances. This cable is worth quite a lot. You can squeeze about one video image through a 20,000 foot length. That's what we did on the *Titanic*. In development now is a fiber optic cable to replace the original co-axial cable which has the same mechanical properties, and has the same diameter, and thus can be used on a lot of the same handling systems, but instead of having a co-axial cable in the core it has three copper conductors capable of handling 10 kilowatts. It is several orders of magnitude higher in terms of its information handling capability. We will do a deep ocean test on this cable later this summer. It's passed all the dry land tests so far and so we're very excited about that.

The *Argo* vehicle has capabilities for both video and 35mm film cameras. Its ancestor, the Angus camera sled, had capabilities for 35mm film cameras. We imaged a helicopter during a survey for the Navy with an electronic still camera. This camera has many of the attributes of film; very high resolution. It is not a TV camera so you don't get a continuous video but it takes snapshots and the electronic sensor acts like film. It has a moderate resolution of about 600 by 1,200 pixels, but has the tremendous attribute of dynamic range: 14 bits per pixel. That means if it were a film camera you could crank the F-stop up or

down five stops and still get the image. So it has tremendous information-gathering capability and, because it's electronic, we can pump it straight up the wire, real time, for the scientists on the surface, unlike film, and it's very manipulable in terms of computer massaging.

Use of electronic zoom with that camera is very effective. We see this replacing film for most scientific purposes using the *Argo*. Unlike the *Titanic* crews where we used the video as a viewfinder, but we took our real pictures with film, we now have the many advantages of a totally electronic machine.

We went back to the *Titanic* the next summer with the submersible *Alvin* and the small robot we call *Jason Jr.*, to test the lower half of the entire *Argo-Jason* system, not just the *Jason* part.

Alvin was launched from the support ship, *Atlantis II*, with three crewmen, the pilot and the two scientists, one of whom was the pilot for the remotely-operating vehicle. The remotely-operated vehicle which was tethered to *Alvin* was controlled by the pilot in *Alvin* using the view from the video camera. *Jason*'s payload is quite limited. It was able to carry the strobe light and a single 35mm still camera. High quality, close-up images are possible with this system.

One of the highlights of *Jason Jr.*'s exploits was to descend what remained of the grand staircase of the *Titanic*. There were disappointments. We had hoped that most of the ship would be well preserved, but unfortunately, woodboring organisms did a lot of damage. The woodwork was almost completely gone. But in terms of the technological demonstration, which formally was the test, this was a big success. It demonstrated the capabilities of the submersible *Alvin* and also opened up the possibilities of remotely-operated vehicles to do this work. *Jason Jr.* took video footage of a light fixture, originally just called the chandelier, and later down-graded to a light fixture. The three people in the *Alvin*-sphere, cramped and huddled, using *Jason, Jr.*, can be forgiven for their excitement.

Can this remotely-operated technology be used to do real archeologist finds? Archeologists require very careful measurements, the same kind of measurements they make on land. You can make those underwater, and then if they do choose to recover objects they need to do it very carefully and in a very methodical, gentle way. Remotely-operated underwater vehicles have been used for this purpose.

Two years ago we put a remotely-operated vehicle under total computer control. We knew right where it was and we could use the computer to fly around. We set a little automatic track for it to follow. Sure enough, we knew where it was accurately enough and were able to program the computer cleverly enough that we could make it behave quite nicely. This has many ramifications for archeology. Just as with geologists, it is not sufficient to putt around in the submarine and look out the window. Archeologists have perhaps even more demanding requirements in terms of making careful measurements. They want to locate every artifact precisely in three dimensions before they even think about touching it. With this kind of measurement technology we can actually do this.

Archeologist Tom McHamilton from the Institute of Nautical Archeologies down in Port Royal, Jamaica, was one of the first users of the same acoustic technology that we use to track the ROV. It's called SHARPS and is essentially a very high frequency, long baseline acoustic navigation system. A diver used one of the acoustic transponders draw the foundations of the buildings that made up Port Royal. This data is very precise and quite accurate, and relatively easy to obtain. Currently, underwater archeologists go down with strings and build very

exotic grids just like they would do on land but, of course, because they are diving progress is extremely slow. With new measurement technology and with capable underwater robots the productivity of this kind of work can be stepped up to a point where it becomes much more practical.

For your information Port Royal literally sunk into the ocean back in, I believe, the 17th century and all that remains now are the foundations. Very careful measurements are being made to understand what was there originally. This was done in very shallow water so it could be done safely by scuba divers, but if you put the *Jason, Jr.*, example together which was in 12,000 feet of water with this kind of measurement technology I think there are very few shipwrecks that could ever be beyond technological reach. If we want to do proper archeology we can do it anywhere. The means for that are evolving very rapidly.

We're now building a *Jason* vehicle in our laboratory. In addition to the measurement capabilities already achieved, we will have very sophisticated manipulators. We're currently testing in shallow water, and it's coming along quite nicely. Unlike most of the manipulators used in the commercial offshore it's not designed for brute strength, but more for very dextrous touch. Again, this is a good intersection with the needs of archeology.

The technology is going to provide us with a lot of choices, and the technology of salvage is evolving very rapidly. It is clear that when technology wants to flex its biggest muscles it can do amazing things. People always ask me, "Do you think they could have brought up the *Titanic*?" Well, maybe they could. It would be a tremendous undertaking and would cost a lot of money but I wouldn't put anything past the people who work in ocean technology today. On the other hand, we do have choices to make and if we choose to do careful archeology at high standards rather than to salvage things, I think that's just as well.

At Woods Hole we're still working towards these goals, particularly, the needs of deep ocean science and of archeology, which are very compatible. The tools for one will be very transferable to the other. One of the big questions is whether the archeological treatment of these treasures will have the proper support so they can utilize these tools. Sometimes I wonder whether the geologists and the biologists are going to get the support that they need to use the tools we are developing. The archeologists are certainly one step removed in terms of those kinds of budgets. The technology will not restruct the choices. It will be funding, and what society values.

COMMENTARY

Historical and Archaeological Treasures

Brian J. Hoyle
U.S. Department of State
Washington, D.C.

I would like to share a few thoughts with you on the international legal principles applying to shipwrecks. It is convenient to treat this issue in two parts, that part of international law pertaining to ships entitled to sovereign immunity and that pertaining to all other ships.

With regard to the first category, Article 95 of the 1982 Law of the Sea Convention (hereafter, the "Convention") provides that warships on the high seas have complete immunity from the jurisdiction of any State other than the flag State. Similarly, Article 96 provides that ships owned or operated by a State and used only on governmental non-commercial service shall, on the high seas, have complete immunity from the jurisdiction of any State other than the flag State. The important aspect of this immunity to note is that unless the warship was captured as a result of enemy action in wartime the wreck, its crew and artifiacts are still entitled to sovereign immunity (e.g., the law of salvage does not apply and the ship cannot be the subject of salvage). Article 29 defines "warship" as "a ship belonging to the armed forces of a State bearing the external marks distinguishing such ships of its nationality, under the command of an officer duly commissioned by the government of the State and whose name appears in the appropriate service list or its equivalent, and manned by a crew which is under regular armed forces discipline." State practice recognizes further in this regard that a presumption against abandonment by the sovereign power applies. In other words, as in U.S. practice, unless there is a positive act of abandonment by a sovereign State, its sunken warships continue to be immune. How far back in time this presumption continues to apply is not certain; I can however state that in the U.S. case, we have claimed it as applying to U.S. warships lost in the War of 1812.

A difficult issue arises when the warship is located in the territorial sea of another State. As the coastal State is sovereign in its territorial sea a conflict between sovereigns occurs and neither can proceed without the consent of the other. If the wreck is not a warship but is of an archaeological and historical nature, coastal State rules prevail in the territorial sea and presumably (per Article 303(2)) in the contiguous zone as well. If it is not a warship and is not of an historical and archaeological nature, coastal State rules only apply in the territorial sea.

Article 303(2) warrants some analysis. It provides that a coastal State, in exercising its contiguous zone competence, may presume that the removal of archaeological and historical objects within the zone would result in an infringement within its territory or territorial sea of the laws and regulations referred to in that article. As we assume that certain ships classify as historical or archaeological objects, the effect of this article from a practical vantage is to vest the coastal State with as great an authority over this class of ships as it enjoys in the territorial sea, *i.e.*, plenary in the case of non-warships.

Having given the state of the law, some current examples of shipwrecks under consideration might make the discussion more meaningful.

In the case of the *USS Somers*, a U.S. warship which sank in a storm off Vera Cruz within the Mexican territorial sea during the 1846-48 War (and therefore not the subject of prize), the location of the ship was recently discovered by a U.S. national. After the United States informed the Government of Mexico that the warship was still entitled to sovereign immunity as the United States had not abandoned her, the Government of Mexico responded that it considered the ship and her remains to be the property of Mexico as it constituted war booty. The State Department rejected this contention and has entered into negotiations with Mexico to resolve the issue in order to achieve the desired goal -- preserving the wreck and her artifacts as well as respecting its status as a war grave.

The case of the *CSS Alabama* is to my knowledge unique. The *CSS Alabama*, a Confederate raider built in Birkenhead, England, engaged the Union *USS Kearsarge* off the French coast in the English Channel off Cherbourg in 1864, and was sunk. Although beyond the French territorial sea at the time, it now lies within the French territorial sea in that the latter was subsequently extended to twelve nautical miles. In that the *CSS Alabama* does not constitute a U.S. warship as it was under a Confederate regime and is therefore not entited to sovereign immunity, it does, however, constitute U.S. Government property pursuant to legislation enacted by Congress after the Civil War which vested title in all former Confederate States of America (CSA) property in the United States. As the location of the *CSS Alabama* was recently discovered and several non-U.S. ventures were planned to investigate/salve/raise the *CSS Alabama* and its artifacts, the Department of State informed the Government of France that she constituted U.S. Government property. France responded that in her interpretation of the applicable 1870 Congressional statute the *CSS Alabama* was not U.S. property. As matters currently stand, the Department will enter into discussions with the Government of France later this year, at the invitation of France, to cooperate to achieve the desired objective. Each State will no doubt preserve its juridical position in any settlement reached. At least two bills have been introduced in Congress directing the Secretary of State to enter into negotiations with France to preserve the *Alabama* and stating that the *Alabama* and its artifacts are U.S. property.

Perhaps the best current example of a shipwreck not entitled to sovereign immunity is that of the *RMS Titanic*, which as we know sank in April, 1912 approximately 450 miles off the coast of Newfoundland in 13,000 feet of water. Of English registry, she remained on the ocean floor inviolate until discovered in 1985 by Bob Ballard. In that she was a commercial vessel beyond the territorial sea and contiguous zone of any coastal State and clearly abandoned in that she remained in 13,000 feet of water, her coordinates unknown for more than three quarters of a century, either the law of salvage or the law of finds applies to the *Titanic*. The Cunard-White Star Line, the owners of the *RMS Titanic*, are still in existence and it is certainly arguable that as the owner is still identifiable, even though seventy-five years have passed, the law of salvage would apply. Similarly, the insurance companies that paid the claims following the *Titanic* disaster exist. Salvage rights continue so long as the owner has not abandoned his vessel. Since it was impossible to find the vessel for almost seventy-five years, the owner of the vessel or any residue rights could probably not be said to have abandoned his rights. If an abandonment could be found, the law of finds

would apply. The principal distinction between finds and salvage, as maintained by the Fifth Circuit in 1978 in the *Atocha* case, is that under the law of salvage the claim of the finder of abandoned property is satisfied by the proceeds from the sale of property paid into the court. In the case of the *Atocha*, sunk in 1622 off the Marquesas Keys, it was determined that the law of find applied, given the inability to identify the owner. For the purpose of our discussion today, however, it is immaterial which of the two apply. Both approaches run counter to the desire of Congress expressed in the Titanic Memorial Act that the vessel be protected as a maritime memorial. This would require the co-operation of the most concerned countries, the U.S., U.K., and France and Canada. With the exception of Canada, no other country has shown any interest in protecting the vessel.

Given the subject and the discussion this afternoon, a few observations regarding national and international practice as to the issue of encompassing shipwrecks within the continental shelf jurisdiction of a coastal State are in order.

In this regard, I believe it reasonable to assume that a coastal State, in proclaiming a continental shelf regime, will arrogate to itself as much sovereign rights and jurisdiction over shelf resources as it believes itself legally entitled to. In the case of the United States, the Outer Continental Shelf Lands Act, in claiming the natural resources of the continental shelf for the United States, defined "natural resources" as including "oil, gas, and all other minerals, and fish, shrimp, oysters, clams, lobsters, sponges, kelp and other marine animal and plant life but does not include water power, or the use of water for the production of power." The Canadian Oil and Gas Production and Conservation Act, as amended in 1970, claims sovereign rights and consequent regulatory authority over gas, defined as "natural gas," and oil, defined as "any hydrocarbons except coal and gas." It is a fact that at no time since the Truman Proclamation was promulgated in 1945 has the United States claimed that shipwrecks constitute a natural resource. This is not surprising as the adjective "natural" abnegates inclusion of a structure made by man. To my knowledge no other State has formally claimed that shipwrecks constitute a continental shelf natural resource. Parenthetically I would also point out that the Truman Proclamation of 1945 was the prototype and catalyst on which the continental shelf doctrine of other States was based, and it in no way encompasses shipwrecks within its coverage.

It has long been recognized in international law that a coastal State enjoys jurisdiction over the natural resources of its continental shelf. In the 1958 Geneva Convention on the Continental Shelf, natural resources are defined as consisting of the "mineral and other non-living resources of the seabed and subsoil together with living organisms belonging to sedentary species, that is to say, organisms which, at the harvestable stage, either are immobile on or under the seabed or are unable to move except in constant physical contact with the seabed or the subsoil." The 1982 Law of the Sea Convention also recognizes the sovereign rights of the coastal State over the natural resources of its continental shelf for the purpose of their exploration and exploitation.

If there were any doubt at all about the non-inclusion of shipwrecks within the definition of natural resources of the continental shelf, two ineluctable facts contained in the 1982 Convention are proof positive in dispelling that doubt. First, and to my mind most significant, Article 303 of the Convention, entitled "Archaeological and historical objects found at sea," provides several pertinent indicia.

If, for example, Article 303(2) permits the coastal State within its contiguous zone (the bottom of which is of course subsumed within the continental shelf of a State) to presume that the removal of a shipwreck without its prior approval would result in an infringement within its territory or territorial sea of its contiguous zone competence, such a provision would be redundant were shipwrecks to constitute continental shelf natural resources, for the coastal State would then enjoy sovereign rights and jurisdiction over them, and the presumption would not be necessary. In similar vein, were shiprecks to be included within the definition of continental shelf natural resources, it would be inconsistent to impose, as does Article 303(1), a duty on the coastal State to cooperate with other States to protect objects if they were an archaeological and historical nature. At the very least the drafters would have included a provision in Article 303(1) to the effect of "Notwithstanding the sovereign rights of a coastal State over its continental shelf natural resources recognized in Article 77(1) ...". This type of caveat formulation appears throughout the Convention when two otherwise inconsistent provisions ae included (*e.g.*, Article 233). To sum up the above relevance of Article 303 with regard to the issue before us, the maxim *inclusio unius est exclusio alterius* is apt.

Second, given that Article 7 recognizes coastal State continental shelf sovereign rights for the purpose of exploring and exploiting its natural resources, when has one been said to "explore and exploit" a shipwreck, particularly one of an archaeological and historical nature? The very choice of words itself belies the proposition that shipwrecks constitute continental shelf natural resources.

I would like before concluding my remarks to make a few parting observations regarding the status of shipwrecks which lie on the ocean floor beyond the limits of natural jurisdiction, a subject which was addressed briefly last year. As you know (and I need not repeat the U.S. position on Part XI of the Convention), Article 136 of the Convention provides that the Area and its resources are the common heritage of mankind, which are not subject to alienation. "Resources" are defined as "all solid, liquid or gaseous mineral resources *in situ*...". "Activities in the Area" mean all activities of exploration for an exploration of resources. Article 157 is the single and principal grant of power to the Authority. This authority organizes and controls activities in the Area. Since salvage and recovery of historic objects are not "activities in the area", the authority has no powers in regard to archaeological and historical objects. Article 149 provides, in language reminiscent of Article 303, that all objects of an archaeological and historical nature found in the Area shall be preserved or disposed of for the benefit of mankind as a whole, particular regard being paid to the preferential reights of the State or country of origin, or the State of cultural origin, or the State of historical and archaeological origin. Several relevant points should be noted.

First, there is no doubt that warships and other ships entitled to sovereign immunity remain inviolate and unaffected by Article 149. As Article 95 provides that warships on the high seas have complete immunity from the jurisdiction of any State other than the flag State, a non-sovereign entity such as the Authority can in no way enjoy a power-precluded State. Second, it is important to note that Article 149 refers to the preferential rights of the State or country of origin with regard to objects (*viz.*, ships) of historical and archaeological nature. It is unclear how this restricts the application of the power of the Authority to "preserve or dispose" of such objects for the benefit of

mankind as a whole (itself a rather ill-defined power), but it certainly restricts it. Finally, and most importantly, whatever the reach of Article 149, it can in no way be likened to the exercise of sovereign authority of a coastal State in its territorial sea over shipwrecks as provided for in Article 303 (and extended as a presumption in Article 303 to the contiguous zone), for Article 303 is based on *sovereign* rights, and not, as is the case of Article 49, on the powers granted a non-sovereign entity which at best enjoys international personality for very limited purposes. The U.S. position on Part XI aside, I believe that Article 149 would have very little practical effect on the rights of salvors or owners of objects of historical and archaeological value, and none, as stated previously, on warships.

As all of us here today know full well, dispositive answers to law of the sea issues are not frequently found within the provisions of the 1982 Convention. However, I believe the above indicia are more than substantial ones in proving the merit of my proposition, and I hope they have shed some light on the subject.

John Craven: I have a long personal interest in this question of whether a naval ship is salvageable. In the Civil War, one of my ancestors who had the grace of having children before the war was the captain of the iron-plated ship *USS Tecumseh* which was sunk in Mobile Bay and is now the subject of a salvage dispute between Alabama and the federal government as to whether it is salvagable. In my own personal career, I have had the good fortune of being in charge of the search for the H-bomb off of Palomares and the submarine *USS Scorpion* in the Atlantic and I may have or may have not been involved with some operations in the Pacific. [laughter]

In all of these operations, a part of the plan of the operation was a detailed study of this question as to whether or not a warship is capable of salvage.

I cannot tell you the results of those studies because they are all classified. But I will tell you that the results are all different [laughter] depending upon the vessel to be salved and the particular operation. I will also point out that Senor Cortez, a fisherman of Palomares who saw the H-bomb go into the water, appeared in the federal court in New York with his attorney, Herbert Brownell, suing for salvage rights for seeing the bomb fall into the water. And the suit pointed out that the salvage right for seeing the wreck go down is a very small percentage, about one or two percent of the intrinsic value of the object being salved. Intrinsic value means value to the owner. The suit alleged that the Secretary of Defense had indicated that the salving of the H-bomb by any other nation would cost the United States two billion dollars in loss of information and so this was a suit for one percent of two billion dollars. [laughter] I'm sorry that the case never got to trial because we don't have a legal precedent but it was settled out of court and I don't know if this is an acknowledgement on the part of the U.S. government that a military device is capable of salvage, but Senator Cortez is a very wealthy man. [laughter]

Edgar Gold: Brian, you mentioned the U.S. regulation which allows the State to take custody of a wreck within the territorial sea. As a matter of fact Canadian law does not specify the territorial sea. It simply says that wrecks in or near the coast of Canada must be handed over to the Receiver of Wreck. The Receiver of Wreck is not the Salvation Army, but it is, in actual fact, a senior Coast Guard officer. I believe United States jurisdiction is somewhat similar.

If you are concerned at this particular stage, and we have heard from Woods Hole that the technology is available for people to visit the wreck, and we want, in the interim, to protect the wreck, would it not be right at least for some State to take over some type of custodial responsibility until such time as the law is clarified?

At present anybody can go down there because we all agree that there is no real jurisdiction. There are these "quasi" types of jurisdictions but no real jurisdiction and it is rather similar to the case of the *Alabama*, which you mentioned, where you would like to do something but you feel you don't have the jurisdiction. As a result if anybody goes down to the *Titanic* now there is really no custody.

Brian Hoyle: The United States established a marine sanctuary around the *USS Monitor* and Congress suggested establishing a marine sanctuary around the *Titanic* at one point until it was pointed out to Congress that this was a British flag vessel on the high seas or on Canada's continental shelf, and that both the U.K. and Canada might not take kindly to the notion of a marine sanctuary being established either around their flag vessel or on their continental shelf. At that point Congress backed off. It is not an easy question to answer and I, quite frankly, never dreamed we would have as much trouble as we did, when Congress enacted the Titanic Act, trying to obtain the cooperation of the U.K. and France, particularly in establishing what really would have been nothing more than agreed-upon guidelines to impose on our nationals to act responsibly to agree upon what scientific methods of preservation should be employed, and what techniques will be used, so that no one would go in there like a bull in a china shop and wreck something before he realized what he was doing. And no one seemed to want any part of it. I am not overly optimistic that this is an easily soluble problem.

Edgar Gold: Well, may I make just one supplementary comment on that one. As a matter of fact, when David VanderZwaag first started to look into this, I, in actual fact, called the Receiver of Wreck, who is the Regional Director of the Canadian Ministry of Transport in Halifax and I said: why do you not take custody over the *Titanic*? And he, as a senior civil servant, was silent for at least 16 or 17 seconds and then he said, "Well, but why should I?" I said, "Because it says so in the Canada Shipping Act." And he said, "Well, I will have to speak to External Affairs about that." That was six months ago, but I have had no answer so far.

Gerard Mangone: First a comment. I am very grateful to Mr. Hoyle for the discussion, but I want to clarify, as I understand them, the differences in maritime law between salvage and findings. Those terms were used interchangeably.

As I understand maritime law, there is no conversion of title on the salvage; it is simply a matter of the reward for the risks and perils and for the maritime objects that are taken. There is, of course, the question as to whether there was true abandonment, whether there was still constructive possession of the ship. He argues that he could show that after 75 years. I am not quite sure that after all the insurance claims were paid the vessel would be more or less in oblivion. The new technology for deepsea exploration would raise questions of constructive possession. If we are seeking new forms of international law, what consideration should we give to incentives to recovering vessels? The law of salvage, after all, was designed for a common good, mainly that salvors should take the risk in order to rescue vessels from peril or to recover some of their value. Why did Woods Hole go out to the *Titanic*? Well, the incentive was not the vessel itself, but the technology for observation and recovery in the future. What international law is needed for the deep seabed? Certainly not a marine memorial that essentially serves as a preserve that no one can tread upon. How will you raise archeological rewards without some kind of constructive opportunity? That is the question.

Brian Hoyle: I think it is extremely important to preserve the law of salvage. It serves a very important role in maritime commerce. Archeological significance is a little easier to try to determine, but there is a

much greater remoteness in time. But certainly the *Titanic* is of historical interest. IMO and the SOLAS conventions really trace their origin to the *Titanic* convention or the *Titanic* disaster, so I think there is a tremendous amount of historical interest totally aside from the large number of lives lost and the emotion attached to that. But it seems to me that, at some point, we need to work on where one moves from a vessel subject to salvage under the normal commercial rules, to something which has achieved this historic importance, which sets it aside from the normal salvage rules.

Gerard Mangone: I am still groping for the law that would encourage people to search for those treasures without some sort of reward.

Brian Hoyle: That's a real problem. I think it is very possibly demonstrated by Senator Weicker's Act which was enacted precluding any importation into the United States of objects taken from the *Titanic* if they are imported for profit. Now, does that mean that a show of *Titanic* objects brought into the United States is prohibited if that show is brought here with the objective of earning a profit? Because if it does then the citizens of the United States will probably be precluded from seeing a show that will certainly travel to all other countries with an access to the *Titanic* and these citizens will enjoy the fruits of the recovery operation.

Howard Strauss: I would like to mention just a comment in relation to the point you raised. We did try at one IMO meeting to get Britain and France to cooperate and not raise objects from the *Titanic*. And we met with the same lack of success that you did. We took one practical measure to try and frustrate their efforts. The French wanted to use the ROV 5000, the remote-operated vehicle that was being developed by our Department of Fisheries and Oceans, and we tried to get them not to raise objects, just to use it for photography, and they said no. So we turned down their requests to use the submersible and they went ahead with a French submersible.

Brian Hoyle: Just as an aside, when my deputy, Peter Bernhardt, was a little boy of 12 years old he sent a dollar to Cunard offering to buy the *Titanic* and they returned his dollar to him with a letally very well drafted note, not really claiming ownership of the vessel but making clear that they were not willing to sell their ownership for a dollar or any other amount. [laughter]

Howard Strauss: Perhaps one last comment on the question of MSR. We did an awful lot of toing and froing on whether salvage was MSR and it wasn't an easy question. I guess in the end we decided not to press the issue.

Brian Hoyle: Well, the danger is, isn't it, that you would propel the group into claiming that they were engaged in salvage, and then you would lose any nexus over your ability to have them cooperate with you.

Howard Strauss: At least then you would be forced to address the question as to the rights of salvage. I'm not sure we wanted to do that. [laughter]

Daniel Elder: The U.S. and Canada are signatories to the World Heritage Convention. Might they use that convention and declare the place a cultural site?

Brian Hoyle: That route was looked into and received no more enthusiasm than more direct approaches. Basically, the problem really came down the same: no one wanted to foreclose any options.

Tullio Treves: Well, I think we can come to a conclusion. This subject has been very fascinating. It verges on the borderline not only of jurisdictional questions but also of more general questions of international law including immunity of warships and the status in international law of the law of salvage. The latter is a thorny point to which, perhaps, we could come back in another Law of the Sea Institute meeting. Thank you all.

PART III

IMPACTS OF NEW DEVELOPMENTS ON THE EXPLOITATION AND MANAGEMENT OF LIVING MARINE RESOURCES

PANEL III

INTRODUCTION

Edward Wolfe: It is always a pleasure to attend these functions and I wish to tip my hat to the organizers: you always manage to gather an impressive and significant body of ocean experts to discuss the current issues we are confronting.

Today's session discusses new developments in the field of living marine resources, and we have with us an excellent panel of experts. Before I introduce our speakers and panel, I would like to briefly discuss a "new development" that is currently troubling the west coast and, specifically, the Alaskan fishing industry; that of foreign fishing in the Bering Sea area, just beyond the U.S. and Soviet jurisdictions, the so-called "donut" area. In the early to mid-1980s foreign fleets caught relatively small quantities of fish in the donut region. Over the past three years, however, fishing efforts in this area by Japan, Poland, Korea, and China have increased dramatically and it is estimated that about 1 million metric tons of pollack were harvested in both 1986 and 1987. Furthermore, there has been new evidence presented in January 1988 suggesting that some foreign fishing vessels may fish illegally in the U.S. EEZ and report their catch as having come from the donut area.

In light of the potential conservation problems for fish stocks in the U.S. EEZ, the United States has recently initiated negotiations with foreign countries regarding the Bering Sea donut fisheries. The first step in this process has been the establishment of a U.S.-Soviet working group to consider the legal, technical, and enforcement aspects of this issue. Because the fish stocks in the "donut" straddle both the U.S. EEZ and the Soviet EEZ, cooperation between the two coastal countries is essential for considering conservation measures. Once the work of this bilateral working group is completed, it is anticipated that the United States will approach other countries regarding the conservation of fisheries stocks in the donut area.

The Bering Sea donut issue raises several new legal and policy issues regarding fisheries in an area beyond national 200-mile zones. It is clear that harvesting countries in such a region do not have a right, under accepted international legal principles, to expand their fisheries to the detriment of the United States in this case or other interested States. On the other hand, measures adopted for conserving fisheries stocks must not hamper legitimate high seas rights, such as freedom of navigation. It is anticipated that the problems associated with the Bering Sea donut fisheries will be one of the primary international fisheries issues in the Pacific Northwest over the next several years.

In this regard, I am happy to announce that a new comprehensive fisheries agreement between the U.S. and USSR was signed in Moscow on May 31 by Secretary Shultz and Foreign Minister Shevardnadze. The agreement addresses this issue in both its preamble and in a specific article which establishes a basis for the Soviets and the United States to consult and cooperate on appropriate conservation and management measures for living marine resources in international waters and beyond their respective 200-mile zones.

Regarding the issue of tuna and the South Pacific, the United States will deposit its instrument of ratification in Port Moresby, Papua New Guinea tomorrow, June 15, 1988. An agreement will enter into

force with fourteen Pacific island states, allowing the U.S. fleet to fish in approximately ten million square miles of ocean in the South Pacific. We began this negotiation in 1984. It has been a long process, but I think it is in the best interests of the United States and our allies in the South Pacific. I would like to personally thank Judy Swan, from the Forum Fisheries Agency, for all of her efforts in getting us to this point.

Large Marine Ecosystems: A Case Study

Kenneth Sherman
Narragansett Laboratory
Narragansett, Rhode Island

A new era in ocean use was initiated when, in 1982, the United Nations Law of the Sea Convention established exclusive economic zones up to 200 miles from the baselines of territorial seas, granting coastal States sovereign rights to explore, conserve, and manage the natural resources of the zones. Within the boundaries of the new economic zones are large marine ecosystems (LMEs) that are being subjected to increased stress from growing exploitation of renewable resources, the dumping of urban wastes, and the fallout from aerosol contaminants. LMEs are defined as relatively extensive areas of unique bathymetry, hydrography, and productivity within which populations have adapted reproductive, growth, and feeding strategies (e.g., North Sea, California Current, Northeast Continental Shelf, Gulf of Mexico). Populations of LMEs can be altered significantly by natural and anthropogenic changes leading to severe economic consequences in some coastal States, and increasing yields in others.

Nearly 95 percent of global biomass of usable marine resource is produced in LMEs within the newly expanded exclusive economic zones of coastal States. Large-scale shifts in biomass yields have been reported for LMEs. Decadal fluctuations in abundance of populations of the Northeast Continental Shelf ecosystem have been investigated in support of the conservation and management of the fisheries resources of the region. The fish stocks were reduced by 50 percent during the mid-1960s through 1970s. Based on an analysis of the trophodynamics and oceanography of the Northeast Shelf system, it appears that the fishing mortality imposed on the ecosystem was sufficient to cause a significant multimillion metric ton flip in dominance among herring, sand eels, and mackerel stocks. The fish component of the ecosystem is now showing evidence of recovery, indicating that the lower end of the food chain remains robust. The Northeast Shelf ecosystem is considered by the author as a predator-driven system that presents an array of options to maximize sustained yields of fishery resources contingent on the goals of fisheries management.

An Ecosystem Perspective of Ocean Biomass Yields

Controversy surrounds the prediction of annual global levels of marine fisheries biomass yields. The annual yield based on FAO statistics in 1976 was 59.1 million metric tons (mmt). By 1986 the annual yield was 77.3 mmt. The increase is largely from the population explosions of herring within the Oyashio/Kuroshio Current ecosystems off the coast of Japan and the Humboldt Current ecosystem off the Chilean coast. The potential of increased yields from these ecosystems was not predicted in the yield projections given in the *Global 2000 Report* prepared in the mid-1970s (Council on Environmental Quality, 1980) which estimated the annual global yields to remain about 60 mmt. In contrast, a level of 100 to 120 mmt was the estimated annual yield by the year 2000 in *The Resourceful Earth* (Wise, 1984). The divergence in yield estimates is not unexpected when one considers the meager efforts presently underway to

overcome the gaps in knowledge between the primary productivity of the sea (Platt and Sathyendranath, 1988) and global yields of usable biomass. Earlier estimates of 70 mmt reported by Ryther (1969) were challenged as too low by 50 percent (Alverson *et al.*, 1970). The estimate of 100 to 120 mmt offered by FAO (Gulland, 1971) was acknowledged as an approximation that would require considerable refinement to understand the process of food chain energy transfer. Since 1971, little progress has been made on this topic (Lasker, 1988).

Fisheries resources that were previously shared among nations are now under national regulation. In accordance with the tenets of the Law of the Sea, extensions of national jurisdictions have been claimed over the 200-mile Exclusive Economic Zones (EEZs) of maritime nations. Restrictions on the use of fisheries within the EEZs are often imposed with little regard for the natural boundaries of marine ecosystems. Most coastal populations of fish are highly mobile, migrating hundreds to thousands of kilometers within relatively large marine ecosystems where they grow, reproduce, and die. Critical spawning strategies and feeding migrations have evolved since the last ice-age that are difficult to understand unless observed throughout the population ranges of the stocks under investigation.

Future progress in estimating annual global yields is unlikely without benefit of measurement of biological energy transfers in the ocean at the appropriate regional scales (Ricklefs, 1987). LMEs have been proposed as the appropriate spatial scale for investigating and managing events controlling the yields of living marine resources. The LMEs are extensive areas, generally greater or equal to 200,000 km^2 in extent, within which biological communities have evolved in response to unique bathymetry, hydrography, and productivity (Sherman, 1986). The designation of LMEs as global management units is based not only on biological and physical criteria, but also on the basis of geopolitical, legal, and economic considerations (Alexander, 1986; Christy, 1986; Morgan, 1988; Belsky, 1989).

Within the EEZ of the United States seven LMEs have been identified within which studies are underway to improve the information base for forecasting changes in biomass yields -- Northeast Continental Shelf, Southeast Continental Shelf, Gulf of Mexico, California Current, Gulf of Alaska, East Bering Sea, and Insular Pacific including the Hawaiian Islands. The aerial extent of the ecosystems is shown in *Figure 1*. Biomass assessment programs are being conducted from an ecosystem perspective by NOAA's National Marine Fisheries Service. They have been described in detail by NOAA's Office of Oceanography and Marine Assessment (NOAA, 1988).

The research strategy employed by NMFS can, in my view, be considered part of a hierarchial system designed to link local events to those of regional and global significance (*Table 1*).

Increasing attention has been focused over the past few years on synthesizing available biological and environmental information influencing the natural productivity of the biomass yields within LMEs. Of the 18 LMEs for which syntheses have been reported (*Figure 2*), initial determinations indicate that in four -- the Yellow Sea, Gulf of Thailand, Great Barrier Reef, and the Northeast Continental Shelf -- the controlling variable in relation to species yields of the biomass appears to be predation. Major changes in the Great Barrier Reef ecosystem have been attributed to the predation effect of the crown-of-thorns starfish (Bradbury and Mundy, 1989). The principal variable in the other three is recruitment over fishing, considered for purposes of

this discussion as human predation (Tang, 1989; Piyakarnchana, 1989; Sissenwine, 1986). For six other LMEs the predominant variable is environmental change -- Oyashio, Kuroshio, (Minoda, 1989; Terazaki, 1989), California Current (MacCall, 1986a), Humboldt Current (Canon, 1986), Iberian Coastal (Wyatt and Perez-Gandaras, 1989), and Benguela Current (Crawford *et al.*, 1989). It appears that the dominant influence on the Baltic is coastal pollution (Kullenberg, 1986). For the remaining LMEs, the information for making an initial determination is inconclusive.

The Case Study: The Northeast Continental Shelf Ecosystem

Those LMEs controlled by natural predation and fishing predation offer more options for increasing yields through directed fishing effort, or species enhancement, than exist for stocks in environmentally controlled LMEs.

The biomass of commercially important fish stocks of the Northeast Continental Shelf ecosystem declined by approximately 50 percent between 1968 and 1975 (*Figure 3*). The principal cause of the loss of biomass is thought to be excessive fishing mortality on juvenile and adult stocks (Clark and Brown, 1977; Sissenwine, 1986). The predominance of the Atlantic herring, *Clupea harengus*, of Georges Bank "flipped" with sand eel, *Ammodytes* spp. (*Figure 4*). A biomass flip occurs when the population of a dominant species rapidly drops to a very low level and is replaced by a second species. Sand eel, herring, and mackerel inhabit, at least for part of the year, the same areas on Georges Bank and the Southern New England continental shelf. Evidence of herring predation on sand eel, sand eel predation on herring larvae, and mackerel predation on the early developmental stages of both species has been observed on the Northeast Continental Shelf (M.D. Grosslein, personal communication), and for the North Sea, where the distribution of the three species overlap. It is possible, in the absence of any prolonged environmental signal, that the decline in both herring and mackerel stocks during the mid-1970s released predation pressure on sand eel and allowed the population to explode (Sherman *et al.*, 1981). Fishing mortality has been reduced on herring and mackerel stocks since the mid-1970s. No fishery exists for sand eel. It appears that the reduction of fishing mortality on mackerel and herring has allowed the stocks to begin a recovery trend. The present biomass of mackerel is estimated at 1.4 mmt and is increasing. Also, evidence of herring returning to Georges Bank has been reported from the recent discovery of juveniles in stomachs of spiny dogfish, *Squalus acanthius*, and other predators.

Unlike the North Sea, for which recent climatic changes have been reported (Garrod and Colebrook, 1978), no long-term climatic change has been observed for the Northeast Shelf ecosystem. The dominant features of the physical oceanography of the system are the seasonal cycle of changes in temperature and water column structure (*Figure 5*) and the non-tidal circulation features depicted by a large counter clockwise gyre in the Gulf of Maine, a clockwise gyre on Georges Bank, and southwesterly flow of waters along the shelf south and west of Georges Bank. The general circulation pattern is interrupted periodically throughout the year by the east-to-west passage of warm core rings along the shelf-slope front (*Figure 6*). The level of primary production remains high with values ranging from 500 $gC/m^2/yr$ in the mid-Atlantic Bight to 260 $gC/m^2/yr$ in the vicinity of the shelf-slope front (*Figure 7*). Zooplankton production has been estimated for both macrozooplankton ($57\,mgC/m^2/day$) and microzooplankton ($75\,mgC/m^2/day$). The predominant zooplankton are copepods, which undergo a marked seasonal succession in

abundance among four subareas of the Northeast Shelf ecosystem. The Gulf of Maine is dominated by the copepod *Calanus finmarchicus*, whereas the number of dominants increases southward to the mid-Atlantic Bight where the abundance of several species of copepods is augmented by cladocerans (*Figure 8*).

No declining trend in primary production, or zooplankton biomass, has been detected (Sherman *et al.*, 1983a). The energetics of the shelf ecosystem appear tightly bound in relation to fish production. Recent estimates on the Georges Bank subarea place fish predation on fish at 70 percent of annual production, followed by approximately 10 percent as fisheries yield, 10 percent consumed by marine mammals, 5 percent by marine birds, and 5 percent by apex predators, including sharks, tunas, and billfish (Sissenwine, 1986). The estimated 70 percent predation of large fish on smaller sizes of fish within the Northeast shelf ecosystem offers the potential that selected fishing for large size classes of highly predatory Atlantic cod (*Gadus morhua*) and silver hake (*Merluccius bilinearis*) could increase fisheries yields from the present level of 10 percent of the total natural finfish production of the ecosystem (Fogarty *et al*, 1987). A multispecies predator-prey model of the North Sea fish stocks suggests that by selectively eliminating large Atlantic cod through targeted fishing, the total fishery yields from the North Sea ecosystem could increase threefold (Andersen and Ursin, 1977).

Another example of biomass flips occurred in the Northeast Atlantic, where the dominance of species among the finfish stocks of the North Sea ecosystem changed during the 1960s. The pelagic herring and mackerel yields decreased from approximately 5 mmt to 1.7 mmt whereas sand eel, Norway pout, and sprat increased by about 1.5 mmt along with an approximate 36 percent increase in gadoid yields. Both density-dependent predation and density-independent environmental changes have been proposed as processes controlling recruitment and causing the biomass flips (Hempe, 1978). None of the arguments, however, can be considered more than speculative at this time without a better understanding of the recruitment process within the North Sea ecosystem. The need for more systematic measurements of variability within the North Sea ecosystem from a fisheries perspective has been acknowledged (Hempel, 1978; Daan, 1986) and is presently underway (ICES, 1987).

Management of LMEs and Global Change

The evidence for global change is growing in relation to ozone depletion (Cicerone, 1987) and the apparent increasing levels of atmospheric CO_2 (NAS, 1979). Against this background of change is the increase in global yields of fisheries biomass. The higher biomass yields appear to reflect natural increases in productivity within coastal upwelling ecosystems. In contrast, the yields from predation-driven ecosystems are in decline in at least two ecosystems -- the Northeast Continental Shelf and the Yellow Sea.

More enlightened management of living marine resources, based on an improved understanding of the density-dependent processes controlling new recruitment to the species within these ecosystems, can lead to improvement in yields. New hypotheses are being developed and tested to determine the relationship between environmental and physical factors on variability in the abundance of fish populations.

Although the new ecosystems approach to management of living resources is in the developmental stages within the United States (Marchesseault, 1986; MacCall, 1986b), it is being practiced in at least one major international management agency, the Commission for the

Conservation of Antarctic Marine Living Resources (CCAMLR). The CCAMLR has adopted a conservation approach that seeks to:

1. Prevent any harvested population from falling below the level that ensures the greatest net annual increment to stable recruitment;
2. Maintain the ecological relationships between harvested, dependent, and related populations of Antarctic living marine resources;
3. Restore depleted populations; and
4. Prevent or minimize the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades.

The importance of the CCAMLR ecosystem approach to conservation and management of living marine resources is underscored by its membership. Among the 19 countries that are signatories are the principal fishing nations of the world, including Chile, Japan, U.S., and the USSR. Whether these countries will adopt a more holistic ecosystem approach to fisheries management following the CCAMLR model remains an open question.

Comparative studies of natural fisheries production among different LMEs can lead to the narrowing of problems, and the avoidance of duplication in effort. It is likely that a systematic approach to the study of LMEs by the international scientific community including oceanographers, fisheries scientists, marine ecologists, and resource managers will lead to cost-saving advantages and more rapid application of findings to the conservation and management of living marine resources.

LITERATURE CITED

Alexander, L.M. 1986. Introduction to part three: Large marine ecosystems as regional phenomena. pp. 239-240. *In* K. Sherman and L.M. Alexander (eds.) Variability and management of large marine ecosystems. AAAS Selected Symposium 99, Westview Press, Boulder, CO., 319 pp.

Alverson, D.L., A.R. Longhurst, and J.A. Gulland. 1970. How much food from the sea: Science 168:503-505.

Andersen, K.P., and E. Ursin. 1977. A multispecies extension to the Beverton and Holt Theory of Fishing, with accounts of phosphorus circulation and primary production. Medd. Danm. Fisk.-og. Havunders. N.S. 7:319-436.

Belsky, M. 1986. Developing a management regime for large marine ecosystems. *In* K. Sherman and L.M. Alexander (eds.) Variability and management of large marine ecosystems. AAAS Selected Symposium 99, Westview Press, Boulder, CO., pp. 145-174.

Bradbury, R., and C.N. Mundy. 1989. Large scale shifts in biomass of the Great Barrier Reef ecosystem. *In* K. Sherman and L.M. Alexander (eds.) Biomass and geography of large marine ecosystems. AAAS Symposium Series, Westview Press, Boulder, CO., (in press).

Canon, J.R. 1986. Variabidad ambiental en relacion con la pesqueria neritica pelagica de la zona Norte de Chile, pp. 195-205. *In* P. Arana (ed.) La Pesca en Chile. Escuela de Ciencias del Mar, Facultad de Recursos Natjurales, Universidad Catolica de Valparaiso, 359 pp.

Christy, F.T., Jr. 1986. Can large marine ecosystems be managed for optimum yield? pp. 263-267. *In* K. Sherman and L.M. Alexander

(eds.) Variability and management of large marine ecosystems. AAAS Selected Symposium 99, Westview Press, Boulder, CO., 319 pp.
Cicerone, R.J. 1987. Changes in stratospheric ozone. Science 237:35-42.
Clark, S.H., and B.E. Brown. 1977. Changes of biomass of finfishes and squids from the Gulf of Maine to Cape Hatteras, 1963-74, as determined from research vessel survey data. Fish. Bull., U.S. 73:1-21.
Colton, J.B., Jr., R.R. Marak, S. Nickerson, and R.R. Stoddard. 1968. Physical, chemical and biological observations on the continental shelf, Nova Scotia to Long Island 1964-66. U.S. Fish. Wildl. Serv., Data Rep. 23.
Council on Environmental Quality and the Department of State, U.S. Gerald O. Barney (Director). 1980. The global 2000 report to the president: Entering the twenty-first century, Vols. I-III, U.S. Government Printing Office, Washington, D.C.
Crawford, R.J.M., L.V. Shannon, and P.A. Shelton. 1989. Characteristics and management of the Benguela as a large marine ecosystem. *In* I. Sherman and L.M. Alexander (eds.) Biomass and geography of large marine ecosystems. AAAS Symposium Series, Westview Press, Boulder, CO., (in press).
Daan, N. 1986. Results of recent time-series observations for monitoring trends in large marine ecosystems with a focus on the North Sea, pp. 145-174. *In* K. Sherman and L.M. Alexander (eds.) Variability and management of large marine ecosystems. AAAS Selected Symposium 99, Westview Press, Boulder, CO., 319 pp.
Fogarty, M.J., M.P. Sissenwine, and M.D. Grosslein. 1987. Fish population dynamics. pp. 494-509. *In* R.H. Backus (ed.) Georges Bank. MIT Press, Boston, 593 pp.
Garrod, D.J., and J.M. Colebrook. 1978. Biological effects of variability in the North Atlantic Ocean, Rapp. P.-v. Reun. Cons. int. Explor. Mer 173:128-144.
Gulland, J.A. (Editor). 1971. The fish resources of the ocean. FAO, Fishing News (Books) Ltd., Surrey, England.
Hempel, G. 1978. Synopsis of symposium. *In* North Sea fish stocks - recent changes and their causes. Rapp. P.-v. Reun. Cons. Perm. Int. Explor. Mer 172:455-449.
ICES [International Council for the Exploration of the Sea]. 1987. Report of the Working Group on Larval Fish Ecology to the Biological Oceangraphy Committee of ICES, Hirtshals, Denmark 17-19 June 1987. ICES C.M. 1987/L:28.
Ingham, M.C., R.S. Armstrong, J.L. Chamberlin, S.K. Cook, D.G. Mountain, R.J. Schlitz, J.P. Thomas, J.J. Bisagni, J.F. Paul, and C.E. Warsh. 1982. Summary of the physical oceanographic processes and features pertinent to pollution distribution in the coastal and offshore waters of the northeastern United States, Virginia to Maine. Dep. Commerce, NEMP Oceanography Summary Rep., NEMP-IV-82-C-004.
Kullenberg, G. 1986. Long-term changes in the Baltic ecosystem, pp. 19-31. *In* K. Sherman and L.M. Alexander (eds.) Variability and management of large marine ecosystems. AAAS Selected Symposium 99, Westview Press, Boulder, CO., 319 pp.
Lasker, R. 1988. Food chains and fisheries; an assessment after 20 years. *In* B.P. Rothschild (ed.) Toward a theory on biological-physical interactions in the world ocean. D. Reidel Publishing Co., Dordrecht, Holland.
MacCall, A.D. 1986a. Changes in the biomass of the California Current ecosystem, pp. 33-54. *In* K. Sherman and L.M. Alexander (eds.)

Variability and management of large marine ecosystems. AAAS Selected Symposium 99, Westview Press, Boulder, CO., 319 pp.
MacCall, A.D. 1986b. Rethinking research for fishery and ecosystem management, pp. 179-193. *In* J.G. Sutinen and L.C. Hanson (eds.) Rethinking fisheries management, Proceedings from the tenth annual conference held June 1-4, 1986. Center for Ocean Management Studies, Univ. Rhode Island, 236 pp.
Marchessault, G.D. 1986. A New England Fishery Management Council perspective, pp. 167-177. *In* J.G. Sutinen and L.C. Hanson (eds.) Rethinking fisheries management, Proceedings from the tenth annual conference held June 1-4, 1986. Center for Ocean Management Studies, Univ. Rhode Island, 236 pp.
Minoda, T. 1989. Oceanographic and biomass changes in the Oyashio Current ecosystem. *In* K. Sherman and L.M. Alexander (eds.) Biomass and geography of large marine ecosystems. AAAS Symposium Series, Westview Press, Boulder, CO., (in press).
Morgan, J.R. 1988. Large marine ecosystems: An emerging concept of regional management. Environment 29(10):4-9 and 29-34.
NAS [National Academy of Science]. 1979. Carbon dioxide and climate: A scientific assessment. Climate Research Board, National Academy of Sciences.
NOAA [National Oceanic and Atmospheric Administration]. 1988. Fishery resource programs. Folio Map No. 7, A national atlas: Health and use of coastal waters, United States of America. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, Office of Oceanography and Marine Assessment, Washington, D.C.
Piyakarnchana, T. 1989. Yield dynamics as an index of biomass shifts in the Gulf of Thailand Ecosystems. *In* K. Sherman and L.M. Alexander (eds.) Biomass and geography of large marine ecosystems. AAAS Symposium Series, Westview Press, Boulder, CO., (in press).
Platt, T., and S. Sathyendranath. 1988. Oceanic primary production: Estimation by remote sensing at local and regional scales. Science 241:1613-1620.
Ricklefs, R.E. 1987. Community diversity: Relative roles of local and regional processes. Science 235:167-171.
Ryther, J.H. 1969. Photosynthesis and fish production in the sea. Science 166:72-76.
Sherman, K. 1986. Introduction to parts one and two: Large marine ecosystems as tractable entities for measurement and management, pp. 3-7. *In* K. Sherman and L.M. Alexander (eds.) Variability and management of large marine ecosystems. AAAS Selected Symposium 99, Westview Press, Boulder, CO., 319 pp.
Sherman, K. 1988. Large marine ecosystems as global units for recruitment experiments, pp. 460-476. *In* B.J. Rothschild (ed.), Toward a theory on biological-physical interaction in the world ocean. Kluwer Academic Publishers, Dordrecht, Holland.
Sherman, K., J.R. Green, J.R. Goulet, and L. Ejsymont. 1983a. Coherence in zooplankton of a large Northwest Atlantic ecosystem. Fish. Bull., U.S. 81:855-862.
Sherman, K., C. Jones, L. Sullivan, W. Smith, P. Berrien, and L. Ejsymont. 1981. Congruent shifts in sand eel abundance in western and eastern North Atlantic ecosystems. Nature 291:486-489.
Sherman, K., R. Lasker, W. Richards, and A.W. Kendall, Jr. 1983b. Ichthyoplankton and fish recruitment studies in large marine ecosystems, Mar. Fish. Rev. 45(10-11-12):1-25.

Sissenwine, M. 1986. Perturbation of a predator-controlled continental shelf ecosystem, pp. 55-85. *In* K. Sherman and L.M. Alexander (eds.) Variability and management of large marine ecosystems. AAAS Selected Symposium 99, Westview Press, Boulder, CO., 319 pp.

Tang, Q. 1989. Changes in the biomass of the Huanghai Sea ecosystem. *In* K. Sherman and L.M. Alexander (eds.) Biomass and geography of large marine ecosystems. AAAS Symposium Series, Westview Press, Boulder, CO., (in press).

Terazaki, M. 1989. Recent large-scale changes in the biomass of the Kuroshio Current ecosystem. *In* K. Sherman and L.M. Alexander (eds.) Biomass and geography of large marine ecosystems. AAAS Symposium Series, Westview Press, Boulder, CO., (in press).

Wise, J.P. 1984. The future of food from the sea, pp. 113-127. *In* J.L. Simon and H. Kahn (eds.) The resourceful earth. Basil Blackwell Inc., New York.

Wyatt, T., and G. Perez-Gandaras. 1989. Biomass changes in the Iberian ecosystem. *In* K. Sherman and L.M. Alexander (eds.) Biomass and geography of large marine ecosystems. AAAS Symposium Series, Westview Press, Boulder, CO., (in press).

TABLE 1

Ecosystem R & D Strategy for U.S. Fisheries
A Hierarchial System Based on Spatial-
Temporal Scaling Factors

Spatial	Temporal	Unit
1. **Global**	Millennia-Decadal	Biogeographic
2. **Regional**	Decadal-Seasonal	Large Marine Ecosystems
3. **Local**	Seasonal-Less Frequent	Subsystems

4. Biological Elements

   4.1 Spawning Strategies
   4.2 Feeding Strategies
   4.3 Recruitment, Production, Trophodynamics/Mortality

5. Environmental Elements

   5.1 Natural Variability
   Hydrography
   Currents
   Water Masses
   Weather

   5.2 Human Perturbations
   Fishing
   Waste Disposal
   Petrogenic Hydrocarbons
   Aerosols
   Eutrophication

6. Options and Advice

   6.1 Bioenvironmental and Socioeconomic Models
   International
   National
   Local

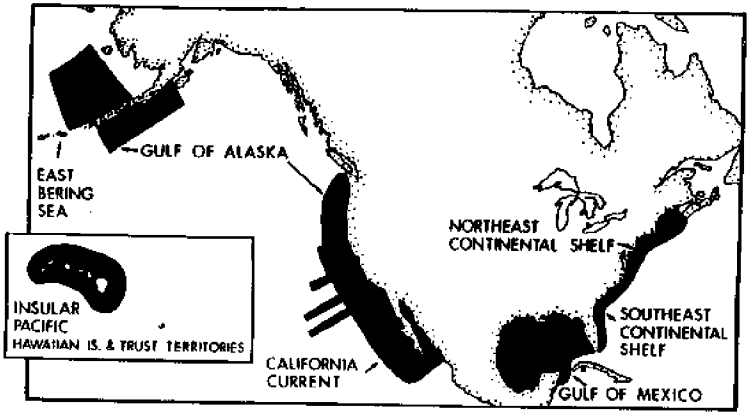
   6.2 Predictions to Optimize Fisheries Yields
   International
   National
   Local

7. Feedback Loop

   7.1 Evaluation of management results on fisheries yields
   7.2 Evaluation of management actions on socioeconomic practices

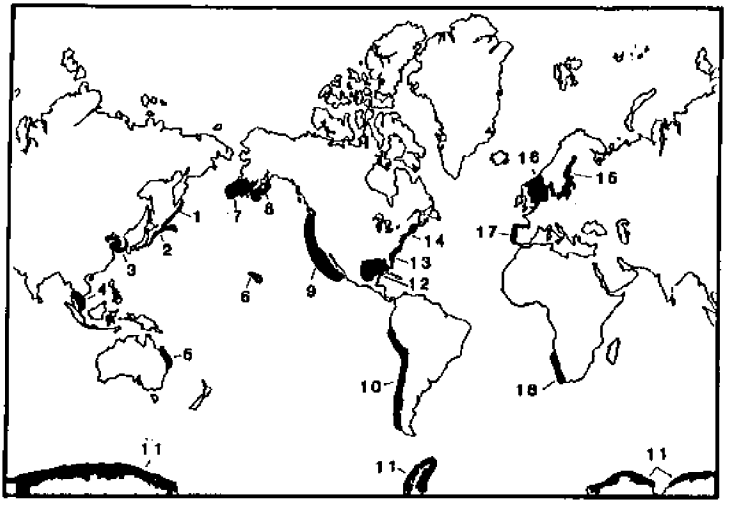
FIGURE 1

Large Marine Ecosystems Under Investigation (NMFS)



Large marine ecosystems (LMEs) where fishery stock assessment studies are underway by the National Marine Fisheries Service. (Adapted from Sherman *et al.*, 1983b).

FIGURE 2

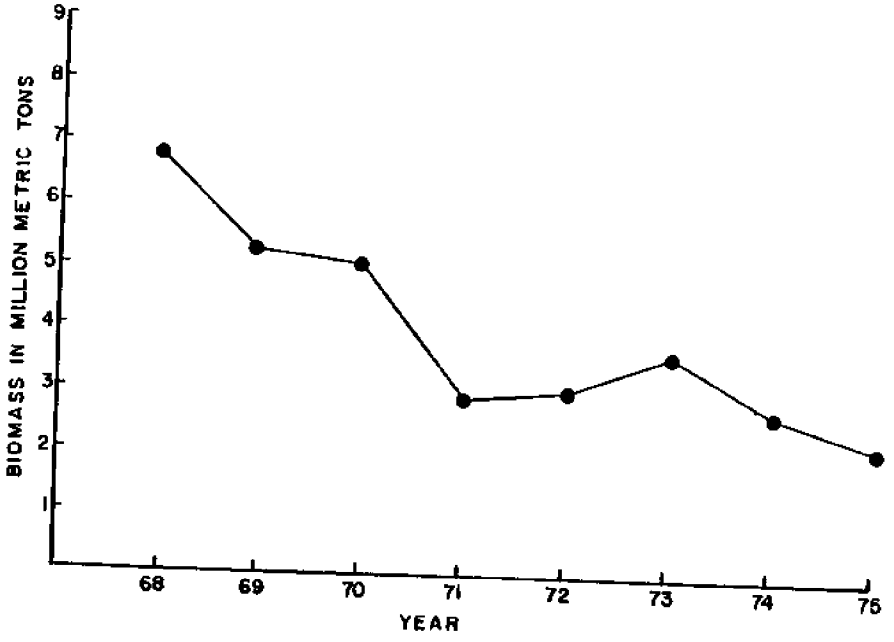


1 OYASHIO CURRENT ECOSYSTEM (0)
2 KUROSHIO CURRENT ECOSYSTEM (0)
3 YELLOW SEA ECOSYSTEM (X)
4 GULF OF THAILAND ECOSYSTEM (X)
5 GREAT BARRIER REEF ECOSYSTEM (X)
6 INSULAR PACIFIC ECOSYSTEM (+)
7 EAST BERING SEA ECOSYSTEM (+)
8 GULF OF ALASKA ECOSYSTEM (+)
9 CALIFORNIA CURRENT ECOSYSTEM (0)
10 HUMBOLDT CURRENT ECOSYSTEM (0)
11 ANTARCTIC ECOSYSTEM (+)
12 GULF OF MEXICO ECOSYSTEM (+)
13 SOUTHEAST CONTINENTAL SHELF ECOSYSTEM (+)
14 NORTHEAST CONTINENTAL SHELF ECOSYSTEM (X)
15 BALTIC SEA ECOSYSTEM (P)
16 NORTH SEA ECOSYSTEM (+)
17 IBERIAN COASTAL ECOSYSTEM (0)
18 BENGUELA CURRENT ECOSYSTEM (0)

Predominant variables influencing changes in fish species biomass in large marine ecosystems. Predominant variable -- Predation (X); Environment (O); Pollution (P); Insufficient Information (+). (From Sherman, 1988).

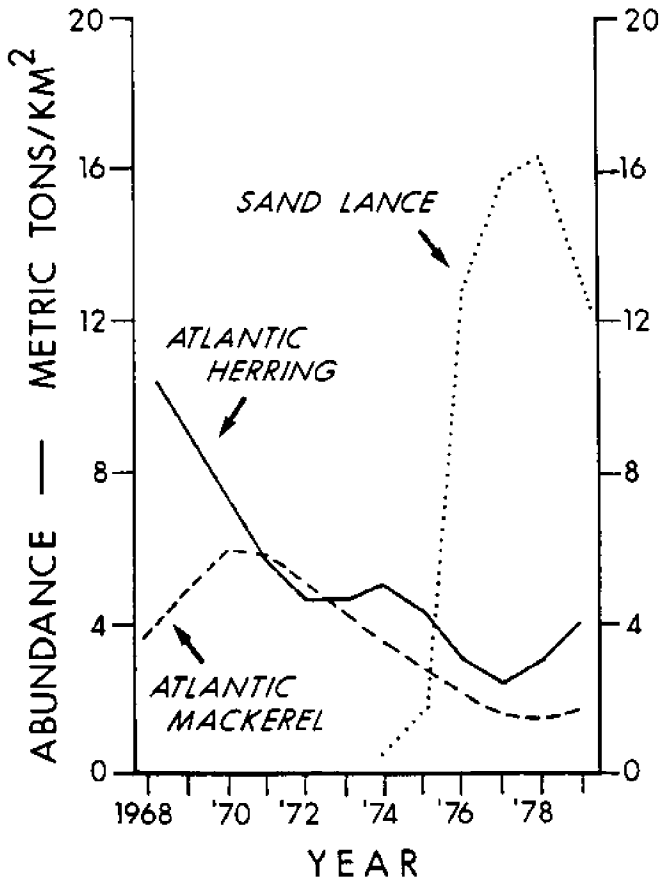
FIGURE 3

Fishable Biomass of Georges Bank, Gulf of Maine, and Southern New England



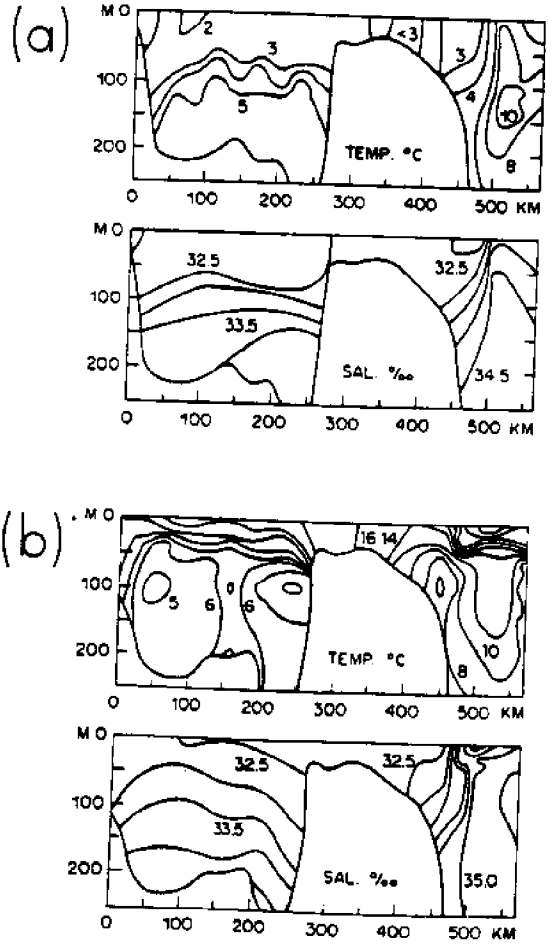
Decline in the fishable biomass of Georges Bank, Gulf of Maine, and Southern New England between 1968 and 1975. (Adapted from Clark and Brown, 1977).

FIGURE 4



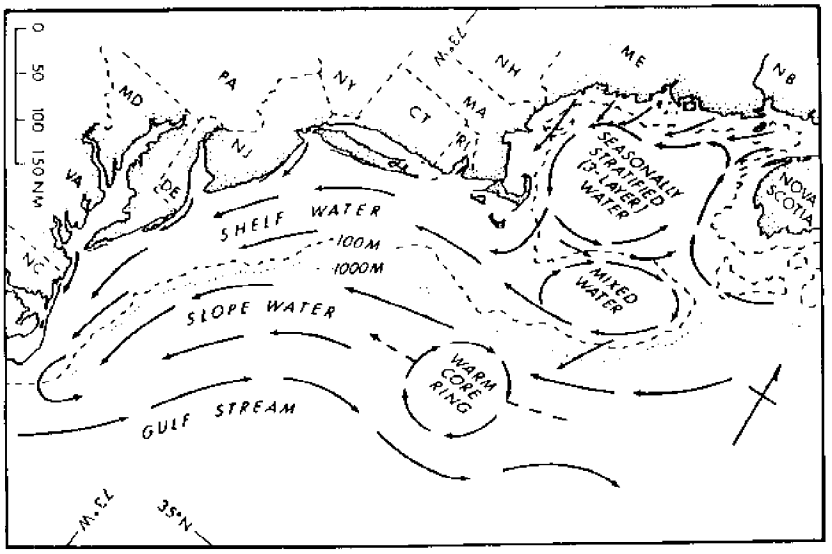
Decline of Atlantic herring and Atlantic mackerel and apparent replacement by the small, fast-growing sand eel in the Northeast Continental Shelf ecosystem (measured in metric tons per sq. km. 1968-1979). (From Sherman *et al.*, 1983b). Note: Sand eel and sand lance are used interchangeably).

FIGURE 5



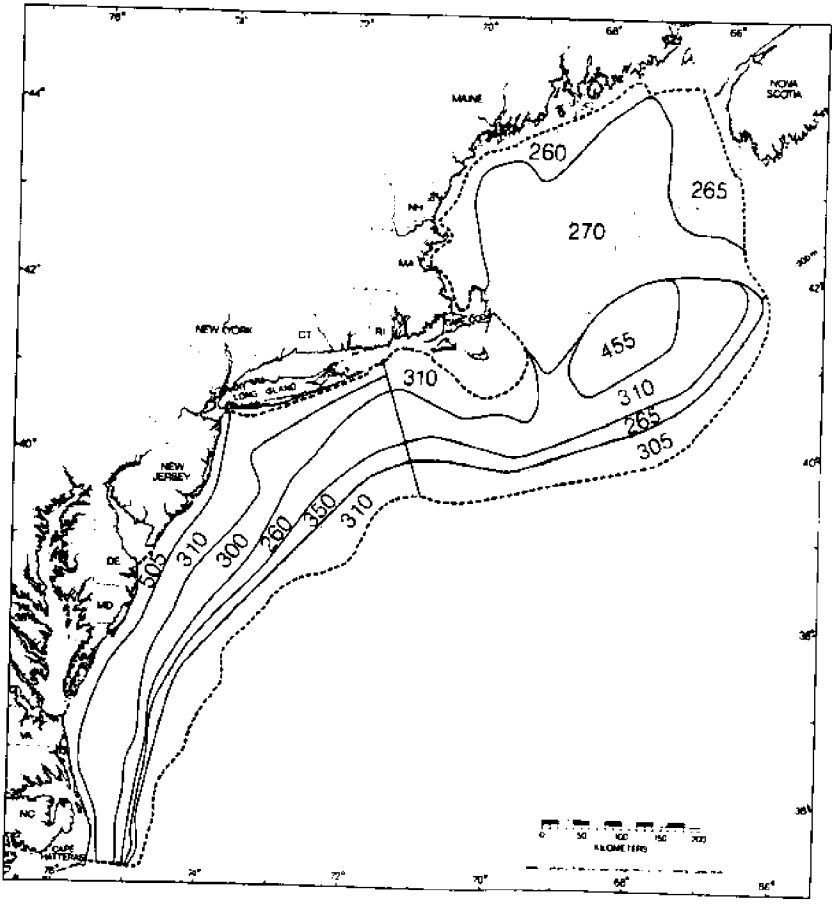
Water-column changes in temperature and salinity in the Gulf of Maine from early spring (a) March, to late summer (b) September 1965. (From Colton *et al.*, 1968).

FIGURE 6



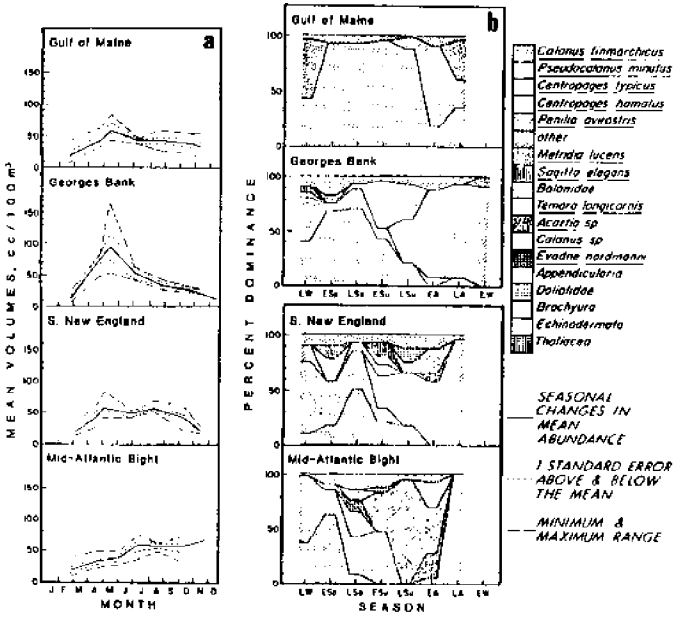
Mean, non-tidal surface circulation in the Gulf of Maine, Georges Southern New England, and the mid-Atlantic Bight. The northern se the shelf ecosystem is characterized by a cyclonic gyre and a sea stratified three-layered water-mass system over the deep basins Gulf of Maine, and mixed water with an anticyclonic gyre over th bottom of Georges Bank. Further south, the waters move southwes along the broad shelf of Southern New England to the narrower, s sloping shelf plain of the mid-Atlantic Bight. (From Ingham *et* 1982).

FIGURE 7



Estimated annual total primary production (particulate and dissolved organic carbon) from Cape Hatteras to Nova Scotia by subarea (gCm^{-2} yr^{-1} [1 gC = 10 kcal = 41.67 kJ]). (From Sherman, 1988).

FIGURE 8

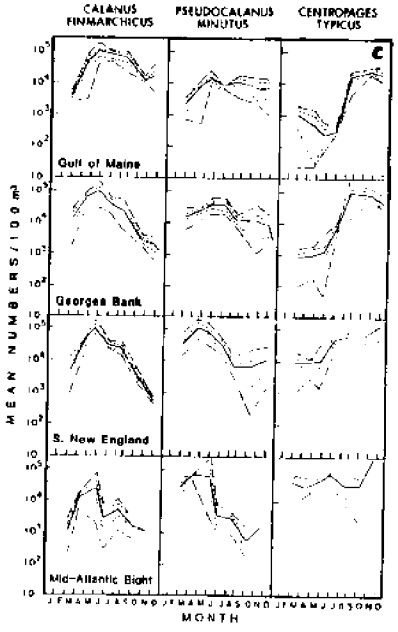


Patterns of zooplankton coherence in four northeastern U.S. continental shelf subareas -- Gulf of Maine, Georges Bank, Southern New England, and the mid-Atlantic Bight.

(a) Seasonal patterns in mean zooplankton standing stock (cc/100 m^3 for the 5-year MARMAP time-series. Solid line represents the mean, short dashed line is one standard duration, and long dashed line is the range.

(b) Seasonal patterns of dominance of zooplankton by subarea shown as a percentage of the samples with a dominant taxon on the 5-year MARMAP time-series. LW = late winter, ESp = early spring, LSp = late spring, ESu = early summer, LSu = late summer, EA = early autumn, LA = late autumn, EW = early winter.

FIGURE 8 (cont'd)



(c) Seasonal pulses in abundance of the three dominant copepod species -- *Calanus finmarchicus*, *Pseudocalanus minutus*, and *Centrophages typicus* (no./100 m^3) in each of the subareas for the 5-year time-series. Solid line represents the mean, short dashed line is one standard deviation, and long dashed line is the range.

(Adapted from Sherman *et al.*, 1983a).

Extended jurisdiction also made it more likely that an ecosystem, or at least large parts of an ecosystem, were within one nation's ocean space. Government regulators were forced to consider the interrelationships of species and the cumulative impact of marine activity on those species.[37]

Broader economic zones also increased the number of overlapping jurisdictional claims and the potential for conflict between adjacent coastal States. To avoid such conflict, cooperative action would be required to deal with resources in newly created disputed areas.[38] Adjacent States also sought to conserve any shared resources for the present and future use of their nationals[39] and to minimize adverse impacts on their coasts and adjacent ocean space from activities of nearby States.[40]

Government officials were, thus, forced to recognize that the need for multi-State cooperation in policy-making and action meant consideration of a comprehensive approach. Resources existed in an ecosystem and efforts to control activities and resource exploitation had to take that scientific fact into account.[41]

The Comprehensive Ecosystem Approach

As the leaders of nation-states began to develop responses to their new and increased obligations over a broader patrimonial sea, they were also faced with increased public concern about the need for environmental protection, premised on a comprehensive approach to problems.[42] In response, they began to look at the connection between environmental and resource management programs.[43]

This individual nation-state concern with comprehensive approaches to environmental protection was reflected in emerging international law principles. A new legal doctrine provided nation-state responsibility to not only prevent harm to one's resources and property but also to take affirmative cooperative action, with other nation-states, to assure that resources would be used in a way to avoid harm.[44]

Perhaps the most significant illustration of this new multi-State recognition of responsibility was the Declaration of the United Nations Conference on the Environment, held in Stockholm in 1972.[45]

In a series of Principles and Recommendations, later endorsed by the United Nations General Assembly,[46] the Declaration assumed that "to achieve [the international goal of preserving and protecting the environment], governments and peoples [must] exert common efforts for the preservation and improvement of the human environment."[47] In the Declaration, the international community stressed the fact that everything is part of an interdependent system, and that pollution and resource management are inextricably intertwined.[48] Nation-states have the individual obligation to "safeguard and wisely manage,"[49] and to "take all possible steps to prevent pollution."[50] To satisfy these obligations "to achieve a more rational management of resources and improve the environment, [nations must] adopt an integrated and coordinated approach to their development so as to ensure [compatibility] with protection of the environment."[51]

Nation-states also have a collective responsibility. "States have, in accordance with the Charter of the United Nations and the principles of International Law, the sovereign right to exploit their own resources ... and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or to areas beyond the limits of national jurisdiction."[52] To fulfill this responsibility, they must take steps, by "cooperation

through multilateral or bilateral arrangements or other appropriate means ... to effectively control, prevent, reduce and eliminate adverse environmental effects...."[53]

The premise of the Stockholm Declaration and later United Nations Resolutions is that this comprehensive approach must be premised on the ecosystem model. Thus, the Declaration states: "The natural resources of the earth including the air, water, land, flora and fauna and especially representative samples of natural ecosystems must be safeguarded for the benefit of present and future generations."[54] A later Draft World Charter for Nature[55] adopted this thesis when it called for the actions by the community of nation-states and their citizens to be conducted in such a way so as not to threaten the "integrity of the ecosystems and organisms with which they coexist."

The Ecosystem Approach and the Ocean as Commons

This ecosystem approach to environmental protection developed at the same time as nation-states were attempting to deal with their new responsibilities for increased adjacent ocean zones. The community of nations had already adopted the arguments of scientists and scholars that the oceans were unique international resources and thus the responsibility of the world community.[56] This responsibility, by the nature of international law, and its premise on voluntary action by nation-states, had to be implemented by individual governments.[57]

Such implementation included protective rules for a nation's marine areas and regulations governing activities by nationals and flag ships in and on the oceans.[58] It also meant concurrent and collective actions by the community of nations to safeguard the "oceans commons."[59] The question was how best to protect the "ocean commons."

Scientists had already demonstrated the approach necessary to assure adequate protection. *Ad hoc* ocean management arrangements would not work.[60] What was required was a comprehensive set of rules (1) to control activities in, on, and near the oceans; (2) to reduce and possibly eliminate pollutants which adversely affect the oceans and their resources; and (3) to establish procedures and standards for the conservation and exploitation of living marine resources.[61] Comprehensive oceans management means total ecosystem management -- consideration of the whole system encompassing the resources of an area and the habitats for these resources.[62]

This was the most appropriate domestic and international policy. But is it required? Is it a mandate of international law? The next part of this paper argues that it is. The comprehensive ecosystem approach has been recognized by nation-state leaders in their State practice[63] and by groups of nations in their development of new resource regimes, such as those in and offshore Antarctica.[64] It has been codified in the 1982 United Nations Convention on the Law of the Sea,[65] which is now accepted as our new international "oceans policy."[66]

The "Ecosystem Model" and the Nature of International Law

Municipal laws are established by the legislatures or the political executives of each nation-state.[67] International law is not promulgated by any world-wide legislature or agency.[68] Rather, international law rules are established by (1) the practice of nations, (2) acceptance by the world community as a general principle of law, (3) judicial decisions and scholarly consensus, and most importantly, (4) international conventions.[69] Using these tests, the ecosystem model has evolved into a new and binding legal doctrine.[70]

Marine Ecosystem Model: The Law of The Sea's Mandate for Comprehensive Management

Martin H. Belsky*
Albany Law School
Albany, New York

Introduction

More than four years ago,[1] I first suggested that the evolving law of the sea, as expressed in recent nation-state practice and international agreements and resolutions, had been moving towards a comprehensive approach to ocean management. This comprehensive approach was premised on the total ecosystem model. "Such total ecosystem management requires procedures and standards for the conservation and exploitation of living marine resources, for the study and protection of those resources and their habitats and for consideration of the whole system encompassing the resources and habitats."[2] The problems of pollution control and resource exploitation are interrelated and, scientifically, must be concurrently addressed.[3]

This evolution towards an ecosystem approach, I argued, had been confirmed and codified in the United Nations Convention on the Law of the Sea (UNCLOS),[4] which, for all relevant purposes, had become binding customary international law on all nation-states.[5]

Since that first article, I have now concluded that this comprehensive ecosystem approach has, in fact, become binding customary international law. As such, nation-states must apply this model in their domestic law and practice, and in their foreign policy.[6] Some scholars have criticized this model as impractical and non-progressive.[7] The purposes of this paper are to give an overview of my thesis, to respond to the criticisms of it, and to thereby allow the reader to make his or her own evaluation of its propriety and validity.

The Ecosystem Model

Marine scientists have long recognized and urged that the only way to deal with the oceans was to view it as a series of ecosystems. Actions which affect any part of a marine ecosystem should be undertaken only upon recognition that such actions would necessarily affect the whole ecosystem.[8] The ocean is a total resource system consisting of many interrelated species. Management of the ocean space has to consider all the species in an ecosystem and the impact of marine-related activities, and the pollution caused by those activities, on that ecosystem.[9]

Scientists have adopted the concept of the "ecosystem model" as the shorthand for their call for holistic or comprehensive ocean management.[10] An ecosystem can be defined as "the pattern of relationships between all biotic (living) and abiotic (non-living) entities within a defined boundary of space and time."[11] An ecosystem management model, therefore, is simply a set of research and regulatory decisions that recognizes this "pattern of relationships."

Despite the clear scientific preference for a comprehensive approach to ocean management, it was not until quite recently that this approach became acceptable to government officials at both the national and international level.[12]

National Sovereignty and the Comprehensive Ecosystem Approach

Nation-state refusal to take a holistic approach to marine management was premised on traditional doctrines governing international relations and law. Political leaders were unwilling to cede any territorial prerogatives and saw any attempts to limit their power as a violation of their nation's sovereign rights.[13]

Under international law, each country could claim that the ocean areas adjacent to its coast were part of its territory, and therefore, each nation could and did design and enforce its own laws for that adjacent area.[14] The "high seas" beyond the coastal waters belonged to no one.[15] Activities in this *res nullius* were to be regulated only by voluntary controls placed by a particular country on its own nationals or vessels.[16]

Until the 1960s, nation-states exercised their "sovereign" territorial rights, and power over citizens and flag ships with little consideration of environmental consequences. Over-exploitation and pollution control were not major concerns[17] and each nation-state sought to exploit resources to the maximum.[18] Multi-state cooperation in conserving and protecting ocean resources was viewed as external interference in domestic issues.[19]

Even in the late 1960s, when there was, at last, some response to the increasing problems of overfishing, endangered species, and vessel and land-based pollution,[20] domestic legislation had to be justified on a case-by-case basis and had to be documented by examples of "real" problems.[21] This *ad hoc* approach meant separate rules for different types of pollution problems and separate management regimes for particular species.[22]

Nation-states extended this new, albeit limited, environmental and resource sensitivity to the international level and, in the 1950s and 1960s, undertook some cooperative action.[23] Early agreements, minimal in scope,[24] formed a basis for broader, multi-lateral arrangements.[25] Still, nation-states were concerned about the precedent of ceding authority or potential resources to any other country.[26] As a result, as with domestic regulations, when nation-states did act, they did so on an *ad hoc* basis and in response to a specific perceived pollution or marine species protection problem.[27] Ecosystems remained largely unregulated.[28]

These incremental actions did provide, however, the basis for broader ocean management policies. By the 1970s, nation-states were enacting domestic legislation to provide stringent controls over pollution of coastal and ocean waters, to require coastal zone policies and plans, and to reconcile conflicting uses of their ocean space.[29] Concerns about foreign fishing and over-exploitation led to plans and sometimes restrictions for both endangered and commercial species.[30]

The pressure from a newly awakened environmental constituency,[31] and an increased desire by nation-states to secure international rights to resources and control over activities beyond their traditional limited territorial seas,[32] also made nation-states more willing to negotiate broader pollution agreements[33] and to consider joint management of shared resources.[34]

New jurisdictional zones out to 200 miles meant that resources and activities were either in one nation's "exclusive zone" or in the zones of two or more adjacent states. Fewer resources and activities were in international waters.[35] This increased responsibility led governments to secure authority to manage the increased resources and to control activities that could cause harm to those resources.[36]

First, State practice indicates that nations accept the obligation to coordinate their ocean policies, both on a domestic and international level, based on an ecosystem or comprehensive approach.[71] Leading ocean States, like the United States, have explicitly stated that their fisheries management programs are to be based on an ecosystem model.[72]

Second, collective actions by nation-states, in United Nations Resolutions and Reports,[73] and multilateral agreements for Antarctic offshore resources,[74] indicate that this comprehensive approach is accepted by the world community as a general principle that should be applied by all countries. Third, legal scholars have long argued that the oceans are a "commons" and that a comprehensive ecosystem approach to oceans management is both essential and the evolved rule.[75]

Perhaps, the strongest support for a new international law mandate of comprehensive ocean ecosystem management can be found in the text of the 1982 United Nations Convention on the Law of the Sea (UNCLOS). Under the 1982 Convention, nation-states are responsible for their ocean space and, with other nations, responsible for the world's seas.[76] Each nation is to control activities in its ports, its coastal areas and its exclusive economic zone. It also must control the activities of its nationals and vessels in all ocean areas.[77] These responsibilities include obligations to minimize and control pollution.[78] They also include an obligation to manage fisheries on an ecosystem model to avoid overexploitation, to consider the environmental impacts on habitats, and to consider the interrelationships of species.[79]

UNCLOS mandates that these obligations are to be implemented in domestic laws, and in bilateral and multilateral treaties and other cooperative arrangements.[80] For those nations that have ratified UNCLOS, a comprehensive approach is, therefore, mandated.[81]

The ecosystem approach is not only binding on signatories to the treaty but to all nation-states - as a statement of customary international law. For example, the United States, while refusing to sign UNCLOS, has accepted the environmental and management obligations of the treaty as binding.[82] The international community accepts the Convention, except for certain provisions, not relevant here, as stating current law.[83]

Implementation of the "Ecosystem Model"

It is a truism that rules of international law are binding. Political leaders have an international obligation to seek to conform their countries' actions to international law. Treaty obligations must be followed "in good faith."[84] Customary international law responsibilities must similarly be complied with "in good faith."[85] Thus, government officials have the international legal responsibility to incorporate the ecosystem model, as either a treaty or customary rule, into their own legal system and in new bilateral and multilateral agreements and in any informal marine regulatory or management programs.[86]

In addition, these leaders may have a domestic obligation to apply the ecosystem approach. In many nations, like the United States, international law is part of the domestic law unless specifically overridden by domestic law.[87] Failure to apply international law, again assuming there is no directly inconsistent domestic law,[88] is a violation of a nation-state's own law and redressable in the domestic courts.[89]

It might be argued that present domestic law precludes an ecosystem approach. There are, as discussed above, numerous statutes in most jurisdictions that deal separately with marine pollution problems and various laws, policies and plans that deal individually with particular

marine species.[90] However, few, if any of these statutes, plans, rules or policies are *directly* inconsistent with the ecosystem approach. Enough discretion is granted regulators to maximize environmental protection and balance resource management so that statutes can be interpreted and applied so as to be consistent with the ecosystem model.[91] International law and the domestic law of most States require nation-states to make that reconciliation where possible.[92] Therefore, under the dictates of their own law, government officials must obey the international law mandate for an ecosystem approach, and interpret and apply other statutes and rules in a manner most consistent with that approach.[93]

In those nations that incorporate international law into their domestic law, the mandate of the ecosystem model is also required to be applied *in foreign relations*. A country's representatives have the constitutional obligation to further the laws and policies of their government.[94] This duty to uphold and further domestic law means insistence on an ecosystem approach in negotiating bilateral or multilateral marine environmental protection or resource management agreements.[95]

In the United States, this is expressed in the command of the Constitution that the President "take care that the Laws be faithfully executed."[96] The President, of course, as the Chief Executive of a nation-state, has an international responsibility to enforce international law rules.[97] However, there has been considerable debate about the ability to challenge a President's violation of international law, especially customary norms, in domestic courts, or whether such challenges are barred by the "political question" doctrine.[98] This debate focuses on efforts by the President to change customary law and to disregard international law in order to protect significant national security interests. It focuses on the relationship of executive power to contrary legislative action and on the ability of the national courts to control executive action.[99]

This debate, however, is irrelevant to a discussion of whether there now exists a legal obligation on the Executive Branch to apply the ecosystem model in its international dealings. The President has accepted the relevant provisions of the United Nations Convention on the Law of the Sea as binding customary law.[100] Those provisions mandate a comprehensive ecosystem approach.[101] Where the President has accepted a customary rule of international law as binding, so that he may shape customary law, the dictates of this rule must be followed by his Executive Branch officers.[102]

Conclusion

In this paper, and in previous papers, I have intentionally acted as an advocate in urging that the ecosystem approach is both a preferable rule and a mandatory legal doctrine binding on all nation-states. Critics of this argument do not contest that the evolving law, now codified in UNCLOS, provides for "multi-species or ecosystem management."[103] However, they urge: "[Such an approach] may entail involved and costly investigation of species interactions that are difficult to understand and to evaluate. If this obligation is taken seriously, it will impose onerous burdens on coastal states .... [Such an approach] is a complex undertaking ... beyond the capacity of scientists at the present time. Although progress in these directions is a worthwhile objective, it is probably a mistake to impose these obligations on fishery management at the present time."[104]

These critics, it would appear, seem satisfied, at least for now, with species by species, pollutant by pollutant management. They are convinced that a more comprehensive approach would be "onerous." I am not so convinced. I am, in fact, concerned that continued advocacy of an *ad hoc* approach, even for practical reasons, may be detrimental to the future of fisheries research and marine environmental and resource protection.

Separate rules for each species, and for each pollutant, may, in fact, be worse than no management at all.[105] Establishing standards that may be based on incomplete, or more likely, inaccurate information may result in long-term harm to a species, and certainly to the ecosystem supporting that species.[106] Implementing rules for individual species, without adequate consideration of the impact within an ecosystem of activities and resource development, of coastal and ocean pollution, and of the interaction of species perpetuates the myth, consistently refuted by science, that we can consider problems piecemeal.[107] It reinforces, though in more sophisticated terms, the "tragedy of the commons."[108]

Moreover, these critics misstate the impact of the mandate for an ecosystem model. While accepting the comprehensive approach, they set up the model as an absolute. The "ecosystem approach" described in this paper does not establish onerous burdens. Defining what is an ecosystem, what species are in that system, how the species that are part of that ecosystem interrelate, and how ocean and coastal activities affect the ecosystem and the living resources in that system, are, indeed, complex issues and the state of scientific investigation of marine ecosystems "is still at an early stage."[109]

The "ecosystem model," however, does not call for precise determinations of ecosystems, nor precise determinations of all interactions. Rather, it mandates that resource managers, and environmental planners and regulators, must take a "comprehensive look" at how their policies and rules interact.

The language used in UNCLOS illustrates the process. All the elements of an ecosystem must "be taken into account" in decision-making.[110] The Convention repeatedly notes that the obligations it establishes are to be implemented by "the best practicable means at [each nation's] disposal and in accordance with their capabilities."[111]

The ecosystem model, therefore, is not unduly burdensome on nation-states. Rather, it is a call on such nation-states to make, within their capabilities, all efforts to reach the scientific ideal of total ecosystem management. As I have noted elsewhere,[112] the model is also a mandate for adequate research, including assessment and monitoring, to eventually increase the ability of each nation-state individually, and the community of nations collectively, to answer the difficult scientific questions.

International law is a unique, almost bizarre system. Aggressive support for a particular legal theory can become the basis for existence of that legal theory - whether through incorporation in domestic law, or pressure by legal scholars, or State practice or codification in multilateral agreements.[113]

An ecosystem management approach, realizing the present scientific and fiscal limitations in providing absolute answers, is clearly the preferred international policy. My papers and articles, therefore, call upon nation-states to apply the international law mandate of comprehensive ecosystem approach to marine management. They also seek to encourage scientists and other interested individuals to press nation-states and the international community to accept the model and use it as

a basis for research, planning, and regulations. This pressure can be exerted through lobbying, litigation, and other means, including scholarly papers and articles.

NOTES

* Dean and Professor of Law, Albany Law School; B.A., 1965, Temple University; J.D., 1968, Columbia University.

1. My "ecosystem model" was first proposed in a symposium held at the 1984 American Association for the Advancement of Science Annual Meeting. *See* Belsky, *Legal Constraints and Options for Total Ecosystem Management of Large Marine Ecosystems*, in Variability and Management of Large Marine Ecosystems at 241 (K. Sherman & L. Alexander eds. 1986) (hereinafter cited as Belsky 1984 AAAS Paper). *See also* Belsky, *Management of Large Marine Ecosystems: Developing a New Rule of Customary International Law*, 22 San Diego L. Rev. 733 (1985) (hereinafter cited as Belsky, San Diego Article).
2. Belsky 1984 AAAS Paper, *supra* note 1 at 241.
3. *See id.* at 249.
4. United Nations Convention on the Law of the Sea, U.N. Doc. A/Conf. 62/121 (1982), *reprinted in* 21 Int'l Leg. Mat. 1245 (1982) (hereinafter cited as UNCLOS).
5. Belsky 1984 AAAS Paper, *supra* note 1 at 250-52.
6. *See* Belsky, M.H., The Marine Ecosystem Management Model and the Law of the Sea: Requirements for Assessment and Monitoring, Paper presented at 21st Annual Conference of the Law of the Sea Institute (August 3-6, 1987). *See also* Belsky, *A Still Evolving "Law of the Sea"*, 17 Cal. W. Int'l L. J. 355 (1987).
7. At the time of my presentation to the 21st Annual Conference of the Law of the Sea Institute, see note 6, *supra*, Professor William T. Burke, of the University of Washington School of Law, suggested that requiring nation-states, many of which were technologically unsophisticated, to adopt the ecosystem management approach would be unduly burdensome and unrealistic. Professor Burke has expressed this concern before. *See* Burke, *The Law of the Sea Convention and Fishing Practices of Nonsignatories, with Special Reference to the United States*, in Consensus and Confrontation: The United States and the Law of the Sea Convention, Law of the Sea Institute Workshop at 314, 319 (J. Van Dyke ed. 1985).
8. *See* D. Ross, Introduction to Oceanography at 237 (3rd ed. 1982).
9. *See* J. Kindt, Marine Pollution and the Law of the Sea at 144, 783 (1986); Gordon, *Management of Living Marine Resources: Challenge of the Future*, in Center for Ocean Management Studies, Comparative Marine Policy at 145, 163-64 (1981).
10. Frye, Book Review, 26 Nat. Res. J. 653 (1986) (Reviewing the book, Variability and Management of Large Marine Ecosystems (K. Sherman & L. Alexander eds. 1986)). *See* Byrne, *Large Marine Ecosystems and the Future of Ocean Studies: A Perspective*, in Variability and Management of Large Marine Ecosystems at 299, 300 (K. Sherman & L. Alexander eds. 1986).
11. T. Hoban, & R. Brooks, Green Justice: The Environment and the Courts at 5 (1987).
12. *See* Friedheim, *Ocean Ecology and the World Political System*, in Who Protects the Ocean? at 151, 151-53 (J. Hargrove, ed. 1975).

13. Bilder, *International Law and Natural Resources Policies*, 20 Nat. Res. J. 451, 452 (1980). *See* A. Springer, The International Law of Pollution at 737 (1983) (territorial sovereign rejects controls over international pollution affecting his territory); Christy, *The Distribution of the Sea's Wealth in Fisheries*, in The Law of the Sea: Offshore Boundaries and Zones at 106, 110 (L. Alexander ed. 1967) (nations make maximum use of their "historic right" to a resource).
14. *See* Knight, *International Fisheries Management: A Background Paper*, in The Future of International Fisheries Management at 1, 1-3 (H. Knight ed. 1975). *See also* The *S.S. Lotus* Case (France v. Turkey), 1927 P.C.I.J., Ser. A, No. 10, at 18-19.
15. MacRae, *Customary International Law and the United Nations' Law of the Sea Treaty*, 13 Cal. W. Int'l L. J. 181, 187, 195-96 (1983).
16. *See* United States v. Flores, 289 U.S. 137 (1933); Lauritzen v. Larson, 345 U.S. 571 (1953).
17. T. Hoban and R. Brooks, *supra* note 11 at 5.
18. *See* Comment, *An Environmental Assessment of Emerging International Fisheries Doctrine*, 4 Colum. J. Envir. L. 143, 144-45 (1977) (hereinafter cited as Columbia Comment).
19. *See* D. VanderZwaag, The Fish Feud at 41-43 (1983). *See also* Wenk, *Global Principles for National Marine Policies: A Challenge for the Future* in Center for Ocean Management Studies, Comparative Marine Policy at 3, 4-5 (1981).
20. Belsky, San Diego Article, *supra* note 1 at 740, 750-51.
21. *See e.g.*, Chasis, *Marine Environmental Protection in the United States* in Center for Ocean Management Studies, Comparative Marine Policy at 187 (1981); D. Brooks, America Looks To the Sea at 8-9 (1984).
22. Belsky, San Diego Article, *supra* note 1 at 740-42.
23. *See* R. Churchill & A. Lowe, The Law of the Sea at 216 (1983); (marine pollution agreements); Carroz, *Institutional Aspects of Fishery Management Under the New Regime of the Oceans*, 21 San Diego L. Rev. 513, 515-16 (1984).
24. Friedheim, *supra* note 12 at 153-59.
25. *See* R. Churchill & A. Lowe, *supra* note 23 at 200-05 (fisheries); 216-22 (pollution).
26. Columbia Comment, *supra* note 18 at 143-44.
27. *See* Belsky, San Diego Article, *supra* note 1 at 740-42.
28. *See* Carroz, *supra* note 23 at 514-15.
29. *See generally* Lutz, *The Laws of Environmental Management: A Comparative Study*, 24 Am. J. Comp. L. 447 (1976).
30. *See* Copes, *Marine Fisheries Management in Canada: Policy Objectives and Development Constraints* in Center for Ocean Management Studies, Comparative Marine Policy at 135, 136 (1981). Farnell, *EEC Fisheries Management Policy* in Center for Ocean Management Studies, Comparative Marine Policy at 137, 140 (1981); Gordon, *supra* note 9 at 146. While the major purpose of most of these laws was to provide exclusive access of a particular nation's citizens to the resources off that country's coasts, these laws often also included detailed provisions for the protection of the species and its habitat and included provisions to restrict fishing and preclude overexploitation. *See e.g.* Fishery Conservation and Management Act of 1976 (later retitled Magnuson Fishery and Conservation Management Act), Pub. L. No. 94-265, 90 Stat, 331 (1976) (codified in 16

U.S.C. 1801-1882 (1976, 1982 and Supp. III 1985) (hereinafter cited as MFCMA).

31. Stanfield, *In the Same Boat*, Natl. J., August 16, 1986 at 1992, 1993; Sohn, *Implications of the Law of the Sea Convention Regarding the Protection and Preservation of the Marine Environment*, in Law of the Sea Institute, The Developing Order of the Oceans at 103, 103-04 (R. Krueger and S. Riesenfeld, eds. 1984).
32. Pinto, *Emerging Concepts of the Law of the Sea: Some Social and Cultural Impacts*, in Managing the Oceans: Resources, Research, Law at 297, 301 (J. Richardson, ed. 1985). *See also* MacRae, *supra* note 15 at 210.

    Nation states made unilateral claims to the right to exploit hydrocarbon and living marine resources in zones as far out as 200 miles from their coasts. *See e.g.*, MFCMA, *supra* note 30; Outer Continental Shelf Lands Acts Amendments of 1978, Pub. L. No. 95-372, 92 Stat. 629, 16 U.S.C. 1456-56a, 1464; 43 U.S.C. 1331-56, 1801-1866 (Supp. 1981).

    As a result, more of the ocean space came under individual nation-state control. In fact, it is estimated that 38 percent of the oceans, over 90 percent of the potential commercially exploitable fish stocks, and 87 percent of offshore hydrocarbons exist within the collective EEZ's (200-mile exclusive economic zones) of all nations. *See* R. Churchill & A. Lowe, *supra* note 23 at 126.
33. Speranskaya, *Marine Environmental Protection and Freedom of Navigation in International Law*, Ocean Yearbook 6 at 197 (E. Borgese, N. Ginsburg, J. Baylson, N. Dunning, & D. Dzurek, eds. 1986).
34. Lie, *Marine Ecosystems: Research and Management*, in Managing the Oceans: Resources, Research, Law at 311, 325 (J. Richardson, ed. 1985); T. Hoban and R. Brooks, *supra* note 11 at 6-7.
35. R. Jackson, Extended National Fisheries Jurisdiction at 5-8 (Donald L. McKernan Lecture in Marine Affairs 1981).
36. *See* Murphy & Belsky, *OCS Development: A New Law and a New Beginning*, 7 Coastal Zone Mgt. J. 297 (1980); Smith, *Management of Living Resources* in Center for Oceans Law and Policy, Managing National Ocean Resources at 57, 57-58 (Oceans Policy Study 2:1 1979).
37. *See* Gordon, *supra* note 9 at 163-64.
38. *See* Belsky, San Diego Article, *supra* note 1 at 749-50.
39. *See* D. VanderZwaag, *supra* note 19 at 95-98 (U.S. Canada shared fishery).
40. Comment, *Compensating Private Parties for Transnational Pollution Injury*, 58 St. John's L. Rev. 528, 528-33 (1984).
41. Lie, *supra* note 34 at 325.
42. T. Hoban and R. Brooks, *supra* note 11 at 6-7. A major factor in this political support for a comprehensive environmental approach was the writings of various scientists, like Garret Hardin, who described in his *Tragedy of the Commons*, 162 Science 1243, 1244-45 (1968), how an otherwise "rational being" would seek only to maximize his or her own gain and thus increase his or her own exploitation of resources and his or own discharge of pollutants. These individual actions, taken without regard to their cumulative and comprehensive adverse effect, could prove disastrous, for the future survival of the "commons."

43. *See* E. Wolf, *On the Brink of Extinction: Conserving the Diversity of Life*, Worldwatch Paper 78-79 at 41 (June 1987) (nation-states are using data about ecosystems in development plans).
44. For example, Article 3 of the U.N. Charter of Economic Rights and Duties of States (1975) provided for nation-states to cooperate in the use of resources so as to avoid harm. *See* Bilder, *supra* note 13 at 459. A new concept of "state responsibility" to prevent harm to shared resources - "equitable utilization" - emerged as a binding rule of customary international law. *See* Handl, *National Uses of Transboundary Air Resources: The International Entitlement Issue Reconsidered*, 26 Nat. Res. J. 405, 410-11 (1986); Handl, *The Principle of 'Equitable Use' as Applied to Internationally Shared Natural Resources: Its Role in Resolving Potential International Disputes over Transboundary Pollution*, 14 Revue Belge De Droit Int'l 40, 44-45, 52-53 (1978).
45. Stockholm Declaration, Report of the U.N. Conference on the Human Environment, U.N. Doc. A/Conf. 48/14, 11 I.L.M. 1416 (1972) (hereinafter cited as Stockholm Declaration).
46. G.A. Res. 2994, 27 U.N. GAOR Supp. (No.30) at 42, U.N. Doc. A/8730 (1972).
47. Stockholm Declaration, *supra* note 45, Preamble, 7.
48. *See* Smith, *The United Nations and the Environment: Sometimes a Great Notion?* 19 Tex. Int'l L. Rev. 335, 338 (1984).
49. Stockholm Declaration, *supra* note 45, Principle 4.
50. Stockholm Declaration, *supra* note 45, Principle 7.
51. Stockholm Declaration, *supra* note 45, Principle 13.
52. Stockholm Declaration, *supra* note 45, Principle 21.
53. Stockholm Declaration, *supra* note 45, Principle 24.
54. Stockholm Declaration, *supra* note 45, Principle 2.
55. On October 30, 1980, the United Nations General Assembly adopted, without vote, a Resolution calling for a Draft World Charter for Nature. G.A. Res. 35/7, 35 U.N. GAOR Supp. (No.48) at 14, U.N. Doc. A/35/48 (1980), *reprinted in* 20 I.L.M. 462 (1980). *See* Smith, *supra* note 48 at 341.
56. Speranskaya, *supra* note 33 at 197.
57. *See* Belsky, San Diego Article, *supra* note 1 at 735.
58. *See* Boczek, *The Concept of Regime and the Protection of the Marine Environment*, Ocean Yearbook 6 at 271, 289 (E. Borgese, N. Ginsburg, J. Baylson, N. Dunning, & D. Dzurek, eds. 1986).
59. *See* Stockholm Declaration, *supra* note 45, Principle 7 (states obligation to "take all possible steps to prevent pollution of the seas"); Recommendation 92 (proper management of the oceans so as to not "impair" its quality and resources).
60. Such *ad hoc* approaches, which dealt separately with problems of pollution control and resource exploitation, did not adequately deal with the scientific reality that all ocean activities are interrelated. Waldichuk, *An International Perspective on Global Marine Pollution*, in Center for Ocean Management Studies, Impact of Marine Pollution on Society at 37 (V. Tippie & D. Kester, eds. 1982). King, *Introduction: Science, Technology, and the Marine Resource System*, 17 Ocean Dev. & Int'l L. 1, 7 (1986).
61. *See* Belsky, San Diego Article, *supra* note 1 at 757-58.
62. Lie, *supra* note 34 at 325.
63. *See* National Oceanic and Atmospheric Administration, NOAA Fishery Management Study at 16, 25 (1986); Ocean Science News, February 15, 1987 at 2 (head of National Marine Fisheries Service quoted as

saying that agency will apply ecosystems approach to fisheries management).

64. *See* Boczek, *The Protection of the Antarctic Ecosystem: A Study in International Environmental Law*, 13 Ocean Dev. & Int'l L. 347, 375 (1983).
65. United Nations Convention on the Law of the Sea, *supra* note 4. *See* Borgese, E., The Future of the Oceans: A Report to the Club of Rome at 3 (1986); Boczek, *supra* note 58 at 289.
66. Statement by the President on United States Ocean Policy (Reagan Ocean Statement), accompanying his Proclamation establishing an Exclusive Economic Zone, 19 Weekly Comp. Pres. Doc. 383 (March 14, 1983), *reprinted in* 22 Int'l Leg. Mat. 464 (1983) (UNCLOS, except for provisions on mining, states governing oceans policy). *See* Boczek, *supra* note 64 at 393 (UNCLOS codifies for the oceans the general environmental law of the 1972 Stockholm Declaration - especially as they are related to a comprehensive obligation to protect the marine environment).
67. *See* L. Henkin, How Nations Behave at 24-25 (1968).
68. Restatement (Revised), Foreign Relations Law of the United States at 18-19 (Tentative Draft No. 6. 1985) (hereinafter cited as 1985 Restatement).
69. Statute of the International Court of Justice, Art. 38(1). *See also* 1985 Restatement, *supra* note 68, 102, 103.
70. *See* Boczek, *supra* note 64 at 388 (international environmental law's latest stage of development is based on "man's realization that the environment must be approached from an ecological viewpoint, i.e., as part of a complex web of interdependent phenomena which related environmental features to man as a social being").
71. Boczek, *supra* note 58 at 290. *See* Lutz, *supra* note 29 at 450 (trend by nation-states towards comprehensive environmental management institutions premised on "ecological control").
72. *See* R. Roe, The Management of Interjurisdictional Fisheries, Proceedings, University of Delaware, Center for Marine Science, "Coastal States are Ocean States" at 33, (April 1-3, 1987) (representative of U.S. National Marine Fisheries Service states that "our goal should be to provide an ecosystem-side management program for fish and other living marine resources").
73. *See* discussion in notes 46-55, *supra*, describing Stockholm Declaration and Draft World Charter for Nature).
74. Under the Convention for the Conservation of Antarctic Living Marine Resources, *done* May 7, 1980, T.I.A.S. No. 8826, *reprinted in* 19 I.L.M. 841 (1980), management is based on a total ecosystem conservation standard. Preamble, Art. II(3). In addition, the Convention requires signatory states to conduct their affairs so as to minimize risks to the Antarctic marine ecosystem. Arts. V, XXI, and XXII. This is a useful precedent for the concept of an international mandate for an ecosystem approach. *See* Boczek, *supra* note 64 at 375-76, 394; Joyner, *Antarctica and the Law of the Sea: An Introductory Overview*, 13 Ocean Dev. & Int'l L. 277, 281 (1983); Oxman, *Antarctica and the New Law of the Sea*, 19 Cornell Int'l L. J. 211, 233 (1986).

    The Antarctic Treaty Consultative Parties are now in the process of considering a Convention for the management and exploitation of Antarctica's non-living resources. The most recent draft of proposed elements of this Convention are premised on maintenance of the conservation elements, including the ecosystem

standard, of the living resource Convention. *See* Laughlin, *The Antarctic Treaty System as a Conservation System* at 9-10, Paper Presented at the Center for Oceans Law And Policy Seminar, "The Polar Regions" (March 26-28, 1987). *See also* Joyner, *The Southern Ocean and Marine Pollution: Problems and Prospects*, 17 Case W. Res. J. Int'l L. 165, 185-89 (1985).

75. They point to the new United Nations Convention on the Law of the Sea as strong evidence that the comprehensive approach is internationally mandated. *See* Speranskaya, *supra* note 33 at 197-98; Oxman, *supra* note 74 at 233; Sohn, *supra* note 31 at 105.
76. *See* Pardo, *The Convention on the Law of the Sea: A Preliminary Appraisal*, 20 San Diego L. Rev. 489, 490 (1983); Sohn, *supra* notes 13 at 108; Speranskaya, *supra* note 33 at 198.
77. UNCLOS, *supra* note 4, Arts. 218 (ports), 220 (coasts), 56 (EEZ); Arts. 94 (obligation of flag state for vessels on the high seas), 211, 217 (Enforcement of standards by flag states against vessels); 117-18 (obligation over nationals for fishing). For a provision by provision analysis of the relevant articles of the Convention applicable to these requirements, see Sohn, *supra* note 31 at 106-08.
78. UNCLOS, *supra* note 4, Arts. 194, 207, 210.
79. UNCLOS, *supra* note 4, Arts. 61 (EEZ), 63 (shared stocks), 64 (highly migratory species), 65 (marine mammals), 66 (anadromous stocks), 67 (catadromous species), 117-20 (high seas). These provisions adopt the "maximum sustainable yield" standard, but say this standard has to be qualified by other "relevant environmental and economic factors" and to take into account, the "interdependence of stocks." This, of course, is the "ecosystem approach." *See* Boczek, *supra* note 64 at 394.

    The Convention is intended to be read as a whole. Thus, these specific provisions on management of living resources must be read in light of Art. 194(5), which requires nation-states to include in pollution measures all those necessary "to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life."
80. UNCLOS, *supra* note 4, Arts. 117-18 (obligation for fishing); 194, 197 (general obligation for pollution control); 207, 213 (obligation for pollution from land-based sources); 210, 216 (dumping); 211, 217-220 (vessel pollution).
81. By definition, of course, a treaty is binding on those states who have agreed to it. This is the doctrine of *pacta sunt servanda.* Vienna Convention on the Law of Treaties, Art. 26, U.N. Doc. A/Conf. 39/27, *reprinted* 8 I.L.M. 679 (1969). *See* H. Kelson, Principles of International Law at 454-56 (R. Tucker 2d Rev. ed. 1966); 1985 Restatement, *supra* note 68, Vol. II at 86.
82. *See* Reagan Ocean Statement, *supra* note 66; Malone, *Who Needs the Sea Treaty?*, 45 Foreign Affairs Sept. 1984 at 44, 59-61 (James Malone was the Assistant Secretary of State for Oceans, International Environmental and Scientific Affairs, and was the Special Representative of the President to the Law of the Sea Conference).
83. *See* MacRae, *supra* note 15 at 221-22; Sohn, *The Law of the Sea: Customary International Law Developments*, 34 Am. U. L. Rev. 271, 279-80 (1985).
84. Vienna Convention on the Law of Treaties, *supra* note 81, Art. 26 and commentary thereto. *See* UNCLOS, *supra* note 4, Art. 300; 1985 Restatement, *supra* note 68, Vol. II, 321 and commentary thereto.

85. L. Henkin, R. Pugh, O. Schachter, & H. Smit, International Law - Cases and Materials 36 (1980); 1985 Restatement, *supra* note 68, 102, comment j. (customary law and law made by international agreement are deemed to have equal authority as international law). *But see* Trimble, *A Revisionist View of Customary International Law*, 33 UCLA L. Rev. 665, 669 (1986).

86. Schneider, *State Responsibility for Environmental Protection and Preservation*, in International Law - A Contemporary Perspective at 602-03, 604 (R. Falk, F. Kratochwil & S. Mendlovitz, eds. 1985) ("basic obligation under international law for nation-states to prevent pollution and other destructive impacts on both inclusive and exclusive resources"; obligation means use of "all instruments of policy [including] the whole range of diplomatic, economic, ideological and military strategies"). *See* 1985 Restatement, *supra* note 68 at 18: "International law is law like other law, promoting order, guiding, restraining, regulating behavior. States, the principal addressees of international law, treat it as law, consider themselves bound by it, attend to it with a sense of legal obligation, and with concern for the consequences of violation." The ecosystem based provisions of UNCLOS, "by express or tacit agreement accompanied by consistent practice [have been accepted by states generally] ... as statements of customary law binding upon them ...." *Id*, Vol. II at 165.

87. U.S. Const. Art. VI, cl. 2. *See* The Paquette Habana, 175 U.S. 677, 700 (1900); Whitney v. Robertson, 124 U.S. 190, 194 (1888). *See also* Borchard, *The Relation Between International Law and Municipal Law*, 27 Va. L. Rev. 137, 144 (1940) (British law); Cohen, *Justice for Occupied Territory? The Israeli High Court of Justice Paradigm*, 24 Colum. J. Trans. L. 471, 484 (1986) (Israeli law). *See generally*, L. Henkin, R. Pugh, O. Schachter, & H. Smit, *supra* note 85 at 118 (1980) (majority of nations give effect to international law unless contrary controlling municipal law).

88. Some commentators have argued that "new" customary international law mandates are new provisions of domestic law and that in those states that incorporate customary international law into their domestic law, they supercede all prior statutes and judicial precedents. Henkin, *International Law as Law in the United States*, 82 Mich. L. Rev. 1555, 1565 (1984). Others argue that only specific statutes or implemented treaties can overrule prior domestic law. Goldklang, *Back on Board the Paquette Habana: Resolving the Conflict Between Statutes and Customary International Law*, 25 Va. J. Int'l L. 143, 149 (1984). *See* discussion at notes 97-102, *infra*.

89. *See* L. Henkin, R. Pugh, O. Schachter, & H. Smit, *supra* note 85 at 118; Borchard, *supra* note 87 at 144. *See e.g.* The Paquette Habana, 175 U.S. 677, 700 (1900).

90. *See* United Nations Legislative Series, National Legislation and Treaties Relating to the Law of the Sea, U.N. Doc. ST/LEG/SER.B/19 (1980); Office of the Special Representative of the Secretary-General for the Law of the Sea, The Law of the Sea: National Legislation on the Exclusive Economic Zone, the Economic Zone and the Exclusive Fishery Zone, U.N. Sales No. E.85.V.10 (1986).

91. *See* Belsky, *Environmental Policy Law in the 1980's: Shifting Back the Burden of Proof*, 12 Ecology L.Q. 1, 15-18, 30-33, 44-50, 71-77 (1984).

92. Borchard, *supra* note 87 at 144; Lauritzen v. Larson, 345 U.S. 571, 582 (1953) (mutual obligation of nation-states to interpret

domestic law in accordance with international law to avoid instability in foreign affairs). *See* Murray v. Schooner Charming Betsy, 6 U.S. (2 Cranch) 64, 118 (1804) ("an Act of Congress ought never to be construed to violate the law of nations, if any other possible construction remains"); 1985 Restatement, *supra* note 68, 134 ("Where fairly possible, a United States statute is to be construed so as not to bring it into conflict with international law ...").

93. I am now in the process of preparing an article describing specifically how the ecosystem model, as a mandate of international law, and thus an integral part of United States law, can be used to establish a coordinated and comprehensive "National Ocean Policy." For a history of previous attempts to establish such a policy, see Abel, *The History of the United States Ocean Program*, in Making Ocean Policy at 3 (F. Hoole, R.Friedheim, & T. Hennessey eds. 1981). *See also* Commission on Marine Science, Engineering and Resources, Our Nation and the Sea (1969) (Stratton Commission Report).
94. *See* Sasse, *The Common Market: Between International and Municipal Law*, 75 Yale L. J. 695, 712-13 (1966) (citing German and Italian Constitutions).
95. *See* L. Henkin, Foreign Affairs and the Constitution at 56 (1972) (authority to the President to faithfully execute laws as applying to Presidential initiatives pursuing powers in treaty or exercising discretion in foreign affairs is "unquestionable"). *See also* Henkin, *The President and International Law*, 80 Am. J. Int'l L. 930, 935-36 (1986) (In describing authority of President to exercise foreign policy powers, including actions with other states, Professor Henkin notes: "President has no power - as such - to violate international law, just as he has no power - as such - to repeal a treaty or a customary principle as law of the land.").
96. U.S. Const., Art. II, 3. *See* Henkin, *supra* note 88 at 1567.
97. 1985 Restatement, *supra* note 68, 135(1)(b).
98. *See* Lobel, *The Limits of Constitutional Power: Conflicts Between Foreign Policy and International Law*, 71 Va. L. Rev. 1071, 1114-1130 (1985).
99. *See* Charney, *The Power of the Executive Branch of the United States Government to Violate Customary International Law*, 80 Am. J. Int'l L. 913 (1986); Glennon, *Can the President Do No Wrong?*, 80 Am. J. Int'l L. 923 (1986).
100. *See* text at and discussion in note 82, *supra*.
101. *See* text at and discussion in notes 76-81, *supra*.
102. Myers v. United States, 272 U.S. 52, 135 (1926) (the President has the authority, as head of the Executive Branch, to "supervise and guide" executive officers in "their construction of the statutes under which they act in order to secure that unitary and uniform execution of the laws which Article II of the Constitution evidently contemplated in vesting general executive powers in the President alone."); J. Mashaw and R. Merrill, Administrative Law: The American Public Law System at 155 (2d Ed. 1985) (early statutes recognized the power of the President to totally direct executive agents in foreign policy). *See* Glennon, *Raising the Paquette Habana: Is Violation of Customary International Law by the Executive Unconstitutional?*, 80 Nw. U. L. Rev. 321, 335 (1985) ("The executive branch invariably claims that ... presidential actions comply with international law."); L. Henkin, *supra* note 67

at 46-48 (cost-benefit analysis of why political leaders obey international law; nation-states seek to maximize the policies they support).

103. *See* Burke, *supra* note 7.
104. *Id.* at 319.
105. *See* Teclaff & Teclaff, *International Control of Cross-Media Pollution - An Ecosystem Approach*, 27 Nat. Res. J. 21, 25-26 (1987).
106. *See* Yuru, *Amassing Scientific Knowledge to Preserve the Marine Environment*, in Managing the Ocean at 125, 127 (J. Richardson ed. 1985).
107. Stanfield, *supra* note 31 at 1992.
108. *See* Hardin, *supra* note 42. *See* discussion in note 42, *supra.*
109. Alexander, *Large Marine Ecosystems as Regional Phenomena*, in Variability and Management of Large Marine Ecosystems at 239, 240 (K. Sherman & L. Alexander eds. 1986).
110. UNCLOS, *supra* note 4, Art. 61(4).
111. *See e.g.*, UNCLOS, *supra* note 4, Art. 194(1) (measures to control pollution). *See also id.* Art. 61(1) (EEZ living resource conservation management are to be based on measures "taking into account the best scientific evidence available to [the nation-state]); Art. 119(1)(a) (same language for cooperative actions in high seas).
112. Belsky, M.H., *supra* note 6; Belsky, M.H., Interrelationships of Science and Law in the Management of Large Marine Ecosystems, Paper Presented at the Symposium on Frontiers in Marine Ecosystem Research - AAAS (February 14, 1988).
113. *See* Belsky, San Diego Article, *supra* note 1 at 762-63. *See generally* International Law: A Contemporary Perspective at 205-293 (R. Falk, F. Kratochwil, & S. Mendlovitz 1985) (describing various methods of "Lawmaking in International Society").

REFERENCES

Articles and Books

Abel, *The History of the United States Ocean Program*, in Making Ocean Policy at 3 (F. Hoole, R.Friedheim, & T. Hennessey eds. 1981).

Alexander, *Large Marine Ecosystems as Regional Phenomena*, in Variability and Management of Large Marine Ecosystems at 239, 240 (K. Sherman & L. Alexander eds. 1986).

Belsky, *Environmental Policy Law in the 1980's: Shifting Back the Burden of Proof*, 12 Ecology L.Q. 1 (1984).

Belsky, *Legal Constraints and Options for Total Ecosystem Management of Large Marine Ecosystems*, in Variability and Management of Large Marine Ecosystems at 241 (K. Sherman & L. Alexander eds. 1986).

Belsky, *Management of Large Marine Ecosystems: Developing a New Rule of Customary International Law*, 22 San Diego L. Rev. 733 (1985).

Belsky, *A Still Evolving "Law of the Sea"*, 17 Cal. W. Int'l L. J. 355 (1987).

Belsky, M.H., The Marine Ecosystem Management Model and the Law of the Sea: Requirements for Assessment and Monitoring. Paper presented at 21st Annual Conference at the Law of the Sea Institute (August 3-6, 1987).

Belsky, M.H., Interrelationships of Science and Law in the Management of Large Marine Ecosystems, Paper Presented at the Symposium on Frontiers in Marine Ecosystem Research - AAAS (February 14, 1988).
Bilder, *International Law and Natural Resources Policies*, 20 Nat. Res. J. 451 (1980).
Boczek, *The Concept of Regime and the Protection of the Marine Environment*, Ocean Yearbook 6 at 271 (E. Borgese, N. Ginsburg, J. Baylson, N. Dunning, & D. Dzurek, eds. 1986).
Boczek, *The Protection of the Antarctic Ecosystem: A Study in International Environmental Law*, 13 Ocean Dev. 7 Int'l L. 347 (1983).
Borgese, E., The Future of the Oceans: A Report to the Club of Rome (1986).
Brooks, D. America Looks To the Sea (1984).
Burke, The Law of the Sea Convention and Fishing Practices of Nonsignatories, with Special Reference to the United States, in *Consensus and Confrontation: The United States and the Law of the Sea Convention*, Law of the Sea Institute Workshop at 314 (J. Van Dyke ed. 1985)
Byrne, *Large Marine Ecosystems and the Future of Ocean Studies: A Perspective*, in Variability and Management of Large Marine Ecosystems at 299, 300 (K. Sherman & L. Alexander eds. 1986).
Carroz, *Institutional Aspects of Fishery Management Under the New Regime of the Oceans*, 21 San Diego L. Rev. 513 (1984).
Charney, *The Power of the Executive Branch of the United States Government to Violate Customary International Law*, 80 Am. J. Int'l L. 913 (1986).
Chasis, *Marine Environmental Protection in the United States* in Center for Ocean Management Studies, Comparative Marine Policy (1981).
Christy, *The Distribution of the Sea's Wealth in Fisheries*, in The Law of the Sea: Offshore Boundaries and Zones at 106 (L. Alexander ed. 1967).
Churchill, R., & A. Lowe, The Law of the Sea (1983).
Cohen, *Justice for Occupied Territory? The Israeli High Court of Justice Paradigm*, 24 Colum. J. Trans. L. 471 (1986).
Comment, *Compensating Private Parties for Transnational Pollution Injury*, 58 St. John's L. Rev. 528 (1984).
Comment, *An Environmental Assessment of Emerging International Fisheries Doctrine*, 4 Colum. J. Envir. L. 143 (1977).
Copes, *Marine Fisheries Management in Canada: Policy Objectives and Development Constraints* in Center for Ocean Management Studies, Comparative Marine Policy at 135 (1981).
Farnell, *EEC Fisheries Management Policy* in Center for Ocean Management Studies, Comparative Marine Policy at 137 (1981).
Friedheim, R., *Ocean Ecology and the World Political System*, in Who Protects the Ocean? at 151 (J. Hargrove, ed. 1975).
Frye, Book Review, 26 Nat. Res. J. 653 (1986).
Glennon, *Can the President Do No Wrong*, 80 Am. J. Int'l L. 923 (1986).
Glennon, *Raising the Paquette Habana: Is Violation of Customary International Law by the Executive Unconstitutional?*, 80 Nw. U. L. Rev. 321 (1985).
Goldklang, *Back on Board the Paquette Habana: Resolving the Conflict Between Statutes and Customary International Law*, 25 Va. J. Int'l L. 143 (1984).

Gordon, *Management of Living Marine Resources: Challenge of the Future*, in Center for Ocean Management Studies, Comparative Marine Policy at 145 (1981).
Handl, *National Uses of Transboundary Air Resources: The International Entitlement Issue Reconsidered*, 26 Nat. Res. J. 405 (1986).
Handl, *The Principle of 'Equitable Use' as Applied to Internationally shared Natural Resources: Its Role in Resolving Potential International Disputes over Transboundary Pollution*, 14 Revue Belge De Droit Int'l 40 (1978).
Hardin, *Tragedy of the Commons*, 162 Science 1243 (1968).
Henkin, L., Foreign Affairs and the Constitution (1972).
Henkin, L., How Nations Behave (1968).
Henkin, L., R. Pugh, O. Schachter, & H. Smit, International Law - Cases and Materials (1980).
Henkin, *International Law as Law in the United States*, 82 Mich. L. Rev. 1555 (1984).
Henkin, *The President and International Law*, 80 Am. J. Int'l L. 930 (1986).
Hoban, T. & Brooks, R., Green Justice: The Environment and the Courts (1987).
International Law: A Contemporary Perspective (R. Falk, F. Kratochwil, & S. Mendlovitz eds. 1985).
Jackson, R., Extended National Fisheries Jurisdiction (Donald L. McKernan Lecture in Marine Affairs 1981).
Joyner, *Antarctica and the Law of the Sea: An Introductory Overview*, 13 Ocean Dev. & Int'l L. 277 (1983).
Joyner, *The Southern Ocean and Marine Pollution: Problems and Prospects*, 17 Case W. Res. J. Int'l L. 165 (1985).
Kelsen, H., Principles of International Law at 454-56 (R. Tucker 2d Rev. ed. 1966)
Kindt, J., Marine Pollution and the Law of the Sea (1986).
King, *Introduction: Science, Technology, and the Marine Resource System*, 17 Ocean Dev. & Int'l L. 1 (1986).
Knight, *International Fisheries Management: A Background Paper*, in The Future of International Fisheries Management at 1 (H. Knight ed. 1975).
Lamson & VanderZwaag, *Arctic Waters: Need and Options for Canadian-American Cooperation*, 18 Ocean Dev. & Intl L. 49 (1987)
Laughlin, *The Antarctic Treaty System as a Conservation System*, Paper Presented at the Center for Oceans Law And Policy Seminar, "The Polar Regions" (March 26-28, 1987).
Lie, *Marine Ecosystems: Research and Management*, in Managing the Oceans: Resources, Research, Law at 311 (J. Richardson, ed. 1985).
Lobel, *The Limits of Constitutional Power: Conflicts Between Foreign Policy and International Law*, 71 Va. L. Rev. 1071 (1985).
Lutz, *The Laws of Environmental Management: A Comparative Study*, 24 Am. J. Comp. L. 447 (1976).
MacRae, *Customary International Law and the United Nations' Law of the Sea Treaty*, 13 Cal. W. Int'l L.J. 181 (1983).
Malone, *Who Needs the Sea Treaty?*, 45 Foreign Affairs Sept. 1984 at 44.
Mashaw, J., and R. Merrill, Administrative Law: The American Public Law System (2d Ed. 1985)
Murphy & Belsky, *OCS Development: A New Law and a New Beginning*, 7 Coastal Zone Mgt. J. 297 (1980)
Ocean Science News, February 15, 1987 at 1 to 3.

Oxman, *Antarctica and the New Law of the Sea*, 19 Cornell Int'l L. J. 211 (1986).
Pardo, *The Convention on the Law of the Sea: A Preliminary Appraisal*, 20 San Diego L. Rev. 489 (1983).
Pinto, *Emerging Concepts of the Law of the Sea: Some Social and Cultural Impacts*, in Managing the Oceans: Resources, Research, Law at 297 (J. Richardson, ed. 1985).
Restatement (Revised), Foreign Relations Law of the United States (Tentative Draft No. 6. 1985).
Roe, R., The Management of Interjurisdictional Fisheries, Proceedings, University of Delaware, Center for Marine Science, "Coastal States are Ocean States" at 33 (April 1-3, 1987).
Ross, D., Introduction to Oceanagraphy (3rd ed. 1982).
Sasse, *The Common Market: Between International and Municipal Law*, 75 Yale L. J. 695 (1966).
Schneider, *State Responsibility for Environmental Protection and Preservation*, in International Law - A Contemporary Perspective (R. Falk, F. Kratochwil & S. Mendlovitz, eds. 1985).
Smith, *Management of Living Resources* in Center for Oceans Law and Policy, Managing National Ocean Resources at 57 (Oceans Policy Study 2:1 1979).
Smith, *The United Nations and the Environment: Sometimes a Great Notion?* 19 Tex. Int'l L. Rev. 319 (1984).
Sohn, *Implications of the Law of the Sea Convention Regarding the Protection and Preservation of the Marine Environment*, in Law of the Sea Institute, The Developing Order of the Oceans at 103 (R. Krueger and S. Riesenfeld, eds 1984).
Sohn, *The Law of the Sea: Customary International Law Developments*, 34 Am. U. L. Rev. 271 (1985).
Speranskaya, *Marine Environmental Protection and Freedom of Navigation in International Law*, Ocean Yearbook 6 at 197 (E. Borgese, N. Ginsburg, J. Baylson, N. Dunning, & D. Dzurek, eds. 1986).
Springer, A., The International Law of Pollution (1983).
Stanfield, *In the Same Boat*, Nat'l. J., August 16, 1986 at 1992.
Teclaff & Teclaff, *International Control of Cross-Media Pollution - An Ecosystem Approach*, 27 Nat. Res. J. 21 (1987).
Trimble, *A Revisionist View of Customary International Law*, 33 UCLA L. Rev. 665 (1986).
VanderZwaag, D., The Fish Feud (1983).
Waldichuk, *An International Perspective on Global Marine Pollution*, in Center for Ocean Management Studies, Impact of Marine Pollution on Society at 37 (V. Tippie & D. Kester, eds. 1982).
Wenk, *Global Principles for National Marine Policies: A Challenge for the Future* in Center for Ocean Management Studies, Comparative Marine Policy at 3 (1981).
Wolf, E., *On the Brink of Extinction: Conserving the Diversity of Life*, Worldwatch Paper 78-79 (June 1987).
Yuru, *Amassing Scientific Knowledge to Preserve the Marine Environment*, in Managing the Oceans: Resources, Research, Law at 125 (J. Richardson, ed. 1985).

Cases

Lauritzen v. Larson, 345 U.S. 571 (1953).
The *S.S. Lotus* (France v. Turkey), 1927 P.C.I.J., Ser. A, No. 10.
Murray v. The Schooner Charming Betsy, 6 U.S. (2 Cranch) 64 (1804).

Myers v. United States, 272 U.S. 52 (1926).
The Paquette Habana, 175 U.S. 677 (1900).
United States v. Flores, 289 U.S. 137 (1933).
Whitney v. Robertson, 124 U.S. 190 (1887).

Treaties

Convention for the Conservation of Antarctic Living Marine Resources, *done* May 7, 1980, T.I.A.S. No. 8826, *reprinted in* 19 I.L.M. 841 (1980).
Statute of the International Court of Justice (1945).
United Nations Convention on the Law of the Sea, U.N. Doc. A/Conf. 62/121 (1982), *reprinted in* 21 Int'l Leg. Mat. 1245 (1982).
Vienna Convention on the Law of Treaties, U.N. Doc. A/Conf. 39/27, *reprinted* 8 I.L.M. 679 (1969).

Statutes/Regulations

Fishery Conservation and Management Act of 1976 (later retitled Magnuson Fishery and Conservation Management Act), Pub. L. No. 94-265, 90 Stat, 331 (1976) (codified in 16 U.S.C. 1801-1882 (1976, 1982 and Supp. III 1985).
Outer Continental Shelf Lands Acts Amendments of 1978, Pub. L. No. 95-372, 92 Stat. 629, 16 U.S.C. 1456-56a, 1464; 43 U.S.C. 1331-56, 1801-1866 (Supp. 1981).
Statement by the President on United States Ocean Policy (Reagan Ocean Statement), accompanying his Proclamation establishing an Exclusive Economic Zone, 19 Weekly Comp. Pres. Doc. 383 (March 14, 1983), *reprinted in* 22 Int'l Leg. Mat. 464 (1983).

Reports/Studies

Commission on Marine Science, Engineering and Resources, Our Nation and the Sea (1969) (Stratton Commission Report)
National Oceanic and Atmospheric Administration, NOAA Fishery Management Study (1986).
Office of the Special Representative of the Secretary-General for the Law of the Sea, The Law of the Sea: National Legislation on the Exclusive Economic Zone, the Economic Zone and the Exclusive Fishery Zone, U.N. Sales No. E.85.V.10 (1986).
Stockholm Declaration, Report of the U.N. Conference on the Human Environment, U.N. Doc. A/Conf. 48/14, 11 I.L.M. 1416 (1972).
United Nations, Draft World Charter for Nature. G.A. Res. 35/7, 35 U.N. GAOR Supp. (No.48) at 14, U.N. Doc. A/35/48 (1980), *reprinted in* 20 I.L.M. 462 (1980).
United Nations Legislative Series, National Legislation and Treaties Relating to the Law of the Sea, U.N. Doc. ST/LEG/SER.B/19 (1980).

COMMENTARY

Joseph R. Morgan
Department of Geography
University of Hawaii

Since large marine ecosystems are "regions with unique hydrographic regimes, submarine topography, and trophically related populations" it ought to be possible to map them and thereafter use the mapped areas as suitable geographic entities for administration, regulation, and conservation purposes. Presumably, one of the objectives of the Convention on the Law of the Sea is to do just that. There are some articles in the text of the Convention that would facilitate the large marine ecosystem (LME) concept as a tool for conservation of living resources, but there is much in the Convention that makes management on the basis of LMEs difficult.

The Convention defines a number of regions: the Area, territorial seas, internal waters, bays, contiguous zones, straits used for international navigation, archipelagic waters, exclusive economic zones, continental shelves, high seas, enclosed or semi-enclosed seas, and ice-covered areas. With the exception of the Area, high seas, enclosed or semi-enclosed seas, and ice-covered areas, the regions defined in the Convention are treated as limited extensions of the sovereignty of the coastal state. Even ice-covered areas are so considered by countries such as Canada, which seems to desire increased sovereignty over adjacent waters on the basis of the fact that they are ice-covered and should be subject to Canadian control over pollution.

The regulations for the Area are concerned with dividing the wealth which presumably can be obtained from the deep seabed among the maximum number of countries, particularly those of the Third World. Regulations for the high seas incorporate as many of the old time freedoms as possible and are little concerned with sustainable living resource use through concepts such as the large marine ecosystem. Only in the case of enclosed or semi-enclosed seas is there any hint of considering a region from the standpoint of interlinking problems which a number of countries might have in common. To the extent that a semi-enclosed sea might also be a large marine ecosystem -- and many of them are -- the Convention provides a "mechanism" for employing the potentially valuable LME concept.

Article 123, Cooperation of States Bordering Enclosed or Semi-Enclosed Seas, enjoins countries to jointly consider conservation, management, exploration, and exploitation of the living resources of the sea and to coordinate their rights and duties with respect to protection and preservation of the marine environment. If there is a well-recognized LME contiguous with or within a semi-enclosed sea, there is a clear invitation to use the ecological principles and relationships among the various species and the natural environment as a management tool by the nations bordering the sea. Although the Convention does not specifically mention large marine ecosystems, there is nothing in Article 123 that would preclude the use of the concept, and if the countries involved are sufficiently cooperative (rather than competitive) and sophisticated in their scientific approaches to the problems of sustainable fisheries, the LME approach could become popular.

Article 63 of the Convention concerns stocks occurring within the exclusive economic zones of two or more coastal states or both, within the exclusive economic zone and in an area beyond and adjacent to it. These shared stocks should be managed with a view toward conservation and sustainable development of the living resources. According to the article, the needed cooperation is to be obtained through regional or sub-regional organizations. Although nothing in Article 63 so states, these organizations can use the LME concept where appropriate.

Article 197, Cooperation on a Global or Regional Basis, states that States shall cooperate as appropriate for the protection and preservation of the marine environment, *taking into account characteristic regional features* (emphasis added). Large marine ecosystems are defined by characteristic regional features -- unique hydrographic regimes, sub-marine topography, and trophically related populations -- hence, Article 197 might be viewed as an invitation to use the LME concept as clearly consistent with the provisions of the Convention.

Large marine ecosystems fall into three basic categories: those delineated by ocean current systems, semi-enclosed seas, and open seas. There is a fairly well-recognized Gulf Stream LME, and in the South Pacific Ocean the Peru Current LME has been extensively studied. It supports the Peruvian anchoveta fishery, which has been subjected to periodic failures due to the El Nino phenomenon coupled with over-fishing. The semi-enclosed sea LMEs include the Sea of Japan, the Mediterranean, the South China Sea, and the Black Sea. The degree of "closure" of the body of water determines the nature of the ecosystem; Mediterranean species clearly differ from Atlantic species, and the Black Sea system is separated from the Mediterranean LME by the very narrow and shallow Turkish Straits. On the other hand, the South China Sea LME might "slop over" into other nearby LMEs, such as Indonesian Seas. The open sea LMEs include the Gulf of Alaska and the Coral Sea.

From the standpoint of management under the Convention, LMEs falling completely within the archipelagic waters and exclusive economic zone of a single country are ideal. The best example is the Indonesian Seas. Those LMEs classed as open seas, which might also include the very extensive Pacific tuna fisheries, are more difficult to manage under the Convention. LMEs in semi-enclosed seas can be managed under the provisions of Article 123, but much depends on the nature of the relationships of the countries within the region. If they are political rivals, do not maintain diplomatic relations with each other, or tend to treat their exclusive economic zones as national territory to be defended by their navies, cooperation is not likely, and the LME idea becomes useless as a practical means of managing fisheries.

One of the best defined and delineated LMEs is the southern ocean. The Antarctic Convergence, a narrow zone in which colder Antarctic waters meet the relatively warmer waters of the South Atlantic, South Pacific, and southern part of the Indian Ocean, provides an oceanographic boundary. South of the Convergence is a LME dominated by the large zooplankton, *Euphausia superba* (krill). Krill provide a food supply for whales, penguins, seals, squid, and some fish species, and they are a critical link in the food web of the ecosystem. Krill are now being fished commercially, and there is some concern that overfishing could seriously damage the ecosystem.

The southern ocean LME is an example of sensible management *outside* the provisions of the Convention on the Law of the Sea. The Antarctic Continent and the waters south of 60 degrees South latitude are governed by the provisions of the Antarctic Treaty of 1961. The signatories to

the Treaty and a number of additional nations which have subsequently acceded to it are committed to the ideal of managing the region for scientific research and preservation of the still relatively pristine environment. However, resource issues are now coming to the fore, and they can no longer be ignored. Hence, the Treaty members have agreed to a Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR). A noteworthy feature of the CCAMLR is that its northern regional boundary coincides with the Antarctic Convergence, rather than with 60 degrees, the Antarctic Treaty limit. This is the first clear evidence of the use of the LME concept in living marine resource management. Fortunately, the southern ocean LME is relatively easy to delineate, using the Antarctic Convergence as an ocean limit and the Antarctic continent as a landward limit. Moreover, the Treaty signatories, all of whom are also CCAMLR signatories, are free to operate without the sometimes irksome restrictions of the Convention on the Law of the Sea, which in many respects is concerned more with national jurisdictions and country rights than with sensible management principles.

Without doubt the concept of the large marine ecosystem is a sound one, and the potential for managing important fisheries under its general principles is great. However, more research into the actual ecosystems themselves is needed, and we must find better ways to adapt the political structure of the world to natural regions, such as LMEs. This might require important changes in the concepts of sovereignty, jurisdiction, and the nation-state. Fundamental changes of this nature are not easy to come by, and the use of LMEs as management tools, as attractive as the concept is, might be difficult to achieve in the near future.

The Convention on the Conservation of Antarctic Marine Living Resources - A Case Study

R. Tucker Scully
Department of State
Washington, D.C.

The Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), upon its conclusion, was subject to mixed reviews. The explicit ecosystem approach to conservation reflected in the Convention drew considerable interest and was viewed as an important innovation in international arrangements for living resource management. At the same time, there was significant skepticism as to whether this approach could be effectively implemented in practice.

Today, after six years of operation, reviews of CCAMLR continue to be mixed. For example, the fifth annual meeting of the Commission established by CCAMLR in 1986 generated significant pessimism as to its efficacy, because of an impasse which prevented widely supported actions from being taken to protect depleted fish populations in areas of the Scotia Sea (the Atlantic sector). A year later at the sixth (and most recent) annual meeting in 1987, the mood had switched to one of optimism. A number of important measures were agreed upon to deal with those same fish populations, including a total allowable catch (TAC), a closed season and a catch reporting system for the primary target of fishing activity.

In assessing the prospects for implementation of CCAMLR, I would tend toward the optimistic view. However, rather than relying solely on the evidence of conservation measures, I would point to another development at the 1987 CCAMLR meeting: the request by the Scientific Committee to the Commission for guidance with respect to management policy and the Commission's response asking for scientific committee assessment of alternatives for achieving specific (though admittedly preliminary) management objectives with respect to fish populations.

This development is significant in that it indicates the emergence of an effort to come to grips with what I believe to be a central element in the implementation of CCAMLR, or of agreements like CCAMLR; that is, the relationship and interaction between science and policy. As that subject is the theme of this conference, I will seek to outline the way in which CCAMLR illustrates the growing impact of science and technology upon resource management policy.

Recognition of the need for the agreement itself derived in substantial degree from the scientific study of the southern ocean. The negotiation and the provisions of CCAMLR reflected concern to establish a scientific basis for management, both in its ecosystem approach and its emphasis upon data. Successful implementation of CCAMLR will depend upon integrating scientific methodology and understanding into the process of making resource policy decisions.

Recognition of the Need for Conservation

The Antarctic scientific community played an important role in identifying the need to provide for conservation of the living resources found in Antarctic waters. Research coordinated by the Scientific Committee on Antarctic Research (SCAR), during and following the Inter-

national Geophysical Year (IGY) of 1957-58, provided a preliminary picture of the structure and components of that which came to be described as the Antarctic marine ecosystem. SCAR sponsored major symposia on Antarctic oceangraphy both in 1966 and 1970.

The early 1960s also saw the development of interest in fishing opportunities in Antarctic waters. These waters, which had been the arena of intense harvesting and over-harvesting of marine mammal populations (seals and whales), began to attract distant water fishing fleets, particularly from the USSR. Understanding of the fisheries potential - in the short run for finfish, and in the long run, for krill - grew in part out of the research activities. So also did concern over the possible effects of uncontrolled harvesting of fisheries resources, particularly in light of the emerging understanding of the vulnerability to harvesting of the Antarctic marine ecosystem with the heavy dependence of its predators upon a single species - Antarctic krill (*Euphausia superba*).

In response, SCAR initiated steps to orient research in Antarctic waters toward living resources and an understanding of the Antarctic marine ecosystem. In August, 1972, SCAR's Working Group on Biology established a Subcommittee on the Living Resources of the Southern Ocean. This group also received the official co-sponsorship of the Scientific Committee on Oceanographic Research (SCOR) in 1975 and was upgraded by SCAR as the Group of Specialists on the Living Resources of the Southern Ocean in 1976. The work of this group explicitly cited the wise management of the Antarctic marine ecosystem as primary justification for its emphasis.

The need to establish a basis for conservation of Antarctic marine living resources first identified within the scientific community was acknowledged on the political level by the Antarctic Treaty Consultative Parties (ATCPs) at the Eighth Antarctic Treaty Consultative Meeting in 1975 (ATCM VIII). Recommendation VII-10 of that meeting called for encouragement of "studies which could lead to the development of effective measures for the conservation of Antarctic marine living resources" and urged SCAR "to continue its scientific work on these matters."

ATCM VIII also endorsed the idea of a meeting to be convened by SCAR to address programs for the study and conservation of Antarctic marine living resources. That meeting, the First International Symposium on Living Resources of the Southern Ocean, took place in Woods Hole, Massachusetts in August, 1976, immediately followed by a meeting of the SCAR/SCOR Group of Specialists. From these meetings emerged the BIOMASS Program (Biological Investigations of Marine Antarctic Systems and Stocks). BIOMASS was designed as a ten-year cooperative international and interdisciplinary research program with the principal objective of gaining "a deeper understanding of the structure and dynamic functioning of the Antarctic marine ecosystem as a basis for future management of potential living resources."

By this time, awareness of the need for action to address the conservation requirements of Antarctic waters had spread to the political mechanism of the Antarctic Treaty. The possibility of negotiating an agreement to deal with Antarctic marine living resources was considered at preparatory meetings for the ATCM (ATCM IX in 1977) in Paris in 1976 and in London in July, 1977. By the time of ATCM IX (September, 1977), the ATCPs were prepared to commit themselves to conclusion of "a definitive regime for the conservation of Antarctic marine living resources" (Recommendation IX-2). Recommendation IX-2 recognized both the need to establish "a good scientific foundation for appropriate conservation

measures" and "the urgency of ensuring that these resources are protected by the establishment of sound conservation measures that will prevent overfishing and protect the integrity of the Antarctic ecosystems."

Recommendation IX-2 also provided for the establishment of a special negotiating process to conclude the "definitive regime" (a Special Consultative Meeting) and, *inter alia*, directed that the regime "provide for the effective conservation of the marine living resources of the Antarctic ecosystem as a whole." The emphasis upon providing for the effective conservation of "the Antarctic ecosystem as a whole" was also reflected in the description of the area to be covered by "the definitive regime." Paragraphs III 3(d) and (e) of Recommendation IX-2 provides:

(d) the regime should cover the area of specific competence of the Antarctic Treaty;

(e) the regime should, however, extend north of 60 degrees South latitude where that is necessary for the effective conservation of species of the Antarctic ecosystem, without prejudice to coastal state jurisdiction in that area.

Elaboration of the Convention

Negotiations among the ATCPs pursuant to Recommendation IX-2 were initiated five months after its adoption, in Canberra, Australia (February-March, 1978). The negotiations were concluded slightly over two years later, with the adoption of the Convention, also in Canberra, on May 20, 1980. Members of the Antarctic scientific community, as members of ATCP delegations, played an important part in the negotiations - particularly the elaboration of the objective of the CCAMLR, the definition of the area of the Convention and the functions of the CCAMLR Scientific Committee.

The substantive provisions of CCAMLR reflected evolving understanding of Antarctic ecosystems, the importance of regional approaches to conservation, and the necessity of establishing a sound scientific basis for resource management decisions. This imprint was symptomatic of the general evolution in perception of international obligations to conserve living resources, articulated in the emerging provisions of the then draft United Nations Convention on the Law of the Sea (UNCLOS).

Three aspects of CCAMLR are significant in this regard: the definition of the area to which it applies; the objective of the Convention (Article II, which seeks to articulate the ecosystem approach), and the data requirements (both in reporting obligations and in the functions of the institutions established by CCAMLR).

The northern limit of CCAMLR's area of application therefore is identified as the Antarctic Convergence. The Convergence or Polar Front, as it is often called, is a transition zone within which colder Antarctic waters from the south mix with or sink below warmer sub-Antarctic waters from the north. It represents a significant environmental barrier which many species do not cross and has been viewed as the northern boundary of purely Antarctic populations. Though the Convergence is an oceanographic phenomenon, a mixing zone, which varies in time and space in response to physical conditions, CCAMLR sets forth geographic coordinates to approximate its location for its regulatory purposes. (Article I, paragraph 4). Antarctic marine living resources are, in turn, defined as the populations of all species of living organisms found south of the Convergence (Article I, paragraph 2) and

the Antarctic marine ecosystem as "the complex of relationships of Antarctic marine living resources with each other and with their physical environment" (Article I, paragraph 3).

In one sense, the definition of the area of application of CCAMLR represents an outgrowth of an emphasis upon regional approaches to management of living resources. The articles of UNCLOS relating to the conservation of living resources, including Article 61 on the conservation of living resources of the Exclusive Economic Zone (EEZ), Article 63 on "straddling stocks", Article 64 on highly migratory species and Articles 118 and 119 on the conservation of the living resources of the high seas, all refer to appropriate regional or subregional organizations as vehicles for achieving necessary conservation of living resources. CCAMLR takes the concept one step further in defining "region" by reference to an ecosystem. If effect, CCAMLR is the first example of delineating a large marine ecosystem for resource managment purposes.

Objective: The other, and more operational, element of CCAMLR which sets forth an ecosystem approach to management is the Convention's objective described in Article II. The objective of CCAMLR is defined as the conservation of Antarctic marine living resources, with conservation understood to include the "rational use" of such resources. Article II then sets forth (in paragraph 3) three principles of conservation in accordance with which any harvesting and associated activities are to be conducted.

The first of these principles sets forth a standard with respect to populations which are the targets of harvesting:

(a) prevention of decrease in the size of any harvested population to levels below those which ensure its stable recruitment. For this purpose its size should not be allowed to fall below a level close to that which ensures the greatest net annual increment.

The second principle establishes a standard for populations dependent upon or related to harvested populations and for depleted populations.

(b) maintenance of the ecological relationships between harvested, dependent and related populations of Antarctic marine living resources and restoration of depleted populations to the levels defined in subparagraph (a) above;

The third principle elaborates a standard application to the marine ecosystem as a whole, introducing the need to avoid irreversible changes in that ecosystem.

(c) prevention of changes or minimization of the risk of changes in the marine ecosystem which are not potentially reversible over two or three decades, taking into account the state of available knowledge of the direct and indirect impact of harvesting, the effect of the introduction of alien species, the effects of associated activities on the marine ecosystem and of the effects of environmental changes, with the aim of making possible the sustained conservation of Antarctic marine living resources.

The manner in which the area of application of CCAMLR is defined and the three principles of conservation outlined above describe the

ecosystem approach contained in the Convention. How this approach is given effect - in particular through the three principles of conservation - will be a yardstick against which the implementation of CCAMLR will be judged. For present purposes, two observations regarding this approach should be made.

The first is that CCAMLR's ecosystem approach to management, while justifiably characterized as innovative, also reflects general trends towards multi-species management, driven again by evolution in scientific knowledge and capability. The provisions of UNCLOS illustrate these trends. In fulfillment of their obligations to conserve living resources both in EEZs and on the high seas (Articles 61 and 119), States are called upon to take measures, based on the best scientific evidence available to:

> a) maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield as qualified by relevant environmental and economic factors ... and taking into account fishing patterns, the interdependence of stocks and any generally recommended international minimum standards, whether subregional, regional or global; and (to)
>
> b) take into consideration the effect on species associated with or dependent upon harvested species with a view to maintaining or restoring populations of such associated or dependent species above levels at which their reproduction may become seriously threatened.

The second observation is that the effective prosecution of an ecosystem approach is data dependent.

Data: The provisions of CCAMLR, both in the data collection and reporting obligations and in the functions of the institutions, reflect an emphasis on the necessity of adequate data bases for making management decisions. Members of the Commission, established by CCAMLR, are required "to the greatest extent possible, (to) provide annually to the Commission and to the Scientific Committee such statistical, biological and other data and information as the Commission and Scientific Committee may require in the exercise of their functions" (Article XX, paragraph 1). More specifically, Commission members are obligated to provide "in the manner and at such intervals as may be prescribed, information about their harvesting activities, including fishing areas and vessels, so as to enable reliable catch and effort statistics to be compiled" (Article XX, paragraph 2). Finally, Commission members agree that in their harvesting activities "advantage ... be taken of opportunities to collect data needed to assess the impact of harvesting" (Article XX, paragraph 4).

Again, CCAMLR's provisions reflect the more general evolution of international legal obligations to base management decisions on scientific data. Within UNCLOS, Articles 61 (conservation of the living resources (of the EEZ)) and 119 (conservation of the living resources of the high seas) both include the following provision:

> Available scientific information, catch and fishing effort statistics, and other data relevant to the conservation of fish stocks shall be contributed and exchanged on a regular basis through competent international organizations whether subregional, regional or global, where appropriate and with participation by all States concerned.

In this area, CCAMLR's obligations are somewhat more elaborated, extending to the collection as well as to the reporting of necessary data and information.

Recognition of the data-intensive nature of an ecosystem approach to management is also reflected in the functions CCAMLR confers upon the institutions it establishes. CCAMLR provides for a Commission (composed of the original signatories plus acceding Parties during such time as they are engaged in research on or harvesting of Antarctic marine living resources - the members now numbering twenty) and a Scientific Committee (in which all Commission members are entitled to participate), as well as a secretariat to serve both.

From one perspective, the institutions provided for by CCAMLR resemble those of traditional multilateral fisheries agreements: a commission, consisting of the Parties which decides upon management measures (in this case, by consensus) and a scientific committee in which the players are again the Parties rather than independent scientists. What is unique in CCAMLR is the emphasis upon data and information requirements in the functions of the institutions.

The Scientific Committee is called upon to carry out such activities as may be directed by the Commission. However, it is also accorded independent functions to develop the basis for implementing CCAMLR's ecosystem approach. It is to "provide a forum for consultation, study and exchange of information" with respect to Antarctic marine living resources and to "encourage and promote cooperation in the field of scientific research in order to extend knowledge of the marine living resources to the Antarctic marine ecosystem."

As to specific functions, the Scientific Committee is to:

(a) establish criteria and methods to be used for determinations concerning the conservation measures referred to in Article IX of this Convention;

(b) regularly assess the status and trends of the populations of Antarctic marine living resources;

(c) analyze data concerning the direct and indirect effects of harvesting on the populations of Antarctic marine living reosurces;

(d) assess the effects of proposed changes in the methods of levels of harvesting and proposed conservation measures;

(e) transmit assessments, analyses, reports and recommendations to the Commission as requested or on its own initiative regarding measures and research to implement the objective of this Convention;

(f) formulate proposals for the conduct of international and national programs of research into Antarctic marine living resources.

To some extent, it is the specificity and independence in Scientific Committee functions, rather than the references to scientific data and information, *per se*, which are significant. The importance of sound scientific data and information to the achievement of CCAMLR purposes are more striking in the catalogue of the functions of the Commission. The overall function of the Commission - as the political, policy-making institution - is to give effect to the objective and principles set out in Article II (see above). The specific undertakings to achieve this function are to:

(a) facilitate research into and comprehensive studies of Antarctic marine living resources and of the Antarctic marine ecosystem;

(b) compile data on the status of and changes in population of Antarctic marine living resources and on factors affecting the distribution, abundance and productivity of harvested species and dependent or related species or populations;

(c) ensure the acquisition of catch and effort statistics on harvested populations;

(d) analyse, disseminate and publish the information referred to in sub-paragraphs (b) and (c) above and the reports of the Scientific Committee;

(e) identify conservation needs and analyse the effectiveness of conservation measures;

(f) formulate, adopt and revise conservation measures on the basis of the best scientific evidence available, subject to the provisions of paragraph 5 of this Article;

(g) implement the system of observation and inspection established under Article XXIV of this Convention;

(h) carry out other activities as are necessary to fulfill the objective of this Convention.

The first four of these tasks are specifically directed toward establishing the basis of scientific data and information and analytical capability necessary to pursue CCAMLR's ecosystem approach. Efforts to implement their functions in this regard by the Commission and Scientific Committee have been important aspects of the operation of CCAMLR during its initial years.

Implementation of CCAMLR

Analysis of the origin of CCAMLR and of the Convention's provisions demonstrates the impact of science and technology upon contemporary efforts at management of shared resources. It illustrates the opportunities and challenges inherent in attempts to deal with conservation issues in large marine ecosystems.

However, the basic question posed at the outset of this paper remains. Can CCAMLR - or efforts like it succeed? Can it be effectively implemented? Examination of this question, to date, has often concentrated upon the specific measures adopted by the Commission and the consensus process by which the Commission takes its decisions. Beginning at its third annual meeting, the Commission for the Conservation of Antarctic Marine Living Resources, acting in partial response to the advice of the Scientific Committee, has adopted a number of measures aimed at conserving fish stocks in the Convention area. Dissatisfaction with the substances or timeliness of such measures is laid at the feet of the consensus system. Such analyses miss an important - perhaps the most important - aspect of the implementation of CCAMLR, that is, the ongoing efforts to establish and to institutionalize the relationship between the scientific and technical requirements for management and the political process for taking management decisions. In this concluding section, I would like to examine the operation of CCAMLR against this perspective of the relationship between science and policy.

Much of the effort within the institutions of CCAMLR, particularly the Scientific Committee, has been directed at developing the capability to carry out the assessments required to give effect to CCAMLR's objective and principles. This effort has proceeded on a number of fronts: identification of data needs and formats; addressing of methodological problems; examination of research priorities; and creation of necessary institutional structures. At the past two annual meetings, the Commission

and Scientific Committee have also sought to come to grips with the crucial link between the application of assessment capability to management objectives - the need to address management policies or conservation strategies.

At its second annual meeting in 1983, the CCAMLR Scientific Committee established an *Ad Hoc* Working Group on Data Collection and Handling. The *ad hoc* group developed formats for the presentation of inventories of past data from commercial fisheries and on scientific data from research activities in Antarctica, as well as a suggested logbook format for fishing operations in the Convention area - with separate provisions for fish and for krill. The Commission endorsed these formats and called for members to provide data in accordance with them.

This initial work recognized the need for the acquisition of detailed time series catch and effort data, and scientific data and information, as a basis for population assessments - hence the emphasis upon provision of historic data and agreed criteria for collection of future data. There also emerged a perception that the differing characteristics of fish and krill necessitated differing data protocols for each.

The *Ad Hoc* Working Group on Data Collection and Handling was disbanded at the third annual CCAMLR meetings (1984), with three successor groups established, with responsibilities for pursuing the lines of endeavor identified at the previous session. These new groups were:

- the *Ad Hoc* Group on Krill Research Priorities;
- the *Ad Hoc* Group on Fish Stock Assessment; and
- the *Ad Hoc* Working Group on Ecosystem Monitoring

The *ad hoc* group on krill operated during the third meeting of the Scientific Committee. As a result of its deliberations, it was recognized that the unique characteristics of krill, as well as uncertainties regarding its life history, required the development of new methodologies of population assessment and, thus, would generate new ways of collecting and reporting data and information. As an initial step towards addressing this question, the Scientific Committee convened a Workshop on Krill Catch Per Unit Effort (CPUE) prior to its fourth meeting in 1985 and authorized a krill CPUE simulation study to examine development of models for krill populations. Interim reports of the simulation study have been provided to the Scientific Committee with a completed report anticipated for September, 1988 and a workshop to evaluate its content planned for early 1989. In addition, at the 1987 meeting, the Committee proposed, and the Commission approved, establishment of an *Ad Hoc* Working Group on Krill, *inter alia*, to recommend actions with respect to krill stock assessment and ecosystem monitoring. Success in this effort launched by the Scientific Committee to deal with the problem of the assessment of krill populations, is key to the effective implementation of CCAMLR.

The *Ad Hoc* Group on Fish Stock Assessment, established in 1984, was converted into a formal standing working group at the 1987 meetings. As a result of its work, that of the other *ad hoc* groups and of the predecessor group on data collection and handling, the Commission has taken a series of decisions, pursuant to Article XX of CCAMLR, to elaborate the legal obligations of Parties to collect and report data. These include:

a) detailed specifications of finfish data to be collected an archived and of finfish data to be submitted annually to the Commission. (Fourth Annual Meeting 1985);

b) the initiation of routine annual reporting of fine scale catch and effort data on finfish (Fifth Annual Meeting, 1986);

c) specifications of detailed catch data for krill in the statistical sub-area covering the South Orkney Islands (Fifth Annual Meeting, 1986);

d) refinements in reporting fine-scale catch and effort data on finfish (Sixth Annual Meeting, 1987); and

e) specification of fine-scale catch and fishing effort data on krill for the integrated study areas designed for ecosystem monitoring (Sixth Annual Meeting, 1987) (see below).

While these steps lay the groundwork for future collection and reporting, difficulties remain in obtaining historic data in usable form.

The *Ad Hoc* Working Group on Ecosystem Monitoring, established in 1984, was converted into a formal standing working group the following year. As a result of its work, the scientific committee has identified a number of potential indicator species (prey and predator) and identified three integrated study areas for monitoring predator-prey interactions. As with the work on assessment of krill populations, the CCAMLR efforts in ecosystem monitoring address basic methodological questions posed by multi-species management, including how to detect and distinguish between environmentally-driven and harvesting-induced changes in ecological relationships.

A second conclusion has been recognition of the need to pool efforts and divide up areas for research emphasis. In response to this need (at its Fourth Annual Meeting in 1985), the CCAMLR Scientific Committee initiated consideration of its long term program of work. This program is considered and updated at each meeting and is designed to provide an informal means of identifying CCAMLR research priorities and for coordinating the conduct of such research.

The record of the implementation of CCAMLR, viewed from the perspective of addressing and articulating the scientific and technical basis for an ecosystem management approach is impressive. There has been generated, in both the institutional and substantive sense, a major coordinated effort to develop the information base and analytical tools to carry out the Convention's objective. As noted, in my view, this is a more significant indicator than the actual conservation measures taken to date.

An equally important indicator, however, will be the manner in which the Parties to CCAMLR respond to the challenge of integrating the tools that are being developed into the political management decision process. The effort to address this issue is of more recent origin. The issue, perhaps somewhat misleadingly, has become associated with the question of elaborating a conservation strategy for CCAMLR. At its Fifth Annual Meeting (1986), the Commission recognized the importance of developing a process for defining a strategy for the progressive achievement of the objective of the Convention (Article II) and established a working group to examine this issue. It is significant that the working group was formed by the Commission rather than the Scientific Committee - a recognition that management policy is more a political than scientific issue.

The Working Group on Conservation Strategy developed the following terms of reference:

1. To develop a common understanding as to the management implications of Article II of the Convention.
2. To develop possible conservation approaches for achieving the objectives of Article II by means contained in Article IX.
3. To select and apply performance criteria for assessing each approach.
4. To identify, for preferred approaches, specific short- and long-term goals consistent with the objectives of the Convention.
5. To formulate the framework of a strategy for managing activities in order to achieve these goals.
6. To report to the Commission recommending appropriate action.

The group initiated examination of these items at the Sixth Annual Meeting (1987), with an emphasis upon developing a common understanding of the term "rational use" in relation to "conservation," as those terms are used in CCAMLR.

On a separate track, the Scientific Committee, also in 1987, indicated that, with respect to specific issues relating to fish populations, it had difficulty in providing advice to the Commission because the lack of guidance on management policy. In essence, the Committee served notice to the Commission that time had come to provide such guidance. In response, the Commission noted the Scientific Committee's points relating to the need for management strategies and, *inter alia*, requested advice from the Committee on a number of specific matters, taking into account the multi-species characteristic of ongoing fisheries. It also noted that relationship of these matters to the work of the group on conservation strategy.

The significance of these actions resides not in their results - which lie in the future - but in the fact that the Parties to CCAMLR have committed themselves to identify management policies and to sort out the science/policy relationship. What may augur well for the future is that this endeavor is taking place on several fronts. Elaboration of a definitive interpretation of Article II by itself is not likely to be a productive endeavor. In fact, there may be no single definitive interpretation. What is necessary is the recognition that the principles of Article II require interpretation and refinement on a continuing basis, to develop short-term and medium-term, as well as long-term, goals. Further, this continuing interpretation and refinement constitute, and should be viewed as, the process which integrates the scientific and political requirements of CCAMLR. For this reason, the dialogue between Commission and Scientific Committee may be as important as an explicit effort to delineate conservation strategy.

How this process unfolds will, in my view, be another basic test of whether CCAMLR can and will succeed. The emergence of this process, combined with the progress made in developing the data bases, analytical tools and institutional structures necessary for management, lead me to believe that CCAMLR's prospects are good.

Edward Wolfe: As office director in the Department of State for Marine Science and Polar Affairs, Tucker would normally attend one of my weekly staff director meetings. He didn't make it last week. He was too busy meeting with *Time*, and *Newsweek*, and other magazines. In his usual modest style I would report to you that Tucker brought home the bacon last week. We reached an agreement in principle on an Antarctic minerals regime with 20 consultative parties. This will set up the framework for exploration and exploitation in the Antarctic. It has been a six-year negotiation and Tucker deserves a lot of credit for doing a great deal of hard work, with a lot of patience. I would also point out that Lee Kimball was part of that delegation and we really appreciated all of her help.

Philomene Verlaan: My question is both for Tucker and for Marty. Tucker described how CCAMLR operates, incorporating quite a number of countries that are considered less wealthy than the ones that originally were associated with marine scientific research to any extent. The CCAMLR system would actually be quite a constructive answer to Bill Burke's criticism of your theory on the enforceability of large marine ecosystems as an approach to international law of the oceans. Do you consider CCAMLR to be a workable model to extend to other ecosystems which also combine, as in Antarctica, quite a number of countries with varying resources that they could share in the same way to address these issues?

Martin Belsky: There are two aspects that Tucker mentioned that fit in very well with what you said. First of all, both CCAMLR and the Law of the Sea Convention mandate cooperation by nation-states, and the implied message in both of them is: such cooperation should be undertaken to the best of their ability. That is, that poor nations should work together with the rich nations. The second aspect relates to the way international law evolves. CCAMLR, as an example of how something can work, can then be cited as an acceptance by the States who are practicing the Geosystem Comprehensive Approach as further evidence that the rule exists and is accepted by them. The other thing about CCAMLR is that I am not so sure that you cannot apply both CCAMLR and the Law of the Sea Convention interactively. They are not inconsistent. I am not getting into the geographical boundaries issue; I am not getting into the fight about those kinds of things. But if you assume the Law of the Sea Convention creates customary international law, and CCAMLR helps to create customary international law, I think they are interactive and they affect each other and they are creating that geosystem model. So my short answer -- all lawyers talk too much -- is YES.

Tucker Scully: I will only supplement my point, since I think, Marty, you covered the waterfront adequately. I see no inconsistency between CCAMLR and the LOS Convention. The only point I would make is that there is one difficulty with transferring CCAMLR: a political one. The opportunity that was taken within the Antarctic Treaty mechanism derived from the fact that there was a disagreement over coastal State jurisdiction and the jurisdictional issues that are so extensively dealt with in the LOS Convention. It provided, hopefully, a model of how one can approach the management of ecosystems.

John Knauss: I think the large marine ecosystem is a great idea, but I am not convinced that it will necessarily be the solution by which it will be possible to properly manage fisheries in the future. The problems of management, the problems of gathering scientific data that are needed for proper management - are so difficult that you never know enough to be precisely sure what the proper management action should be. All you have to do is look at the history of other types of fisheries management systems. If there is a pressure to overfish, there will always be enough uncertainty in the advice that a fisheries advisor gives, that will allow for that pressure to overfish to carry the day.

Let me give you a simple example. The International Whaling Commission is researching a large marine ecosystem as a management system. They are responsible for the entire world's oceans. If you follow the history of the International Whaling Commission since 1936, the Commission often had very good advice from their scientific advisors as to what should be the allotted whale catch. But there was always a line of uncertainty. The scientists could never quite agree; there was generally a range of options. The political decision makers always had reasons to accept the larger end of the whale catch estimate. Now, I am not talking about the last few years, I am talking about the whole history of the IWC.

You can find a similar situation with fisheries advisors giving their advice to the local managers in every international fisheries agreement that we had, and it always seemed to work the same way. The managers opted for the high end of the range of catch estimates, and on the average that meant overfishing. Now I think there will probably be the same situation with the large marine ecosystem, except that the advice will be somewhat better than what we have now.

Law Enforcement Capabilities in EEZs: Australia and the South Pacific Island States

Peter Varghese
Embassy of Australia
Washington, D.C.

I have been asked to speak about law enforcement capabilities in EEZs and in particular about what Australia and the island states of the South Pacific are doing in this area.

In speaking of the South Pacific I will be referring mainly to that part of the South West Pacific encompassed by member nations of the South Pacific Forum. The Forum, as it is usually called, is the region's premier political organization. It meets annually, traditionally at head of government level, and includes all the independent and self governing countries of the region. Its membership now numbers 15: Australia, New Zealand and Fiji; the Melanesian nations of Papua New Guinea, Solomon Islands, and Vanuatu; the Polynesian countries of Cook Islands, Nauru, Niue, Tonga, Tuvalu, and Western Samoa; and the Micronesian countries of Kiribati, Federated States of Micronesia and the Marshall Islands. The last two - FSM and Marshall Islands - became full members of the Forum in 1987 after their compact of Free Association with the U.S. entered into force. Palau is also expected to join the Forum after its compact has entered into force.

Although the title of this panel is law enforcement, the point I wish to make is that effective maritime surveillance is as much a question of economic security as it is of law enforcement. Maritime surveillance capability is so important to the island states of the South Pacific because marine resources are so crucial to their economies.

If you look at a map of the world the most striking feature about the South Pacific is that it is a maritime environment. It is a region of island nations - short on land but containing vast Exclusive Economic Zones. The Economic Zone of Kiribati, for example, covers some two million square miles of ocean.

In economic terms, this maritime environment is only just beginning to bring in returns. With the exception of fishing, the riches of the sea and the seabed remain unexploited and for the most part unexploitable with current technology and national resources. Indeed, if anything, the location of the Island States has contributed to their problems in terms of economic development. This may change if deep seabed mining and other means of exploiting marine resources - living and non-living - were to become technically feasible and economically attractive. But for the moment many of the island states of the South Pacific have to cope with the almost intractable pattern of maintaining increasing populations in communities which lack land based resources, have micro economies, are vulnerable to cyclones and other natural disasters and where land is scarce and often infertile, and transportation and communications are difficult and expensive. Against this background, control over marine resources takes on a particular importance. Put simply the island States cannot afford to see their maritime resources stolen from them and so

the development of a maritime surveillance capability is a high national priority throughout the region.

In approaching surveillance issues, the states of the region have been conscious that whatever system is developed should be tailored to the special needs and geography of the South Pacific's maritime environment. The region does not need, nor can it afford, high technology systems. Operating costs must of necessity be modest, bearing in mind that so far the income generated by maritime resources is itself not great. Moreover, the main focus of current surveillance activity is associated with distant-water foreign fishing for highly migratory species of tuna, the movements of which are generally well known. So the law enforcers have a fairly good idea of which areas should be given priority at which time of the year.

Let me now turn to what Australia, in cooperation with the island States, is doing to develop and strengthen maritime surveillance capabilities in the region. A central pillar of these efforts is the $A62 million Pacific Patrol Boat Program. Announced in 1983, the Pacific Patrol Boat Program involves the provision to island States of patrol boats specifically designed to meet their needs for surveillance of their 200-mile Exclusive Economic Zones. In all, some 14 boats will be constructed. Four have already been handed over - two to Papua New Guinea and one each to Vanuatu and Western Samoa. Others will progressively be provided to other Forum countries.

As part of the program, Royal Australian Navy officers and technical experts are deployed in the receiving countries for extended periods to assist in establishing operational and maintenance/support systems. In addition, there is an extensive training program for all involved with the boat. This includes not only operational and maintenance skills training, but also training in resource zone laws, fisheries enforcement techniques and surveillance center operations.

The concept of the vessel is to provide a flexibly designed craft that has surveillance and enforcement as its primary function but can also meet medical, search and rescue, disaster relief and police tasks. In addition, the vessel can provide a fisheries research and frozen fish transport capability. Armament varies in accordance with each country's needs but most are modest as befits a policing role.

Integral to the provision of indigenous surveillance and enforcement capabilities is the establishment of national surveillance centers and the establishment of EEZ boundaries. Australia has taken an active role here. In consultation with the Honiara based Forum Fisheries Agency (FFA), New Zealand and the participating countries, Australia is contributing to the development of maritime surveillance/national operations centers and the associated regional communication network.

We have offered to assist the Solomon Islands, Vanuatu, Western Samoa and the Cook Islands to establish surveillance center facilities, and PNG and Tonga to upgrade their centers. This includes, where necessary, assistance with the development of suitable buildings, provisions of communications, data storage, and other equipment together with expert advice and training. Surveillance centers in the Solomon Islands and Vanuatu are well advanced and a feasibility study was concluded for construction of a surveillance center in Western Samoa.

In order that these systems can maximize their effectiveness Australia, and also New Zealand, provide Air Force Long Range Maritime Patrol (LRMP) aircraft deployments regularly in the region. This involves about ten Australian patrols per year, generally extending over five

days each, during which time surveillance of several island states' maritime areas can be accomplished.

Using data available from the FFA the objective is to focus those aerial maritime patrols on the times of the year and the areas where intrusions by foreign fishing and other vessels are known to be most probable. Maritime surveillance authorities in the island countries are consulted when the patrols are planned and we pass reports on to them. We also maintain close liaison with the New Zealand authorities to ensure our patrol efforts are complementary.

Maritime patrols by the Royal Australian Air Force are complemented by regular visits to the island States by vessels from the Royal Australian Navy. These vessels provide additional surveillance assistance and also exercise with local craft to improve operational techniques. The vessels engage in cooperative activities with the islands' maritime authorities including passing on any surveillance observations made in local waters.

In March, 1988, Australia, New Zealand, and the FFA sponsored a maritime surveillance seminar for all members of the South Pacific Forum Fisheries Agency (Palau included). The seminar discussed operational and procedural aspects of maritime surveillance activities in the region and provided a good opportunity to exchange views on national and regional approaches to maritime surveillance. In all these activities our objective is to assist regional maritime cooperation, and eventually to establish a network for regional maritime surveillance based on cooperation and compatible national efforts.

Obviously, such an outcome also serves regional security interests by making a direct contribution to our knowledge of maritime activities in a region of primary strategic interest. We do not seek to hide that Australia, as much as the island States, is a beneficiary of the program. Australia sees its role as that of a partner in an exercise which results in mutual benefit to the island countries and to ourselves.

New Technology in Surveillance and Enforcement and Appropriate Development in the Pacific Islands

Don Aldous
Department of Fisheries and Oceans
Halifax, Nova Scotia

Abstract

One of the primary concerns of fisheries management is the control of foreign fishing in the EEZ. This is implemented through the concluding of access agreements with distant-water fishing nations, and by monitoring the behaviour of foreign fishing vessels. In addition to monitoring, control and surveillance functions are important to the management of foreign fishing vessels. The author shares the experience gained through a two-year appointment to the position of Fisheries Surveillance Advisor to the South Pacific Forum Fisheries Agency based in Honiara, Solomon Islands.

The current paper will examine the progress made in the Pacific island nations of the South Pacific Forum in the management of foreign fishing in coastal States, describe the role of the Forum Fisheries Agency in assisting in this regard and look at some of the options to consider in applying new technology to the field of surveillance and enforcement in the Pacific. The paper is divided roughly into three sections: background on the Pacific and description of the problem of surveillance; a statement of the current surveillance operations underway in the region; and modern technology that has been considered for implementation.

Introduction

Geography

The Pacific islands region occupies approximately 29 million square kilometers and of this, less than two percent is land.[1] The region is a diverse mixture of races, cultures, geography and political entities. The larger islands of Melanesia are remnants of a former continent which included Australia and so have extensive mineral resources. The remainder of the Pacific islands are either volcanic or coral or a mixture of the two. The volcanic islands are mountainous and luxuriant with fertile soil and dark sand beaches. The coral islands are characterized by low land, infertile soil and brilliant white sand beaches.

The cultures of the Pacific islanders have been somewhat arbitrarily divided by anthropologists into three categories: Melanesian, Polynesian, and Micronesian. Within these groups, there are wide varieties of custom and language. Despite their differences, the people of the Pacific share a common dependence on the ocean and fisheries for their livelihood. In fact, "dependence" does not convey the correct sense, for fish have entered every aspect of not only their diet, but their culture, traditions and rituals. In Fiji, at the opening session of tuna treaty negotiations with the United States, the speaker for the Pacific islands delegations said quite simply that, "Fish are our lives."[2] This statement encapsulates the place of fish in the lives of Pacific islanders for it means far more than employment and economics.

Politics

To further dispel the image of the homogeneity of the Pacific islands, a closer study of their politics will reveal a wide diversity of political structures and associations. For example, there is a kingdom (Tonga), a dominion (Solomon Islands), a State where only chiefs can be elected (Western Samoa), a republic (Nauru), an associated state (Cook Islands), an unincorporated territory (American Samoa), a commonwealth (Northern Marianas) and a department (New Caledonia). Of the 21 political entities in the region, there are 12 that are constitutionally independent States, two self-governing states in association with New Zealand and the rest are different forms of dependencies under metropolitan authorities.

Despite the differences in constitutional status, there are few major differences in basic political ideologies. This is not to say there are no political differences but rather those differences take the form of rivalry between competing factions within the nations. In the regional context, political differences are caused by various reactions to unique colonial experiences.[3]

Law of the Sea

With the advent of the 200-mile Exclusive Economic Zone (EEZ), coastal States have gained jurisdiction over increased areas of ocean and resources. This has greatly improved the opportunities for these nations but nowhere in the world is this change more dramatic than in the island nations of the Pacific. The Kiribati land mass is 690 sq. km. with an EEZ of 3.5 million sq. km.. The Marshall Islands has a land mass of 181 sq.km. and a zone of 2.1 million sq. km..[4]

The United Nations Convention on the Law of the Sea (UNCLOS) gives the coastal States sovereign rights over the resources in their EEZ's as well as the responsibility for their management. To many of the Pacific islands, the proper and orderly development of these resources provides their only opportunity for economic independence. In order to gain respect for their rights as coastal States, the nations have banded together in recognition of their common needs, strengths and opportunities.

Forum Fisheries Agency

The South Pacific Forum Fisheries Agency traces its origins to the South Pacific Forum meeting in Port Moresby in 1977, which adopted a Declaration on the Law of the Sea and the establishment of a Regional Fisheries Agency, and outlined the proposed functions of the Agency. The decision to establish an Agency, which would be restricted to Forum Governments and would not include a wider range of countries such as the United States, was taken by the Forum in Niue in 1978.

A Convention was drawn up and was acceded to by the twelve Forum members of the time by October, 1979. The Convention established the Agency to promote regional cooperation in various aspects of fisheries with the objective of securing the maximum benefits from the living marine resources of the region for their peoples, and for the region as a whole and in particular the developing countries.

Member Governments include: Australia, the Cook Islands, the Federated States of Micronesia, Fiji, Kiribati, the Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, the Solomon Islands, Tonga, Tuvalu, Vanuatu, and Western Samoa.

The Work Program of the FFA covers: the harmonization of fisheries regimes and access agreements; fisheries surveillance and enforcement; current information services; tuna fishing development; economic analyses; fishing patterns; fisheries and administrative training; regional fishing vessels register; and delineation of fisheries and related zones.

The Agency has fourteen professional staff, and fourteen office and maintenance staff. The professional staff include: two Computer Staff, two Economists, a Fisheries Development Officer, a Research Coordinator, a Legal Officer, a Fisheries Surveillance Officer, a Statistics Officer, and a Database Officer; in addition to the Director, Deputy Director, and two Finance and Administration Staff.

The on-going operations of the Agency are funded largely by contributions from the Member Governments with support from the United Nations Food and Agriculture Organization (FAO), the United Nations Development Program (UNDP), and the Commonwealth Fund for Technical Cooperation (CFTC). Variable support for particular projects is also received regularly from a range of sources including the Australian Development Assistance Bureau (ADAB), the Canadian International Development Agency (CIDA) and International Center for Ocean Development (ICOD), the New Zealand Overseas Development Assistance (NZODA) Program, the United States Agency for International Development (USAID) and the Government of Chile.

Surveillance Requirements

The surveillance needs of the Pacific islands are unique to the field. Nations, when referring to FFV management, call themselves coastal States. Although this term has legal application, it does not adequately describe the geography of the region. These are ocean States that present a whole set of problems to the field of surveillance that are quite unlike other coastal States. Take for example the fact that much of the region remains uncharted in modern times. This presents a problem for navigation in the area. Take airfields as another example. There exist relatively few places where large aircraft are able to land for refueling. The population and industrial base of the region cannot support the massive expenditure and supporting infrastructure necessary to maintain an extensive surveillance program. The sea conditions themselves vary from the usually benign climate of the equatorial region to the violent storms of the higher latitudes.

It is imperative therefore that the island States of the Pacific set for themselves some realistic goals for surveillance in their EEZs. Recognizing the vastness of the zones and the available funds, manpower and equipment, the island States cannot afford to mount extensive sophisticated programs. They will, however, need some capacity to enforce their rightful jurisdiction over fishing nations. This starts at the bargaining table. The terms of an access agreement must reflect the coastal State's ability to enforce the agreement. For example, if it is not possible by any means of monitoring to verify the quantity of fish caught, then it would make little sense to limit the catch of FFVs to a quota.

Secondly, hardware must be purchased to provide some measure of enforcement capacity. This hardware must be chosen carefully and be appropriate to the particular conditions, needs and capabilities of the island State. Lastly one cannot overemphasize the importance of fisheries training programs. Only by taking advantage of opportunities for

training in EEZ management will the Pacific Island States be able to ensure a crop of knowledgeable administrators for the future.

Regional Cooperation

Harmonization of Access Agreements

The most powerful administrative tool the Pacific island nations have used in controlling foreign fishing in their waters is to band together in their negotiations with Distant Water Fishing Nations (DWFNs). Previous to the establishment of the Forum Fisheries Agency, DWFNs could enter into separate negotiations with each member government in isolation of the others. In this way, DWFNs controlled those negotiations playing off one island nation against the other in the interests of negotiating the cheapest possible deal. Regional co-operation in this area began with the Nauru Agreement in 1982 which was aimed at achieving a common approach to management of fisheries zones. It laid out uniform terms of access agreements and conditions for licensing foreign vessels to fish in EEZs of the signatory nations. The Nauru Agreement was not signed by all Forum members due to differing opinions in fisheries management principles. Before the reader jumps to conclusions regarding an ethnic or racial split on this issue, bear in mind the signatory nations were the ones with the most experience in negotiating access agreements with DWFNs. Robert Keith-Reid expressed that the parties to the Nauru Agreement

> have much richer tuna stocks than other Forum countries because they lie closer to the equatorial zone favoured by skipjacks, and so are most frequented by the Asian and American fleets, particularly Japanese longliners. They have agreed on common terms for fisheries access agreements. (*Islands Business*, June 1983:53).

Regional Register of Fishing Vessels

Out of the Nauru Agreement of 1982 grew the regional register of fishing vessels. Since common criteria had been established for access to EEZs, it was a natural extension to require that in order to be licensed by a Forum member, the vessel would first have to apply to the regional register maintained by the FFA. The process of application involves the vessel owner submitting detailed information regarding the vessel, its fishing operation, communications equipment, owner and crew. The strength of this agreement lies in that in order to be licensed by any nation in the Forum, the vessel has to maintain "good standing" on the register. Any member government could apply for removal of "good standing" for a vessel which had appeared to have contravened fisheries regulations and fled from justice. Once "good standing" has been removed, it can only be reinstated by the vessel owners returning to face the courts for the alleged crime.

The introduction of the regional register has been crucial to the control of foreign fishing vessels in the Pacific in two very important aspects. There has been only one case where a vessel's "good standing" has actually been removed for an offense. In all other cases, the threat of removal was sufficient to have the vessel return to the courts. The other benefit derived from the regional register has been the creation of a large database of information on vessels fishing the Western and South Pacific. At present there are over 2,000 vessels on the register and information is constantly being amended as vessels change hands. This information has been invaluable in forming the nucleus of the FFA

database. Using this information, together with licensing and logsheet data which has subsequently become available from FFA member states, the Agency has been able to build a fairly complete profile of fishing operations.

Multi-lateral Treaties

The FFA has, since its creation, been assisting in the negotiations between member governments and the two major DWFNs: Japan and the U.S. This began with the provision of marketing information and evolved into direct assistance in negotiations. In more recent years, this advisory service has been extended to negotiations with the Taiwanese, Koreans and the USSR. The most difficult task the Pacific Island nations have had to face in this regard is the negotiation of a multilateral fisheries treaty with the U.S.. The necessity for a treaty stemmed from the hardline position of the U.S. in not recognizing coastal state jurisdiction over highly migratory species. This intransigence on the part of the U.S. did much to damage previous good relations between the Pacific islands and the U.S.. The issue came to a head in 1984 when the Royal Solomon Islands Police Force arrested the U.S. purse seiner, *Jeanette Diana*, for fishing illegally in her EEZ. The conviction of the captain and owner of the vessel set off a trade embargo against Solomon Islands tuna products in the U.S.. The 1984 Forum meeting in Tuvalu considered that since the U.S. vessels would likely continue to poach regardless of what Pacific islands might do, that

> the satisfactory long-term solution to this problem lay in the conclusion of a multilateral agreement with the United States, and called for a prompt and successful outcome of negotiations to that end... (FFA Director's Annual Report 1984/85:3.).

After two years and thirteen rounds of negotiations, a five year treaty between the Pacific islands and the U.S. was signed in April, 1987. It is a most comprehensive treaty detailing fishing fees, reporting requirements and compliance arrangements. The process of ratification of the Treaty is continuing and the U.S. has yet to pass the South Pacific Tuna Act which will bring the Treaty into domestic legislation.

In 1987, the Pacific Islands also initiated multilateral negotiations with the government of Japan. These negotiations are underway at the current time.

Current Surveillance Capabilities in Pacific Islands

National Programs

The national surveillance programs of the Pacific Islands are as diverse as their history and culture. In some nations, surveillance activities have been conducted since extended jurisdiction as a part of regular military exercises. In others where there is no military, and there is a scarcity of funds, little has been accomplished. The following will give an assessment of some of the programs in selected nations around the region.

Federated States of Micronesia

In the Federated States of Micronesia (FSM), there has been a surveillance program in existence since 1979 and operated under the auspices of the Micronesian Maritime Authority (MMA). Although FSM does

not have a patrolboat as yet, they have had some success with charter operations. In 1987, the government of FSM committed funds toward the construction of a patrolboat which would be multipurpose in application but dedicated primarily to fisheries enforcement. This project will have a massive effect on the FSM since to date they have been using as their surveillance vehicle an old fishing vessel which was limited to a speed of 6 knots and provided only saltwater bathing facilities. Even under these difficult conditions, however, their program has been one of the most successful in the region, apprehending two U.S. purse seiners. This proves that speed is not of prime consideration. The success in FSM is due to a sense of commitment more than anything else. The MMA has been able to convince its government executive that fisheries surveillance is of primary interest to the nation. The recently signed Compact of Free Association with the U.S. provides funds earmarked for the enhancement of the fisheries surveillance program.

Palau

In Palau, a seized Taiwanese longliner has been used by the Attorney General's office to conduct enforcement in the Palau EEZ for the past few years. Although this sounds like a good idea, it has posed some problems since it is not easily recognizable as an enforcement vessel. In one case, a Japanese captain was shot when he refused to stop his vessel upon being approached by the patrolboat. His testimony said that he thought his vessel was being overtaken by pirates. Participation in regionally sponsored enforcement training has assisted in the enhancement of the Palauan surveillance program.

Solomon Islands

A surveillance program has been ongoing in the Solomon Islands for some time as part of the military function. It was not until 1984 that the seizure of the U.S. purse seiner, *Jeanette Diana*, provided funds for the procurement of a patrolboat dedicated to surveillance activities. The operation, based in the capital of Honiara, is run by the National Police who are now, with the assistance of Australia, setting up a surveillance center from which operations will be coordinated.

The Solomon Islands government has initiated a unique training program for police officers in outer island areas. The course was called a "coastwatch" session in a tradition for which the Solomon Islanders are famous. The first three-day session in 1987 was attended by twenty officers who received instruction from their police headquarters, from Customs, and Quarantine as well as the FFA. The participants learned of the relevance of their work in relation to other government departments. They also learned to identify and report fishing activity to their headquarters and were issued binoculars to assist in identifying vessels. The FFA provided information on how the Agency is able to assist in identification and apprehension of vessels as well as contacting vessel owners.

Cook Islands

In the Cook Islands, there has been virtually no surveillance program conducted to date. The government has recognized the need to become more involved in surveillance and has agreed to participate in the Pacific Patrolboat project of the Australian Navy, a project that will be covered in greater detail below.

The Ministry of Police has set up a Marine Division under a newly-created Superintendent position which will be responsible for the

operation of the new patrolboat. The Ministry has created new positions for manning the vessel and anticipated that recruiting and basic police training would be completed by January, 1988 in readiness for the Patrolboat Training Program. The newly-created Marine Division will include a Surveillance Center from where the vessel's operation will be directed. Such a center is planned for establishment in Rarotonga as part of the Australian Patrolboat project.

To date, there has been little done to monitor the activity of vessels licensed to fish in the EEZ and little surveillance to ensure that no illegal fishing takes place. The Cook Islands have been entirely dependent upon the occasional surveillance flight by RNZAF aircraft to determine the extent of illegal fishing. This is a situation not unique in the region where there is still a lot of work to do. It is essential that catch and position reports are verified by monitoring and surveillance. To date this has not been possible due to lack of staff and computers. When such computers are installed, it will greatly influence the ability to enforce fishing regulations and provide intelligence information for the negotiation of access agreements.

Marshall Islands

Since the formation in January, 1987 of the Marshall Islands Maritime Authority (MIMA), there has been substantial interest in the fisheries sector of the Marshall Islands. There have been a number of studies completed and decisions made which have affected the initiation of a fisheries surveillance program in the Marshall Islands. Officials of the MIMA have concentrated on the options available for development of a surveillance program given the magnitude of the problem of foreign fishing, the resources available, current levels of funding and the opportunities for training.

The government of the Marshall Islands has been wise to realize a surveillance requirement in the purchase in 1987 of a vessel to be used as a patrolboat. At 100 feet long, the vessel is a former oil industry crew boat and required some modest refitting for use as a surveillance vessel. Now outfitted with larger fuel tanks and a boarding craft, the vessel began operations in September of 1987. With regard to air support for the patrolboat, the Marshalls are fortunate to have two Dornier aircraft as part of the Marshall Islands' Airways. These aircraft, although they have relatively short range, when fitted with extra fuel tanks, are able to cover the Marshall's EEZ in three flight patterns.

Papua New Guinea

By late 1987, fisheries surveillance in Papua New Guinea had reached a critical point where decisions had to be made for the future of the program. With four Attack class patrolboats and six Nomad aircraft available for surveillance tasking, the program suffered from a lack of planning and co-ordination with fisheries objectives in mind.

A major study was initiated in 1987 to review surveillance operations in PNG and develop an operational plan for the use of resources. A three-month fellowship for a surveillance official from PNG was set up at the FFA headquarters in Honiara. During this time, the surveillance official and the FFA conducted an exhaustive study of the surveillance program concentrating on a statement of needs, management of information, and co-ordination of the existing and newly acquired resources to provide a well planned and co-ordinated program for the future. The project provided an opportunity for Papua New Guinea to be exposed to

the regional surveillance initiatives and contribute to the building of a network of such advisors in the region.

FFA Surveillance Program

The FFA member states have for some time had fisheries surveillance marked down for prospective regional cooperation. Although initially thought not to be cost effective as a national program, experience has shown how effective regional programs such as the Regional Register can be in influencing the returns in access fees. Thus more emphasis was placed on development of regional cooperation in this field and FFA was requested by the FFC to mount a project.

FFA formally approached the Canadian funding agency, ICOD, regarding this project in August of 1985. The request for funding and assistance was viewed favorably by ICOD since it fit the corporation's objective regarding promotion of regional programs between groups of developing coastal states. The project was approved for inclusion in the work program by the ICOD Board of Directors meeting in December 1985 and a Surveillance Advisor was recruited who reported to the FFA in January 1986.

The Surveillance program in the South Pacific was designed with four main objectives:

a) provision of technical advice to governments on request;
b) the promotion of co-ordinating fisheries surveillance programs;
c) collating of reports and information on vessel activities;
d) the establishment of a training program for surveillance officers, supervisors, and fishery managers.

Pacific Patrolboat Project

The Royal Australian Navy (RAN) has undertaken a massive Defense Co-operation project in the South Pacific. This includes the provision of up to fifteen 31 metre patrol vessels to participating governments complete with:

a) a store of spare parts;
b) two regionally located maintenance centers;
c) fully equipped surveillance center in each participating nation;
d) full training program at Australian Defense College on marine engineering, seamanship, communications, legislation and surveillance;
e) RAN officer to act as Naval Advisor to each nation.

The cost of the entire project has been estimated at AUD 60 million over the next four years and is considered to be the most ambitious Defense Cooperation Project ever undertaken by the RAN. RAN is enthusiastic about the FFA Surveillance Program as it fits into their plan of promoting national enforcement within the region. To date four vessels have been turned over to the region; two to Papua New Guinea and one to Vanuatu and as recently as March '88, one to Western Samoa. The next vessel is due to be turned over to the Solomon Islands in November, 1988.

The project implementation has been difficult since member nations are uncertain about the operational costs and their own ability to run these vessels. One of the major benefits of the project is the training provided at the Australian Maritime College. This is a comprehensive series of courses for ships officers and crew and it is hoped it will be offered as an ongoing commitment to fisheries surveillance in the region.

Regional Air Surveillance

Surveillance is an assertion of a coastal State's sovereign rights over its EEZ. Its broad objective is to ensure that foreign fishing vessels are complying with the access agreement, if any, and all relevant coastal State laws and regulations. An important function of surveillance is to verify that the reports received by the coastal State from foreign fishing vessels are accurate, and representative of all fishing activity in the EEZ. Even if no vessels have been licensed, the State must maintain surveillance of its zone to ward off violators.

At the operational level, surveillance involves the detection and identification of vessels. This usually involves air surveillance to determine whether there is unlicensed activity in the zone. Air surveillance may be conducted by aircraft or satellite. The satellite option has proven to be expensive, unreliable due to cloud cover, and not very effective due to the low resolution of images.

The function of surveillance usually falls to the military in nations where a military exists. The Australian and New Zealand Air Forces conduct what they call sorties of three or four days into the Pacific region beyond their own 200 mile zones. Their primary function during these operations is to detect submarine and surface activity in the region but they are also willing to assist the Pacific Islands with FFA surveillance while they are in the area.

In the South Pacific, the New Zealand and Australian Air Force use the Lockheed P3 Orion to fly patrols. Usually outfitted for anti-submarine warfare, their surveillance equipment includes infra-red radar (IRDS) which gives a television image of the area below the aircraft, even at night. Another device common to this aircraft, but not available in the RNZAF or RAAF aircraft, is a profiling radar which, at great distance, can provide not just a blip on the screen but a profile of the vessel hull and superstructure.

Present annual levels of support are ten sorties by Australia and eight by New Zealand. These flights are co-ordinated with the assistance of the FFA. While this assistance has been useful, it is insufficient to properly monitor fishing activity.

In order to detect, identify and board ships at sea within the vast EEZs of the South Pacific island nations, those nations face decisions involving the spending of millions of dollars. The cost of surveillance hardware must therefore be weighed against the returns from that program. Where there exists little foreign fishing effort from which license fees can be extracted, it makes little sense to mount an extensive program directed primarily at fisheries surveillance. In nations with little or no military hardware to call on, the mounting of a surveillance program is a very expensive proposition.

During the past two years, the FFA has been trying to come to grips with this important problem of provision of air surveillance to the region at cost effective levels. In doing so, they are working on two related projects. The first is an attempt to develop an operational plan for the use of the present level of air surveillance in the region as provided by the Australian and New Zealand Air Forces. There has been a great deal of interest in this project by the military community and the Agency has prepared a comprehensive study of fishing patterns in the Pacific. It is anticipated this study will be a significant contribution to the operational planning of the use of aircraft in surveillance of the Pacific.

The other project which is very much at the formative stage is to consider a civil air surveillance contract which would support the present military flights and concentrate on those areas where the most fishing takes place. Simply stated this project would involve the FFA acquiring an aircraft, signing a service contract for its operation and task it to areas of fishing intensity. It has been proposed that the service contract be funded, at least partially by a user pay principle by those members involved in the project. The first step has been to engage a consultant to provide advice on type of aircraft suitable to the job and the likely cost of a service contract.

Observer Program

The Treaty on Fisheries negotiated between the Pacific Islands and the government of the U.S. allows for the placement of observers on U.S. purse seiners for the purpose of monitoring catch and for the collection of biological data. The information will be used in the management of the fishery by both the FFA and the South Pacifc Commission (SPC). In the first year of operation of the Treaty, it is planned to place observers for approximately 30 trips. The observers require training in all aspects of their duties with respect to the Treaty. It is expected that there will be a continuing need for observer training in the future.

As part of the FFA surveillance program, the Advisor has had some involvement in the design of this program in association with the newly appointed Treaty Manager. A meeting was held in Honiara in July with the U.S. government and industry officials which laid the ground work for the Observer Program. Following this a two week course was conducted at the Marine Training Center in Western Samoa to prepare observers for their task. A substantial effort by all involved in the project resulted in the production of a manual for observers to use in the conduct of their work. A second course is planned for the very near future in Pohnpei.

Surveillance Officials' Meeting

The third Surveillance Officers Meeting was held in Launceston, Tasmania October 5-9, 1987. This meeting is one of the highlights of the FFA Surveillance Program and each session has enjoyed full support by member governments. Fourteen of the sixteen FFA members sent representatives, with regrets received from Niue and Nauru. This meeting is intended to provide officers from member states with a forum for discussion of common problems and development of common approaches in the region. This meeting is one of the most important aspects of the FFA Surveillance Program in that it is the key to promoting regionalism in surveillance of the South Pacific. This assembly has also provided direction to the FFA Surveillance Program by reviewing projects and making recommendations to the Forum Fisheries Committee (FFC).

The topics for discussion at these meetings has been:

- Patterns of foreign fishing in the region;
- Regional air surveillance plan;
- Implications for surveillance of the U.S. Fishing Treaty;
- Lectures on evidence gathering;
- Case studies in fisheries;
- Regional communications;
- Briefing on surveillance flights by New Zealand Defense; and
- Briefing by Australian military on the Defense Cooperation Program.

Training Program

The meeting of enforcement officials held in Honiara in November, 1987 made it quite clear to the FFA that more emphasis should be placed on progress in the training objectives of the Surveillance Program. Following that direction, a suggestion was made to form a small working group to discuss the training requirements and develop a course outline for review by member governments.

This meeting was held in February 1987 in Suva and a course outline was proposed to members with options for implementation. The Agency received support for its proposal to approach the Australian Maritime College and the Royal Australian Navy for implementing the course.

As a result, a six-week course was held at the Australian Maritime College starting in November, 1987. Funding for participation by nations not involved in the South Pacific Patrolboat Project was to be covered by the Canadian ICOD and the Australian Development Assistance Bureau (ADAB). Due to limited funding, FFA is able to support only ten participants to this course but it hoped that funding may be found to support another group of participants in 1988.

New Technology Applications in Surveillance

Vessel Surveillance System

Within most of the member governments of the FFA, there exists severe budgetary and supporting infrastructure constraints that will not allow the development of extensive acquisition of ships and aircraft to conduct surveillance of fisheries zones. It has been suggested that the use of electronic measures may provide some surveillance at much lower costs. High Frequency (HF) radio has been proposed for this use by providing a direct communication link between the ships at sea and shore based national headquarters.

It is proposed that the member governments of FFA consider the use of a HF Vessel Surveillance System (VSS) for fisheries surveillance use. The system involves the placing of an automatic transmitter device on-board selected fishing vessels working in the EEZ. Although this does not address the problem of illegal fishing by unlicensed vessels, it does ensure accurate position-reporting by those vessels licensed to fish.

In its simplest form the VSS will provide a monitoring system for vessel location. The device contains a navigation instrument which is read by the system controller and the unit's position transmitted to the base station. The communications controller performs two primary functions:

1) to detect errors occurring in the transmission of defective data and to request retransmission from the remote station if necessary.

2) address to controls so that transmitted information is received by and recognized by the intended station.

In addition to these primary functions, the communications controller allows any VSS platform to address any other VSS platform, or to designate any other platform as a repeater. This type of configuration becomes a "network" application and would normally require some means of altering the operation of the communications controller. This can be accomplished by a personal computer operating a simple control program. This would be important in applying this to the Pacific region where the distances are vast. In order to work as a reporting system for FFVs to

national governments, there would have to be a system of repeaters set up on remote islands to give full coverage of a nation's EEZ. A more advanced form of the device includes a simple keyboard which is used to send catch reports.

The FFA has been following the development of this system quite closely and has participated in tests at various stages of the system design. The next stage in this project is to test and demonstrate equipment in the Pacific Region. It is proposed that three transmitters be placed in watertight and tamper proof containers and placed on board government vessels in Papua New Guinea. The system would then be tested over a number of days. If the test proves positive, the FFA would seek funding to place a number of transmitters on a fleet of foreign fishing vessels as a pilot project.

Remote Sensing

Some initial work has been carried out by the FFA studies the use of remote sensing for surveillance purposes. The band closest to the Earth's atmosphere is where most of these satellites operate and as such they are relatively short lived. At a height of 250 km., life before re-entry is only 12 days. So a compromise of 700 km. is the usual altitude where satellite life can be expected to be at least five years. Most of these devices are top secret and not available for commercial use. Capabilities are highly classified but the U.S. is said to have satellites capable of resolution to 35 cm.

Commercial remote sensing satellites have been used to map ocean currents and for macro geological surveys. The resolution of these devices is increasing but has not yet reached the stage where it is useful for identification of vessels. One of these devices is getting quite close and that is SPOT. In 1986, the French launched a satellite which is now orbiting the earth at a height of 800 km.. Anyone can purchase from the SPOT people a 60 x 60 km. color image of almost anywhere on the earth's surface for about US$2,000. The resolution of this image is reported to be 10 m., not quite high enough for identification of vessels as fishing vessels but as the resolution of these devices increases over the years, I'm sure they will become useful for the detection and identification functions of fisheries surveillance.

Regional Telecommunications Network

There is an immediate need for increased surveillance in member countries which will require secure and reliable communications systems at both a national and regional level. If FFA is to undertake an efficient and timely surveillance program and develop a regional database which can directly benefit the members, then a new communications system is required using the latest technology which is reliable, easy to install and operate, and cost effective.

The development of a regional database implies that member governments will be able to update and access that information from national centers. Several attempts have been made to conduct such links and have been without success. It has been determined that use of existing public standard telephone links is slow, costly, inefficient, prone to interference and in some areas impossible. The poor quality of existing telephone links and the problem of the double satellite hop necessary to make most connections, severely hamper good communications.

The FFA has been investigating the options available to develop a regional network. The first step was to define these requirements to Telecommunications providers by distribution of the FFA Document 87/4:

"Telecommunications Problems of National and Regional Fisheries Administrations in the South Pacific" at the Pacific Telecommunications Conference (PTC) held in Honolulu, January, 1987.

In response to the Statement of Requirements as distributed INTELSAT has offered the most realistic solution involving FFA member governments sharing space on a transponder under a user pay network. INTELSAT is a non-profit global cooperative created twenty three years ago to provide countries with the ability to interconnect directly via an advanced worldwide satellite telecommunications system. The central goal of the INTELSAT treaty is a single worldwide satellite communications system accessible to both developed and developing countries. INTELSAT has been serving the South Pacific for many years and of all sixteen FFA member governments, only Niue and Tuvalu do not currently operate an INTELSAT earth station. The most interesting aspect of the network proposal is that communications could be conducted at a very fast 9,600 bps, a speed which would allow the use of graphics quite efficiently.

It was clear from the information gathered at the PTC that all the options that will provide the service required involve a satellite link. Large corporations and agencies have approached this problem by setting up their own network on the public system of INTELSAT. Businesses that demand high continuous usage usually rent space on a satellite transponder that is for their own private purpose. For smaller organizations, who demand only "thin route" communications, it is possible to set up a network on a shared basis with other users whose requirements are similar. This means that a whole group of users are sharing the cost of renting space on the transponder.

The FFA has been investigating this last option and has conducted a preliminary study into the feasibility of setting up a network of all FFA members providing voice, data, telex, and facsimile communications at a speed which will allow member governments to access the FFA database.

Information Systems

There is within the member states of the FFA a clear understanding of the need for an enforcement program to back up fisheries laws and agreements. Most States have developed monitoring programs where foreign fishing vessels submit zone entry, zone exit, and weekly catch reports. Some members also insist upon a daily position report from each vessel fishing in their zone.

There is more work to be done, however, in the handling of all this information. There is no doubt that, in order to make sense of the data, administrators need the assistance of computers for summary reports and analysis of data concerning fishing effort and catch.

The FFA has recognized this as a major concern and has commenced a program of providing advice to members on computer acquisition and training programs. Until this program was started, the only computer capability in the region was in Papua New Guinea and the Solomon Islands where computers had been used since the early 1980s. Also Fiji has had a well organized system in operation for some time, and the Federated States of Micronesia has developed their own facility during the last few years.

FFA computer assistance begins with studying the needs of the nation and writing aid-donor proposals to seek funding for development of computer capability. FFA also has the contacts necessary to arrange training programs and fellowships. Once equipment has been acquired, FFA

is available to install the units and develop software necessary to EEZ management.

For Palau and the Cook Islands, aid proposals have been completed for computer installation and training. Vanuatu has had, for a number of years, a system of data collection from its domestic fishery. Approximately 100 enterprises send in daily records of activity to the Village Fishery Development Program (VFDP). The computer proposal there involves the acquisition of micro-computers in every branch of the Ministry.

In Papua New Guinea, the FFA was requested to assist with the reorganization of their information services within Fisheries and to set up administration systems. In Kiribati and the Solomons, the FFA has assisted with the spending of "goods and services" money on appropriate computer hardware. "Goods and Services" is a clause contained in some access agreements which commits the fishing nation to not only the provision of fishing fees, but also the provision of goods and services dedicated to the development of fisheries programs in the coastal State.

The development of computer facilities will have a great impact upon the future effectiveness of surveillance programs in the region. One of the key aspects of the business is information or intelligence gathering. Only when one has the ability to manipulate data from the fishery is it possible to make crucial decisions as to what sort of surveillance program is cost effective and to be efficient in the management of that program.

Airships

One cannot leave the subject of innovations in surveillance without some reference to airships. An airship is a helium filled bag called a balloonet powered by an engine and carrying a gondola for passengers. They were developed from balloons in the 18th century and were used as surveillance craft in both World Wars. Recent applications have fitted the airship with a boarding craft to enable enforcement work to be carried out.

Member states of the FFA will find it difficult to completely control foreign fishing effort in their EEZs through the use of traditional ships and aircraft. The cost and complexities involved in establishing and maintaining fixed-wing and rotary-wing aircraft for surveillance purposes is beyond the means of most members. Consequently, they are reliant upon military flights provided by Australia and New Zealand as well as the occasional charter of small aircraft. Although the present coverage does provide some information to island governments on foreign effort, it is definitely not enough to act as a deterrent to the activity of foreign vessels which may be conducting illegal fishing in EEZs.

One example of the alternative technology being considered by other coastal States to enhance the use of existing surveillance equipment is "Lighter Than Air" ships (LTAs). Assessment projects have been conducted in the U.S. and the U.K. studying the feasibility of using LTA aircraft for military and fisheries surveillance purposes.

Recent focus on LTAs in the Pacific region was provided by a 1986 article in *Pacific Islands Business* which suggested the use of the British built *Skyship 600* for fisheries surveillance in the South Pacific. Although the article was obviously a promotional project by the company itself, it has served to increase people's knowledge that such technology exists and may be appropriate to the region. Another interesting twist is that the Skyship company has been purchased by the Bond

Corporation of Australia which holds majority shares in the newly found company and is flying airships in the Sydney area at present.

It is important to dispel the notion that these ships are high tech. They are simply a helium filled bag made of a very strong nylon called kevlar. They are powered by automotive engines and able to stay aloft for days. As a detection device, they are slower than an aircraft so the coverage per hour is much less. As a boarding craft, they are faster than a ship and have an increased radar coverage. The airship seems to be a compromise resulting in a detection device that is able to board ships.

Airship companies claim that their craft have the following characteristics:

- long endurance;
- stable, low vibration sensor platform;
- low installed power requirements;
- high degree of survivability;
- high fuel efficiency; and
- all weather capability

Airships also have disadvantages which may offset their ability to perform a number of tasks which currently require a combination of surface and air vehicles. For example, they may not, under certain wind conditions, be able to conduct a protracted escort of a surface vessel without the back up of other units. The other crucial factor is the lack of widely available infrastructure and maintenance support which are part and parcel of "conventional" maritime air and surface operations. There is at present no known maritime surveillance system which has airships in dedicated service. So, testing has been done in France and the United States with the *Skyship 600*, but no one has committed themselves to their long term use.

The cost of these units is still quite high at U.S.$5 million. It is anticipated that this price will fall as the craft are put into use and more companies get into the business. The other problem is these craft have quite specific requirements in pilot training. After a pilot has attained a commercial license, he must train an additional 500 hours under a qualified airship pilot in order to gain the certification necessary to carry passengers. Therefore, these individuals are quite rare and therefore quite expensive.

Nevertheless, there is no doubt that airships have an application in the surveillance of the South Pacific. There are two major hurdles to overcome: the high cost of the machines and the fact that they are new and unproven as yet in a fisheries program.

Future Considerations

FFA Surveillance Program

The region appears to have come alive in the field of surveillance during the past two years. There are many projects underway at both the national and regional level which are shaping the future of control of foreign fishing in the region. Some of these are a direct result of the FFA Surveillance Program, others have started on other initiatives. Regardless of the inspiration, the region has focused on surveillance as a key conservation, economic and political issue.

The FFA Surveillance Program has taken, and will continue to take its direction from the Forum Fisheries Committee (FFC). Project proposals

are developed by the FFA or individual member governments, discussed by representatives of member governments at the Annual Surveillance Meeting and forwarded to FFC for endorsement to proceed. The meeting is, therefore, an opportunity for members to review the progress of the program to date and to influence future initiatives.

Regional Communications Project

As discussed earlier, the FFA has been studying the problem of establishing a satellite communications network in the region. So far, this work has been most encouraging and will probably prove to be an actual cost saving to member governments, while providing a much increased quality of service. The Forum Fisheries Committee (FFC) has approved involvement of the FFA in further investigations in this area and implementation is expected to be phased in beginning in 1990.

Regional Surveillance Center

Following the setting up of a regional network of fisheries officials through the annual meeting of surveillance officials, it is anticipated the FFA will be able to assist directly in the operations of surveillance programs in the region. It is anticipated that, with better communications, the member governments will be able to access the regional database of vessel register, the logsheet and market information to assist in decision making for access negotiations, licensing, and surveillance operations. Member governments would then be in a position to suggest tasking of surveillance flights and patrolboats.

It is anticipated that this sort of assistance will require the equipping of a regional surveillance operations center at the FFA headquarters in Honiara. Necessary equipment for the Center will include a microcomputer, a set of regional charts, chart table, communications equipment dedicated to the Center, i.e., facsimile, telephone, telex, wall status boards and work station.

Aside from responding to requests for assistance in analysis, the Surveillance Center would be tasked to provide member governments with regular, perhaps weekly, reports of licensing, fishing and illegal activity in the region.

Regional Air Surveillance Project

It is proposed that, in the future, FFA member governments consider a contract with an airline operator to provide regular air surveillance of those areas of highest fishing activity. Some very preliminary investigations have been conducted to work out the logistics of this arrangement.

With regional cooperation in a common contract involving a company that could provide surveillance services, those services could be provided quite cheaply. For example an aircraft maintained and based in Honiara could cover the Solomons, Nauru, the Gilberts group, and Tuvalu once every 16 days. It is suggested that the cost of the contract to each member be distributed according to the portion of time spent in each EEZ.

The acquisition of an appropriate aircraft is a problem which may be resolved by approaching an aid donor. The FFC has expressed support for further work in this area and an aviation consultant will be engaged in 1988 to provide professional advice on the availability of aircraft that are suitable to address those needs. Once the appropriate aircraft has been selected, an aid donor could be approached for funding. At this

point, the FFA has done little more than investigate the various possibilities and analyze where the air surveillance is needed most.

National Program Development

In order to develop regional co-operation in the field of fisheries surveillance, it is first necessary to build up national program to the level that they may co-operate. This should be the first priority of the FFA Surveillance Program and is an area in which the Agency has concentrated a great deal of its effort in implementing the program to date. There must be a careful balance between time spent on national and regional assistance in order to achieve results in all aspects of the project.

The FFA will continue to respond as best it can to requests for assistance in the area of surveillance program development. If the request is of a technical nature beyond the capability of the Agency, a consultant will be hired to provide that advice. It must be pointed out, however, that the budget for this program is limited and therefore decisions must be made for careful expenditure of the funds.

Training

The FFA surveillance program has, as one of its major components, training courses for enforcement officers from FFA states. The FFA has enjoyed the co-operation of the Australian Maritime College and the Royal Australian Navy in placing participants on the Pacific Patrolboat Course held at the Australian Maritime College. The FFA has been able to provide lectures to that course and arrange for funding of participants from FFA member governments and officials not involved in the Patrolboat Project.

For the future of surveillance training, it is desirable that a program be continued to ensure that Pacific islanders have access to fisheries enforcement training on a continuing basis. The first such training with the AMC was completed in November, 1987. This course proved to be successful and appropriate to the needs as stated by the FFA Members and it is anticipated the Agency will continue to seek funding for participation in the future.

Another very worthwhile opportunity for training is the fellowship program at the FFA. The Agency has had some success in offering three to four-month fellowships to the Agency where individuals are assigned to work on specific projects on behalf of their government while gaining an insight into the workings of the regional organization. The FFA has, in the past, had fellowships in law, economics and computer assistance. The first fellowship in surveillance began in November, 1987 with the participation of the Chief Fisheries Surveillance Officer from Papua New Guinea. It is anticipated that this aspect of training may be continued and expanded as the FFA surveillance program develops.

Appropriate Technology

One aspect above all others must be considered when choosing between various alternatives for fisheries surveillance in the Pacific islands, and in fact all parts of the developing world; and that is the appropriateness of the technology involved. A colleague of mine maintains that if it cannot be fixed with a hammer, it does not belong in the Pacific islands. While this may be overstating the problem somewhat, it is quite likely that the most successful surveillance projects in the Pacific will be those that make use of the simplest of materials.

On the other hand, the problem of surveillance and enforcement in the vast blue Pacific is a daunting one even for developed industrial nations. It is quite likely that the Pacific islands will continue to depend on foreign assistance for surveillance. It is important however that the islands maintain a strong degree of control over these developments. Through such programs as the regional FFA surveillance project, the government officials themselves will continue to determine the direction of fisheries surveillance and enforcement in the region. It is most important that Pacific islanders make these decisions themselves in a climate of trust and in line with other national priorities of development. The FFA will continue to provide options for member governments to consider and work to enhance the national and regional aspects of control of foreign fishing in the Pacific.

NOTES

1. Neemia, Uentabo Fakaofo, Co-operation and Conflict (Suva, Fiji: IPS, USP, 1986) p. 1.
2. Doulman, David J., Tuna Issues and Perspectives in the Pacific Islands Region (Hawaii: East-West Center, 1987) p. 299.
3. Neemia, Uentabo Fakaofo, Co-operation and Conflict (Suva, Fiji: IPS, USP, 1986) p. 6.
4. Doulman, David J., Tuna Issues and Perspectives in the Pacific Islands Region (Hawaii: East-West Center, 1987) p. 299.

BIBLIOGRAPHY

Neemia, Uentabo Fakaofo, Co-operation and Conflict. Suva, Fiji: IPS, USP, 1986.

Doulman, David J., Tuna Issues and Perspectives in the Pacific Islands Region. Hawaii: East-West Center, 1987.

Stanley, David, South Pacific Handbook. Chico, California: Moon Publications, 1984.

Fisheries Law Enforcement Programs, Practices and Problems in Malaysia

Jahara Yahaya
University of Malaya
Lumpur, Malaysia

1. Introduction

Marine fisheries play an important role in the Malaysian economy. The primary sector of the fishing industry alone accounts for 3.4 percent of GDP (Fifth Malaysia Plan, 1986-90). Fish, especially animal protein, is an important source of food. Per capita consumption of fish is estimated to be 27 kg., almost two and one-half times the world average. Fish provides nearly half of the total supplies of animal protein in the country. Fisheries are an important source of foreign exchange earnings, making a direct positive contribution of M$243 million to the balance of payments in 1985 (External Trade Statistics, 1985). In addition, about 110,000 persons are employed in the fisheries sector (Annual Fisheries Statistic, 1985).

Like most fishing nations in the ASEAN region, particularly Indonesia, Philippines and Thailand, Malaysia is constantly faced with the problem of protecting, conserving and managing her valuable fisheries resources. The marine fisheries are continuously threatened with overfishing, blatant encroachment by foreign fishing vessels and destructive fishing practices. Although a variety of fisheries laws and regulations exist to protect and manage the fisheries, there appears to be a high degree of non-compliance due largely to ineffective enforcement. Morever, the laws and regulations enacted are sometimes difficult and expensive to enforce, thus once again resulting in a high degree of non-compliance. For many fishermen, violating the law is one of the many aspects of the nature of their occupation, and getting nabbed by the enforcement authorities is treated as part and parcel of the occupation hazards. Further, given the complex socio-political diversities of a multi-ethnic country like Malaysia, enforcement efforts are often hampered by political interference and other social constraints.

This paper is concerned with two principal objectives. The first is to outline the enforcement systems currently prevalent in the marine fisheries sector in Malaysia. The findings of a preliminary study of fisheries law enforcement in the country will be discussed to the extent available data permit. The second objective is to identify major enforcement problems and issues would be used as a premise for further empirical investigations.

The organization of the remainder of the paper is as follows: fisheries laws and regulations are outlined in Section 2; Section 3 describes, in some detail, the enforcement programs and practices; Section 4 identifies and discusses the major problems and issues of fisheries enforcement in Malaysia and Section 5 contains our conclusions.

2. Fisheries Laws and Regulations

Fisheries legislation in Malaysia evolved from the old fisheries laws of the Colonial Government of British Malaya. After the country gained its independence in 1957 the old colonial laws were replaced with

new federal laws to meet the changing fisheries situation. To date, Malaysia has six major fisheries-related laws:

a) Fisheries Act 1963
b) Continental Shelf Act 1966
c) Fishermen's Association Act 1971
d) Lembaga Kemajuan Ikan Act 1972
e) Exclusive Economic Zone Act 1984
f) Fisheries Act 1985

In addition to the above, there are also a number of fisheries regulations which provide detailed specifications to the basic provisions made in the respective legislation. These include:

a) Fisheries (Cockles Conservation and Culture) Regulation 1984
b) Fisheries Regulation 1967
c) Fisheries (Prohibition of Methods of Fishing) Regulation 1971
d) Fishermen's Association Regulation 1972
e) Fisheries (Prohibition of Import of Piranhas) Regulation 1979
f) Fisheries (Amendments) Regulation 1980

The principal legislation governing the activities of both domestic and foreign fishing vessels are the Exclusive Economic Zone Act 1984, the Fisheries Act 1985 and associated regulations, in particular the Fisheries (Maritime) Regulations 1967 and the Fisheries (Amendments) Regulations 1980. Both the Exclusive Economic Zone Act 1984 and the Fisheries Act 1985 can be regarded as part of Malaysia's plan to strengthen its maritime capabilities in the 200-mile EEZ.

The Exclusive Economic Zone Act 1984

This Act, which came into force in 1984, provides for the control and regulation of all marine-related activities in the Exclusive Economic Zone (EEZ) and on the continental shelf, Part III of the Act, which is devoted fully to fisheries, incorporates three major provisions:

a) the seas comprised in the EEZ shall be part of Malaysian fisheries waters;
b) the Minister charged with responsibility for fisheries to be also responsible for fisheries in the EEZ;
c) any written law for fisheries shall be applicable in the EEZ and on the continental shelf.

In brief, the Exclusive Economic Zone Act 1984 empowers the Government to manage and regulate fishing by both foreign and domestic vessels in the marine waters under the jurisdiction of Malaysia. It should be pointed out that the Act did not include detailed provisions regarding access of foreign fishing and research vessels into the Malaysian EEZ as they were already incorporated in the Fisheries Act 1985. Hence, the inclusion of such detailed provisions in the Exclusive Economic Zone Act 1984 would only represent an unnecessary duplication.

Fisheries Act 1985

This Act, which was enacted in 1985 but enforced in May 1986, replaced the Fisheries Act 1963. Closely modelled after the old Act, the Fisheries Act 1985 retains much of the original intent of managing and regulating fishing throughout Malaysian waters. However, unlike the old

Act, the new Fisheries Act 1985 is more specific in expressing the intention for the conservation, management and development of both marine and estuarine fisheries under Malaysian jurisdiction. Moreover, since the Act was enacted after the 1980 EEZ Proclamation, it incorporates detailed provisions regarding access and control of foreign fishing vessels and fisheries research vessels in the Malaysian EEZ. The detailed provisions on "Foreign Fishing Vessels" are contained in Part IV of the Act with stipulations, *inter alia*, that:

i) foreign fishing vessels are authorized to fish or conduct any fishery survey in Malaysian fisheries waters only under an international fishery agreement in force between the Government of Malaysia and the government of the country or the international organization to which such vessel belongs or is registered;

ii) foreign fishing vessels are not authorized to load or unload any fish, fuel or supplies or tranship any fish in Malaysian fisheries waters without the written approval of the Director-General of Fisheries;

iii) foreign fishing vessels may enter Malaysian fisheries waters for the purpose of exercising their right of innocent passage. However, there is a provision requiring foreign fishing vessels entering Malaysian fisheries water to notify by radio an authorized officer of the name, the flag State, location, route and the types and amount of fish they are carrying. Moreover, foreign fishing vessels are required to abide by the regulation regarding the stowage of fishing appliances when passing through Malaysian fisheries waters; and

iv) the Director-General shall, in considering an application for a permit by a foreign fishing vessel, take into account matters such as the needs of Malaysian fishermen, the extent of cooperation given and contribution made by the relevant country towards fishery research, and the assistance given by the applicant in the development of the fishing industry in Malaysia.

In addition to the above, Part IV of the Fisheries Act 1985 also contains general terms and conditions of access of foreign fishing vessels into Malaysian waters.

Other provisions in the Act which are of particular relevance to the present study include the following:

a) licensing and management of domestic fishing;

b) prohibition and control of certain methods of fishing;

c) offenses and legal procedures relating to the implementation of the Act;

d) surveillance and enforcement to ensure compliance with the provisions of the Act.

Of immediate concern to the study are the provisions which concern penalities for illegal fishing activities. In the case of foreign fishing vessels, these penalities are in the form of heavy fines which are certainly much stiffer than those previously in existence. For the vessel owner and master, the fine is not exceeding M$1,000,000; whereas for individual members of the crew the fine is not to exceed M$100,000. However in all other cases not involving foreign fishing vessels, the fine is not to exceed M$50,000 or prison term not exceeding two years or both (Section 25). It should also be noted that Section 31(1) provides for the compounding of offenses for the sum of not below M$500 and not exceeding the maximum fine for that offense, provided that it is a first

or second offense only. In addition to the fines that may be imposed, Section 52(1) provides that where an offense such as illegal fishing has been committed, the vessel, including all its equipment and the fish on board, may be forfeited. Indeed, such harsh penalties imposed on illegal fishing hopefully encourage compliance by both foreign and domestic fishing vessels. It is also a reflection of the authorities' determination to enforce a tougher maritime regime in the waters under Malaysian jurisdiction.

Fisheries Regulations 1967 and 1980

Since new fisheries reguations under the Fisheries Act 1985 have not been formulated, regulations promulgated under the Fisheries Maritime Regulations 1967 and Fisheries (Amendments) Regulations 1980 are still valid. Under the Fisheries (Maritime Regulations 1967, provisions that are generally considered of high significance concern the terms and conditions of license for trawl fishing. These provisions are as follows:

1. minimum mesh size of any trawl net at not less than one (1) inch extension measure at the cod end;
2. designated waters where trawl nets can be used:
   a) engined boats of 100 gross tonnage and above with 200 horsepower and above shall be used only in waters beyond 12 miles;
   b) engined boats of 25 gross tonnage and above with 60 horsepower and above shall be used only in waters beyond 7 miles;
   c) engined boats of less than 25 gross tonnage with less than 60 horsepower shall be used only in waters beyond 3 miles.
3. restricted time, i.e., between 6:00 A.M. and 6:00 P.M., during which trawling can be carried out except in the case of small trawlers less than 25 gross tonnage and with less than 60 horsepower engine;
4. prohibition on the use of beam trawl nets for catching prawns;
5. specified fish landing places.

Of the above regulations, designated waters where trawling is permitted is the most prevalent followed by prohibition on the use of beam trawl nets and designation of specified fish landing places. The regulations on minimum mesh-size cod end and restricted trawling hours, on the other hand, appear to be less prevalent owing to enforcement difficulties.

Certain provisions made under the Fisheries (Maritime) Regulations 1967 have since been amended when the Fisheries (Amendments) Regulation 1980 came into force. To many, the 1980 Regulation represents a new management regime formulated by the Government to respond to the problems of overfishing of the inshore resources brought about by unlimited and unregulated entry. The main focus of the Fisheries (Amendments) Regulation 1980 was the allocation or delineation of fishing grounds through zoning. Four main zones were established under this Regulation:

Zone I: within 5 miles from the shoreline is reserved for traditional fishing gear owned and operated by fishermen themselves;

Zone II: between 5 to 12 miles is reserved for trawlers and purse seiners less than 40 gross tonnage owned and operated by fishermen themselves;

Zone III: between 12 to 30 miles is reserved for trawlers and purse seiners greater than 40 gross tonnage owned and operated by Malaysian fishermen; and

Zone IV: beyond 30 miles is reserved for foreign or partially-Malaysian owned fishing vessels greater than 70 gross tonnage.

The zoning regulation, in short, completely bans trawling in waters within the 5-mile limit and allocates fishing grounds by types of gear (e.g., traditonal versus commercial fishing gear), size of vessel and ownership status of the vessel. The rationale underlying this regulation was to ensure fair allocation of fishing grounds and resources between the highly efficient mobile trawlers and less efficient traditional gear, thereby eliminating competition and conflict between the two. Despite such regulation, however, the larger trawlers continue to encroach into the waters within the 5-mile limit which are off-limits to them. The regulation to allocate fishing grounds by ownership status of the vessels (i.e., whether owner-operated or non-owner operated), admittedly is not easily enforceable, thus rendering it less prevalent than the other regulations which allocate fishing grounds by type of gear and size of vessels.

As supporting regulatory measures to the above, the Fisheries (Amendments) Regulation 1980 also stipulates that the fishing effort in each zone will be regulated through license limitation in order to prevent overcrowding and overexploitation of the resources. Another important provision of the 1980 Regulation was the extension of the trawl net mesh-size from 1 inch to 1 1/2 inches measure at cod end. The main concern here is to regulate and control the minimum size and weight of the fish that may be captured to prevent depletion of the fish stock. However, owing to vehement opposition and protest by the trawler fishermen, the implementation of this regulation has been postponed indefinitely. The prohibition of the use of beam trawlers as specified under the Fisheries Regulation 1967 remains valid under the 1980 Regulation.

Finally, under the zoning regulation, foreign fishing vessels granted access to the Malaysian EEZ are permitted to fish only in waters beyond 30 miles from the baselines from which the territorial water is measured. This regulation is also applicable to partially-Malaysian vessels operating on a joint-venture basis with a foreign partner. With the enactment of the Exclusive Economic Zone Act 1984, the zoning regulation on foreign fishing vessels, particularly those of the Thais, became high pertinent. Trespassing and sometimes acts of hostility by Thai fishing vessels in Malaysian waters, especially off the east coast of Peninsular Malaysia, have been well documented. Pressurized by the deplorable fishing conditions in waters off their homeland, the Thai fishermen are now turning their sights to the relatively underexploited Malaysian waters. Equipped with larger fishing vessels and superior fishing technology and expertise, the Thai fishermen have for a long time blatantly encroached into Malaysian fisheries waters, helping themselves to the abundant resources available. Fisheries Departments estimates revealed that in 1982, about 860 Thai fishing vessels were spotted in Malaysian waters off Kelantan, Terengganu and Pahang, and in 1983 the total was 769.

Even after the enactment of the EEZ Act 1984, there was no evidence of a reduction in the number of foreign fishing vessels trespassing in Malaysian waters. According to Fisheries Department sources, a total of 2,202 foreign fishing vessels, a majority of them Thai trawlers, were sighted in the Malaysian EEZ. In 1986, the figure almost doubled to reach 4,301 vessels, while the number of sightings up to June 1987 was reported to be 1,285 vessels. It is understood that as high as 80

percent of the total sightings were fishing vessels. Indeed, given such magnitude of intrusion by foreign fishing vessels, it is only understandable that the Malaysian authorities had recently stepped up their surveillance and enforcement activities in the EEZ.

3. Fisheries Enforcement Programs and Practices

Institutional Structure

Enforcement of the laws and regulations under the EEZ Act 1984 and the Fisheries Act 1985 is the joint responsibility of the Enforcement Section of the Fisheries Department's Management and Protection Branches, the Marine Police and the Royal Malaysian Navy. Responsibility for the surveillance and enforcement within the territorial seas lies primarily with the Enforcement Section of the Fisheries Department. However, both the Marine Police and the Royal Malaysian Navy tender substantial support and assistance, on an opportunity basis, to the Enforcement Section, thus making surveillance and enforcement in the territorial waters a joint responsibility of these three principal agencies.

The Marine Police, which in effect can be likened to the U.S. Coast Guard, is primarily responsible for the enforcement of maritime law, immigration, drug prohibition and similar civil responsibilities. Its surveillance and enforcement activities are currently confined only to the territorial waters which are still under the police jurisdiction. Since fisheries matters constitute only one of its many maritime tasks, the Marine Police clearly lacks the necessary resources (facilities, manpower, expertise, etc.) to effectively deal with fisheries law enforcement. Needless to say, there is an urgent need to upgrade the Department's current resources and capabilities if it were to be charged with fisheries enforcement in the territorial as well as the EEZ waters.

Like all armed forces in the country, the Malaysian Royal Navy is primarily charged with the responsibility of protecting the national sovereignty, which in this case are the waters beyond the territorial waters. As mentioned earlier, the Navy also carries out activities on behalf of the Fisheries Department and other departments, but only on an opportunity basis. Previously, in the event that an arrest has been made by the naval craft of an illegal vessel the case is surrendered over to the Police for legal action. More recently, however, every arrest of an illegal vessel is handed over to the Fisheries Department.

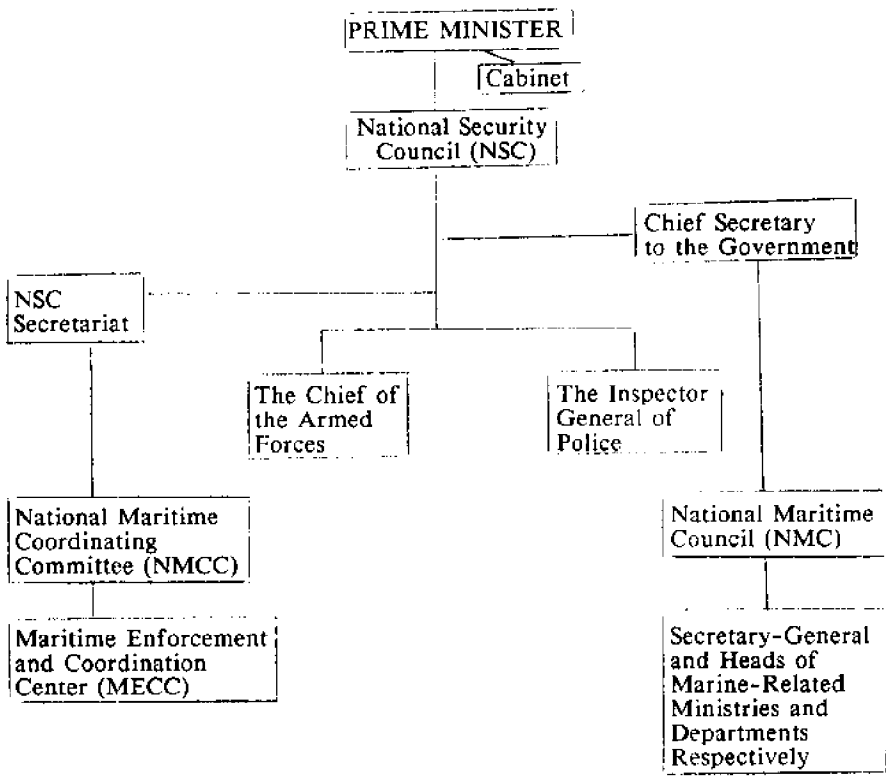
In an effort to streamline and coordinate surveillance and enforcement policies and programs in the EEZ a National Maritime Coordination Committee (NMCC) was set up in 1982. The Committee, which represents the highest decision-making body for maritime affairs, is headed by the Secretary to the National Security Council (NSC) of the Prime Minister's Department (*Figure 1*). Membership of the NMCC comprise representatives from all relevant government agencies such as the Marine Department, the Marine Police, the Royal Malaysian Navy, the Royal Malaysian Air Force, the Department of Environment, the Department of Fisheries and the Mapping and Survey Department. Hence, the NMCC was established to ensure more effective cooperation and coordination between maritime-related agencies.

As an extension of the NMCC, the Maritime Enforcement and Coordination Center (MECC) was set up also in 1982. The MECC in effect acts as the operations arm to the NMCC in coordinating all surveillance and enforcement agencies, in particular the Royal Malaysian Navy, the Royal Malaysian Air Force, the Marine Police and the Department of Fisheries.

It should be noted that the MECC, which in essence is the focal point of the marine enforcement network, is not bestowed with any command or arrest functions. The main function of MECC appears to revolve around the monitoring and coordination of enforcement and surveillance activities by both air and sea. With the setting up of the NMCC and MECC, it appears that Malaysia is now equipped with a well directed and coordinated management and enforcement regime in its territorial and EEZ waters.

FIGURE 1

Malaysia
The Structure of Maritime Policy and Security Arrangements, 1987

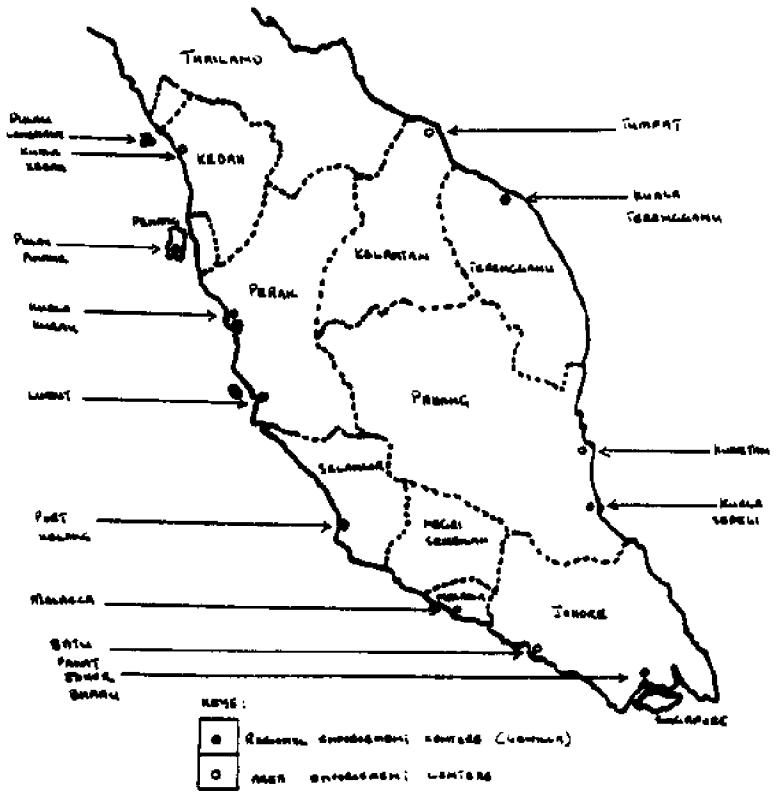


In as far as fisheries enforcement is concerned, the GEWILLA (Regional Enforcement Unit) system represents yet another important feature of the enforcement institutional set-up. Established a few years ago, the system proved effective in providing direct control and command between each GEWILLA and the Fisheries Department's Enforcement Section in Kuala Lumpur. This, to a great extent, has helped to reduce unnecessary bureaucratic inefficiencies and delays. To date, seven GEWILLA

centers had been set up throughout the country (*Map 1*). Each GEWILLA is well-connected to the Enforcement Section's Operation Room in Kuala Lumpur by an impressive radio communication network and telephone hot-lines. It is understood that the Operation Room is manned around the clock by competent officials. In addition to the GEWILLA, smaller enforcement units at area level, known as "Pusat Gerakkan Kawasan" or Area Enforcement Unit, were also set up at strategic points throughout the country (*Map 1*).

MAP 1

Peninsular Malaysia: Fisheries Enforcement Centers



* Regional Enforcement Centers (GEWILLA)
\+ Area Enforcement Centers

Enforcement Modes

Currently only two principal modes are being practiced: sea patrols and air patrols. Sea patrols in the territorial waters are carried out mainly by the Fisheries Department and the Marine Police. It is noted that the Fisheries Department uses both fast speed boats of the PL-class and large PA-class vessels for patrolling the territorial waters. Under the Fifth Malaysia Plan (1986-1990), plans are underway to include larger PX-class patrol vessels to be used primarily for patrolling the EEZ waters. Whereas the larger PA craft can be operated and remain at sea in all weather conditions, the smaller speed boats are more vulnerable to adverse weather, thereby limiting their enforcement potential. It should also be noted that both types of boats can execute detection, boarding and arrest functions. To assist them in carrying out their duties effectively, all enforcement personnel are equipped with light arms and pistols. Currently, sea patrols beyond the limits of the territorial waters are carried out solely by large naval craft belonging to the Royal Malaysian Navy.

Information on the number of patrol days are not readily available. It is understood that patrol operations by the Fisheries Department are carried out on a daily basis and follow the normal working hours (8:00 a.m. to 4:30 p.m.). On the average, however, it has been estimated that effective patrol days worked out to be approximately 14 to 15 days in a typical month. This gives an annual average of 168 to 180 patrol days. But as of July 1, 1987, patrol operations by the Fisheries Department are carried out round-the-clock. At the present moment, the primary concern of the Department's patrol operations appears to be directed at the encroachment by illegal Thai fishing vessels in Malaysia's territorial and EEZ waters, particularly off the east coast of Peninsular Malaysia.

The use of aircraft for fisheries surveillance is relatively new in Malaysia. It is generally recognized that air patrols are capable of not only searching large sea areas but also determining the location, number, type and identity of fishing vessels. Therefore, it would be extremely useful for the surveillance of not only foreign vessels' activities in the EEZ but also of the domestic fishery. With respect to the domestic fishery, air patrols are most useful detecting vessels that have violated the zoning regulations, particularly trawlers. However, violations of certain types of regulations like minimum mesh-size, gear restrictions and unlicensed vessels are usually impossible to detect from the air. Furthermore, air patrols do not and cannot perform arrest functions. In the event of suspected violation by a foreign or domestic vessel, surface vessels would have to be called in to carry out inspection boardings on the suspected vessels. To the extent that air patrols have to be complemented by other enforcement modes, it is important to remember that air patrol alone is not sufficient to achieve enforcement goals. Nevertheless, air patrols would undeniably enhance the effectiveness of surface patrols in the fisheries law enforcement programs.

At present, air patrols are jointly executed by the Royal Malaysian Air Force (RMAF), the Airwing Section of the Police Force, and more recently the Fisheries Department. Steps have been taken by each of these agencies to increase its air surveillance. It is understood that the RMAF has recently acquired special maritime patrol aircraft equipped with modern devices capable of carrying out precise navigation, detection and identification of vessels. It should be remembered, however, that the airforce service is not confined to fisheries patrol but also provide more pressing services such as search and rescue, and monitoring

of pirate and refugee vessels. This would undoubtedly limit the deployment of surveillance efforts available for fisheries patrols.

In view of this limitation, the Fisheries Department recently developed its own aerial surveillance system. For the present moment, however, the Department does not puchase its own aircraft but instead buys air hours from the Department of Civil Aviation. It is understood that these air patrols are carried out based only on operational and emergency requirements. There are no fixed or regular hours during which the air patrols are carried out. On average, the number of air hours is estimated to be approximately 15 hours in a month, thus giving an annual average of 180 hours. It is noted that the air patrols are confined primarily to waters within the territorial limits, using only small aircraft such as Cessna and King Air. The chargeable rates vary from $800 to $1,000 per hour. An enforcement person from the Fisheries Department is placed on board the aircraft to monitor the surveillance activities. If a violation is suspected, the message will be relayed to the nearest GEWILLA for follow-up actions.

Beside sea and air patrols, onshore or dockside enforcement is occasionally carried out by the relevant enforcement agencies. The Fisheries Department, for example, conducts river blockades, boardings and inspections of vessels at landing jetties, harbors, etc., when the situation warrants. Dockside enforcement is normally used for detecting violations with regards to invalid fishing licenses and prohibited fishing gear such as dynamite, poisons and certain types of fishing nets. No information, however, is available on the extent of dockside enforcement activities.

Resources

Owing to lack of information on other enforcement agencies, the analysis in this section will be confined only to the Fisheries Department, the principal agency responsible for fisheries enforcement. As mentioned earlier, the Department employs both fast PL-class speed boats and large PA-class patrol boats for its sea patrols. *Table 1* shows the strength and distribution of the fleet of patrol boats for 1986. The Fisheries Department has at its disposal a total of 27 large PA-class vessels and 35 fast PL-class speed boats. Each boat is equipped with modern navigational devices like compass, radar echo sounder, and wireless radio. Under the Fifth Malaysian Plan (1986-1990), four new PA-class vessels and ten PL-boats will be constructed to replace existing ones which have exceeded their economic life. The cost of each boat, including engine and navigational equipment, is estimated to be M$2.5 million for PA-class vessel and M$200,000 for PL-class boat. It is understood that two PA-class vessels which were constructed in 1985 (Fourth Malaysian Plan) have recently been completed and are already operating.

To cope with its expanded enforcement responsibilities in the EEZ waters, the Fisheries Department will be ordering four more PX-class vessels for its present patrol fleet under the Fifth Malaysian Plan (1986-1990) at M$3.0 million. Measuring about 65 feet in length and equipped with modern navigational devices, these vessels are capable of patrolling the deeper offshore waters in the EEZ and of staying out at sea longer than seven days for every trip. The vessels will be located at strategic places, *viz*, one each in the States of Johore, Terengganu, Perak and Penang, throughout the country so that they can be speedily deployed when the situation warrants. It is hoped that the deployment of such large vessels will further enhance the surveillance and enforcement

of fisheries laws in the Malaysian EEZ, thereby making it more attractive and economically feasible for our own deep-sea fishing ventures.

The extent of manpower resources available for fisheries enforcement can be gleaned from the number of persons directly employed as crew members of the patrols boats. This, therefore, excludes onshore or land-based personnel such as those employed in the clerical and administrative services at the Fisheries Department headquarters and Regional and Area Enforcement Centers. According to the latest statistics, there are a total of 292 crew members manning the existing 62 patrol boats throughout the country. By virtue of its size, the larger PA-patrol vessel has more crew members per vessel (8 persons) compared to the smaller fast speed boats (2 persons). It is understood that an addtional 72 enforcement personnel will be employed once the PX-class vessels are ready for operations.

TABLE 1

REGIONAL DISTRIBUTION OF PATROL VESSELS AND BOATS FISHERIES DEPARTMENT, 1986

		No. of Patrol Vessels	No. of Speed Boats
1) Regional Enforcement Centers			
a) GEWILLA I	Pulau Pinang	4	7
b) GEWILLA II	Port Klang	4	6
c) GEWILLA III	Johor Bahru	3	3
d) GEWILLA IV	Kuala Terengganu	4	2
e) GEWILLA V	Kucing	3	2
f) GEWILLA VI	Labuan	-	-
g) GEWILLA VII	Lumut	2	4
2) Area Enforcement Centers			
a) Pulau Langkawi		1	-
b) Kuala Kedah		-	4
c) Kuala Kurau		2	6
d) Malacca		-	1
e) Batu Pahat		1	-
f) Kuala Sedell		1	-
g) Kuantan		1	-
h) Tumpat		1	-
		27	35

Source: Fisheries Department

Expenditures

Expenditures on enforcement made up an insignificant proportion of total public development expenditures for fisheries matters. Under the Third Malaysian Plan (1976-1980) and Fourth Malaysian Plan (1981-1985), for example, the Fisheries Department's expenditure on enforcement accounted for only 5.0 percent and 3.4 percent respectively of total public expenditures on fisheries (*Table 2*). But the percentage increased quite considerably to 22.1 percent under the Fifth Malaysian Okab (1986-1990). *Table 2* also shows the Fisheries Department's expenditure on fisheries law enforcement since the Third Malaysian Plan (1976-1980). There has been a considerable increase in enforcement expenditures over the last two Malaysian Plans. The allocation for fisheries enforcement expenditure under the Fifth Malaysian Plan (1986-1990) was $41.57 million. This represents a tremendous increase in comparison to the two previous Plans.

Prior to the Exclusive Economic Zone Act 1984 and Fisheries Act 1985, enforcement expenditures were mainly for implementing the Fisheries Act 1963 and its subsidiary legislation, particularly the Fisheries (Maritime) Regulation 1967 and Fisheries (Amendment) Regulations 1980. This means that expenditures were entirely for enforcement on domestic fishing vessels within the Malaysian territorial waters. However, with the enactment of the Exclusive Economic Zone Act 1984 and Fisheries Act 1985 came added enforcement responsibilities (and hence expenditures) on foreign vessels fishing in the EEZ. Hence, the substantial expenditure (allocation) under the Fifth Malaysian Plan (1986-1990) is reflected by the increased enforcement responsibilities associated with implementing the Exclusive Economic Zone Act 1984 and Fisheries Act 1985. It should be noted that the enforcement expenditure (allocation) under the Fifth Malaysian Plan (1986-1990) increased nearly five-fold over the expenditure (actual) under the Fourth Malaysian Plan (1981-1985).

TABLE 2

PUBLIC DEVELOPMENT EXPENDITURE FOR FISHERIES 1975-90
(M $ MILLION)

	Third Malaysia Plan (1976-80)	Fourth Malaysia Plan (1981-85)	Fifth Malaysia Plan (1986-90)
a) Total Fisheries Development Expenditure	155.06	262.42	188.37
b) Total Expenditure on Enforcement	7.75	8.88	41.57
c) Enforcement as percent of total Fisheries Expenditure	5.00	3.40	22.10

Activities

Included as enforcement activities are monitoring and surveillance, sightings or detections, boardings and inspections, arrests, and prosecutions. While the first four activities (surveillance, detections, boardings and arrests) are the responsibility of the enforcement agencies, the act of prosecution lies ultimately with the Magistrate Court. The main chain of enforcement activities are shown in *Figure 2*.

As indicated in *Figure 2*, the chain of activities begins with surveillance and ends with the violators being charged in court. It is pertinent to note that not all sightings result in boardings due to several reasons, such as bad weather, possibility of double-counting and the case of patrol vessels losing the violators in the sea chase. However, once boarding is made, the possibility of arrest is almost 100 percent. The boarding procedure varies from agency to agency. As for the Department of Fisheries, a boarding certificate is usually handed over the to skipper of the vessel by the enforcement officers and the nature of their offenses or violations explained. The enforcement officers are also required to fill in what is known as a Search List containing information on the vessel's inventory such as gear, net, other equipment and the volume of catch (if any) in the vessel.

Once arrested, the two options open to the violator are either court prosecution or compound. If the case is a first or second offense, the violators are usually compounded and a small fine is imposed on them. However, a court case is mandatory for violators on the third offense. If a case is charged in court, the Department of Fisheries has first to submit a letter of consent to prosecute and all the necessary supporting documents such as charge sheet, investigation papers, photographs etc.. Under the Fisheries Act 1985, it is mandatory that the vessel and its catch be confiscated on arrest. The past practice has been that all confiscated vessels will be sunk in the high seas as artificial reefs, while the catch is auctioned. Very recently, however, it has been suggested that all confiscated vessels should be sold to local fishermen intending to venture into deep-sea fishing.

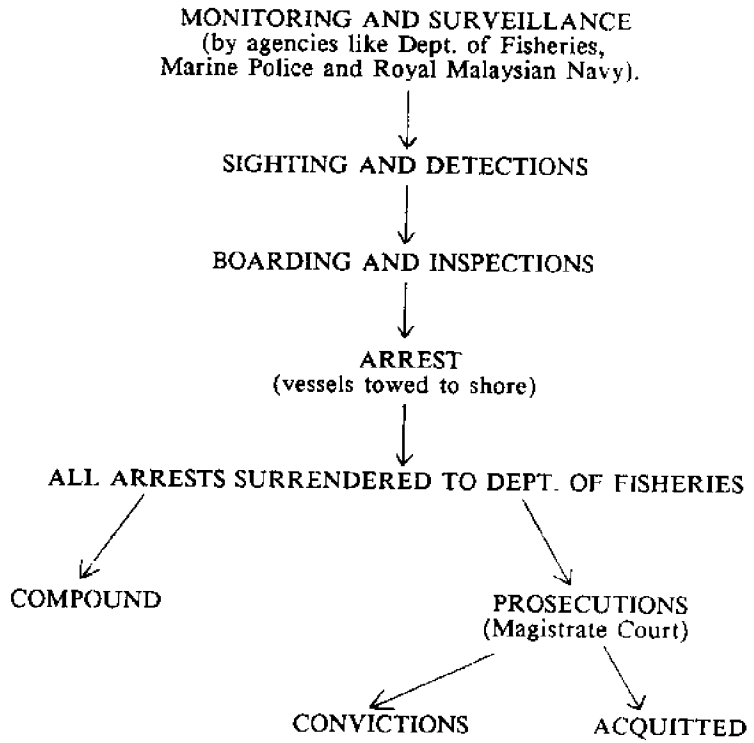
It is understood that the rate of conviction among the prosecuted cases is as high as 85 to 90 percent. The nature of the offense or violation committed is normally in the form of encroachment by trawlers in waters that are off-limits to them and operating without valid licenses in the case of domestic fishing vessels, and illegal fishing in Malaysia's EEZ waters in the case of foreign fishing vessels. Once convicted, heavy fines and penalties will be imposed on the violators. The fines imposed vary between skippers and ordinary crew members and between domestic and foreign fishing vessels.

Table 3 shows the number of arrests of domestic fishing vessels between 1985 and 1987 (third quarter). Out of the total arrest cases, about 80 to 85 percent were compounded, while the remaining were charged in court. It is interesting to note that the total fines imposed, both compound and court, had been on an increase since 1985. For the third quarter of 1987, the compound fines and court fines were in the region of M$702,150 and M$36,000 respectively, registering a considerable increase compared to the two previous years. It is understood that almost 90 percent of the total arrests were due to violation by trawlers in the prohibited 0-5 miles zone reserved for traditional fishermen, while the remaining 10 percent was due to invalid licenses, possession of illegal fishing gear and other minor safety offences.

The arrests of foreign fishing vessels were not properly documented. But from newspaper reports and personal communication with enforcement personnel from the Department of Fisheries Enforcement Unit, it is understood that the total arrests of foreign vessels increased from 77 in 1985 to 117 in 1986. As of mid-1987, the number of vessels arrested

FIGURE 2

ENFORCEMENT ACTIVITIES



was 44, and is expected to increase considerably towards the end of the year. It is understood that encroachment by foreign vessels is most rampant during the monsoon months of November to January. For example, since the beginning of October until mid-November the authorities have detained 17 Thai trawlers and 133 fishermen for violating Malaysia's EEZ off Kelantan and Terengganu.

All vessels caught infringing on Malaysia's EEZ were charged in court under Section 15 of the Fisheries Act 1985. Under this Section,

the skipper of the vessel found guilty would be liable to a fine not exceeding M$1 million and his crew M$100,000 each. To cite an example, the Magistrate Court in Kota Baru, Kelantan, fined the skippers of four Thai trawlers detained recently M$300,000 in default six months jail each, and the crew M$50,000 in default four months jail each. In another example, the Magistrate Court in Kuala Terrengganu fined the skippers of two Thai trawlers M$100,000 in default five months jail each. In most instances, the violators could not pay the fines and thus have to serve the jail sentence. It is understood that in 1987 alone (up to November), 532 Thai fishermen were arrested and brought to court. The total fines came to M$3.5 million. The figures cited here only serve to demonstrate the seriousness of the encroachment problem by Thai fishing vessels into Malaysia's EEZ waters.

TABLE 3

NUMBER OF ARRESTS - DOMESTIC FISHING VESSELS, 1985-87

Year	No. of Cases	Compound Cases	Compound Fines ($)	Court Cases by Court	Fines Imposed ($)
1985	637	550	263,700	87	20,875
1986	571	497	536,100	84	32,975
1987 (third quarter)	596	496	702,150	100	36,000

The foregoing discussion on the enforcement programs and practices provides a general picture of the fisheries enforcement system and explains how various elements are linked together and fit within the policy-making process. In essence, this system contains six elements (*Figure 3*). The first element consists of the rule-making bodies, comprising usually the executive and legislative branches of the federal and state governments. In as far as fisheries policy is concerned the key executive branch agency is the Fisheries Department which is under the Ministry of Agriculture. It should be noted here that all laws and regulations are enacted by Parliament, the highest legislative body in the country.

FIGURE 3

ELEMENTS OF THE MALAYSIAN FISHERIES ENFORCEMENT SYSTEM

No.	Element Type	Specific Entities
1.	Rule-making Bodies	Parliament, Fisheries Department, Ministry of Agriculture
2.	Laws and Regulations	Fisheries Act 1963, Fisheries Act 1985, EEZ Act 1984, and Various Fisheries Regulations
3.	Firms and Individuals	Fishermen, foreign and domestic
4.	Detection and Apprehension Authorities	Fisheries Department, Marine Police, Royal Malaysian Navy, Royal Malaysian Air Force and Police Airwing Unit
5.	Prosecution Authorities	Enforcement Division of Fisheries Department and Marine Police
6.	Conviction and Sanction Authorities	Magistrate Courts

The rule-making bodies enact laws and regulations to express and implement fisheries policy, the second element in our framework. This encompasses laws declaring extended maritime jurisdiction up to the 200-mile EEZ, laws for the development, conservation and management of fishery resources, laws for protecting marine habitats and endangered species, and pacts or agreements with neighboring countries concerning the exploitation of fishery resources in Malaysian waters. In addition, there are supplementary regulations formulated for the purpose of facilitating the execution of the enacted laws. For present purposes, the key provisions of fisheries regulations currently in place include (i) licensing and management of domestic and foreign fishing vessels; (ii) prohibitions and conditions on fisheries exploitation; (iii) administrative or institutional structure for handling violations; and (iv) the penalities and sanctions for violators.

Business firms and individuals which are directly affected by the fisheries laws and regulations constitute the third element in the enforcement system. Typically, these are individuals whose livelihoods depend on the sea, i.e., fishermen, operating in the coastal and offshore waters of Malaysia. Included here are both artisanal and commercial fishermen who employ a variety of fishing techniques ranging from simple traditional gears such as drift nets and gill nets to modern and capital-intensive gear like trawl nets and purse seine nets. Included in this element too are foreign fishing vessels and fishermen operating in

Malaysian waters, and firms and individuals engaged in fisheries-related activities such as marketing and processing of seafood products.

The fourth element consists of agencies charged with the responsibility to ensure compliance of the enacted laws and regulations by the firms and individuals. In other words, these are agencies responsible for detecting violations of fisheries laws and apprehending those who violated the laws. In Malaysia, key agencies authorized to enforce fisheries laws and regulations are the Fisheries Department and the Marine Police. In addition, the Police Airwing Unit, the Royal Malaysian Air Force (RMAF) and the Royal Malaysian Navy (RMN) also carry out surveillance activities for detecting violations in the open seas.

The fifth element consists of agencies authorized to prosecute those found violating the above-mentioned laws and regulations. In Malaysia, the agencies which carry out detection and apprehension activities are also authorized to prosecute violators. Thus the prosecution officers usually are enforcement officers from the Fisheries Department and Marine Police who are specially trained to handle prosecution proceedings in court. The sixth and last element in the fisheries enforcement system consists of the conviction and sanction authorities which, in the Malaysian case, are the Magistrate Courts. These six elements form the essence of a fisheries enforcement system in Malaysia.

4. Principal Problems in Fisheries Law Enforcement

Although a variety of laws and regulations exist for both domestic and foreign fishing vessels, there appears to be a high degree of non-compliance due largely to ineffective surveillance and enforcement. The lack of effective surveillance and enforcement stems from several inter-related reasons (Sharom, 1987):

1. Efforts to enforce the fisheries laws and regulations are seriously hampered by limited enforcement inputs such as operating funds, patrol vessels and aircrafts, and enforcement personnel and equipment.
2. Many enforcement agencies, particularly the Fisheries Department, are overburdened with multiple administrative duties, aggravated by the fact that there is a shortage of qualified staff and equipment to execute these duties.
3. Related to the above, enforcement personnel are not properly trained in the areas of sea operations, investigative work and prosecution of cases.
4. Harassment of enforcement officers by the violators is becoming increasingly rampant. It is becoming a trend among some trawler fishermen, for example, to turn violent when confronted by fisheries enforcement officers patrolling the prohibited zone. In one recent incident trawler fishermen took an enforcement officer "hostage" when the latter tried to detain them for fishing in a prohibited zone near Pulau Ketam in Selangor. The Fisheries Department has taken a serious view of the way the fishermen have acted trying to harass the officers during the course of their duties. In this connection, the Department has taken various steps and measures to safeguard enforcement officers against harassment or any other acts of violence by the violators.
5. Coordination among the various agencies responsible for enforcement is seriously lacking. Although in theory there appears to be some kind of coordination between enforcement agencies with the establishment of the National Maritime Coordinating Committee and the Maritime Enforcement and Coordination Center in Lumit, in practice it has not

been easy for them to coordinate their activities at sea. Effective coordination among enforcement authorities is further undermined by the lack of a clear delineation of duties and responsibilities which often results in overlapping and duplication.

Other problems associated with ineffective enforcement have also been identified (Abdul Hamid, 1987). Firstly, there is the extensive geographic area the enforcement authorities must cover. Indeed, with a coast line measuring some 2,899 nautical miles and sea area covering about 138,700 sq. km. (inclusive of the EEZ), it is hardly surprising that existing patrol vessels could not effectively police the entire sea area and coastline. Moreover, it cannot be denied that since fisheries enforcement is carried out at sea, it is much more expensive and difficult than enforcement on land. Furthermore, fisheries enforcement carried out in the open seas is less visible to other fishermen than actions taken on land. This, therefore, may have less of a deterrent effect than land-based enforcement. The net result of all this is blatant violation of the fisheries laws and regulations despite existing enforcement. Secondly, procedures involving judicial actions for any violators caught are too bureaucratic and complex, resulting in delays and backlogs of cases. To make matters worse, the legal process of bringing the violators to face judicial actions is often hindered by political interference. There were occasions when fines imposed on the violators were lowered and boats confiscated by the court released because of political intervention.

With Malaysia's recent extended jurisdiction of the 200-mile EEZ came added and more demanding surveillance and enforcement responsibilities. Given the existing limited strength and capabilities of the enforcement authorities, it was intially doubted if adequate and effective enforcement could be achieved in the EEZ. But judging from the considerable number of Thai fishermen caught since the EEZ regulation was enforced, such doubt quickly dissipates and one cannot but be impressed by the capabilities of the enforcement authorities. It has been reported that on average the Navy and Fisheries Department together managed to arrest 48 Thai fishermen and confiscate more than three boats a months in the EEZ. However, the number of such incidents increases by leaps and bounds towards the end of each year as the monsoon discourages local fishermen from braving the stormy seas, hence leaving the seas of the EEZ free for the Thais to fish. Over years of experience, the Thai fishermen also know that the monsoon is a period when the seas of the EEZ are most productive - a fact which helps to explain why the Thais are extraordinarily active during this period and their willingness to take the risk of venturing into Malayasia's EEZ.

The frequent arrests of Thai fishermen generate yet another set of problems - i.e., problems related to conviction and sanction. As Abdul Hamid (1987) correctly points out, "the problem of Thai encroachment only begins to snowball when it reaches land." Invariably, the arrested Thai fishermen are convicted by the courts and heavy fines are imposed on them. However, owing to the steep fines imposed, nearly all of them opt for imprisonment in default, serving sentences ranging from two weeks to six months. According to Fisheries Department's statistics, out of the 742 fishermen that were arrested from January 1986 to November 1987 only one decided to pay his fines totalling M$36,200 to avoid imprisonment. The total accumulated unpaid fines for the same period were M$5.19 million.

With such a high number of Thai fishermen imprisoned, the first and foremost concern among Fisheries Department officials and politicians is the fact that the country has to spend a substantial amount of money to keep the Thai fishermen in prison. It has been estimated that feeding some 741 people in the country's prisons at a rough average of M$5 a day per person would cost the Government M$111,300 per month, and this excludes the expenses incurred to send the Thais back to their country once they have completed their imprisonment terms.

Under the Fisheries Act 1985, the penalties for encroachment in the EEZ had been increased substantially to discourage illegal fishing by foreign vessels. However, as Abdul Hamid (1987) remarks "But the Thais keep coming. The increased penalties seem to have no effect on them as they do not pay the fines." In fact, it was also disclosed that the convicted Thai fishermen actually do not mind serving the jail sentence since they are not only living on free meals for a maximum period of six months but also their salaries will be paid in full to their families in Thailand by their Thai employers.

There has been discussion among fishery officials and politicians to re-examine the laws and extend the prison terms to several years to provide a real deterrent. Such suggestion appears highly reasonable since the present maximum six-month imprisonment term is treated lightly by the Thais as a kind of confined holiday. No doubt the prison authorities would be faced with the problem of continued overcrowding and escalating costs but extended prison terms for the convicted Thai fishermen might just provide the right answer to the problem of encroachment in Malaysia's EEZ.

5. Summary and Conclusions

We have reviewed in this paper the marine fisheries legislation and fisheries law enforcement policies of Malaysia. Incorporated in these legislations and policies are laws declaring extended maritime jurisdiction up to the 200-mile EEZ; laws for protecting living aquatic resources and endangered species; laws for the exploitation, management and conservation of fishery resources; and laws relating to the development of fisheries in the EEZ. In addition, supplementary regulations such as the Fisheries Regulations 1967 and Fisheries (Amendments) Regulations 1980 formulated for the purpose of carrying out the intent of the enacted laws were also reviewed. The key provisions of these regulation include control of fishing efforts through licensing; terms and conditions of the licenses; prohibition of destructive fishing gear and practices; minimum mesh sizes; spatial delineation of fisheries exploitation by vessel size and fishing method; administrative or institutional structure for handling violations; and the sanctions or penalties imposed for violators.

In this paper, we have also described the programs and practices of the agencies charged with implementing the fisheries laws and policies, emphasizing mainly the structure of the enforcement system, modes of enforcement, resources available, and enforcement activities and procedures. The major types of violations, number of arrests and the extent of convictions and sanctions has been documented whenever available data permits. Finally, the major problems with enforcing the laws and regulations were identified and discussed. The enforcement problems worthy of mention here include: limited enforcement capabilities and resources, lack of coordination amongst enforcement agencies, harassment of enforcement officers by the violators, general political interference in the

implementation of the enforcement programs, and problems related to convictions and sanctions.

In conclusion, our preliminary study has brought into focus some very pertinent problems and issues related to fisheries enforcement laws and policies in Malaysia. Our next logical concern is to identify ways in which the enforcement system can be improved in order to ensure a high degree of compliance with existing laws and regulations, and ultimately, to formulate specific recommendations capable of answering several policy issues and designing improvements in a fisheries enforcement system such as in Malaysia. Thus, it is our hope to define these problems and issues in researchable terms and use them as a precursor for further detailed investigations in the future.

ACKNOWLEDGEMENTS

We gratefully acknowledge the kind assistance and support of various individuals who have contributed in one way or another to the successful completion of this study. In particular, we would like to extend our sincere gratitude and appreciation to Encik Sharom Majid, Director-General, Fisheries Department, for allowing us access to valuable data and information without which this study would not have been feasible. Our special thanks are also due to Encik Shukor Hamid, Ms. Ch'ng Kim Looi and Puan Rabihah Mahmood from the Fisheries Department for their knowledgeable insights into the subject matter under study. However, the author alone is responsible for all the views and ideas expressed in this paper.

REFERENCES

Abdul Hamid Shukor, 1987. Personal Communication. Chief, Enforcement Unit, Management and Protection Branch, Fisheries Department. Interview conducted October 9, 1987.

Ch'ng Kim Looi, 1983. "Management of Marine Capture Fisheries in Malaysia: Issues and Problems." Paper presented at the International Conference on the Development and Management of Tropical Living Aquatic Resources, Serdang, Selangor, August 2-5, 1983.

Department of Fisheries, *Annual Fisheries Statistics 1985.*

Department of Statistics, *External Trade Statistics 1985.*

Jahara Yahaya, 1984. "A Critical Evaluation of Policies and Programs Affecting Fisheries Management and Regulation in Peninsular Malaysia." Paper presented at the Workshop on Marine Resource Economics: South East Asian Seas in Transition, Honolulu, April 24-27, 1984.

Malaysia, *Fourth Malaysia Plan 1981-85.*

Malaysia, *Fifth Malaysia Plan 1986-90.*

New Straits Times, 1987. Newspaper stories. Various issues.

Sharom Majid, 1984. "Controlling of Fishing Effort: Malaysia's Experience and Problems." FAO Fish Rep. (289). Supplem. 3.

Personal Communication. Director-General, Fisheries Department. Interview conducted October 10, 1987.

Sutinen, J.G., 1986. "Enforcement Economics and Southeast Asian Fisheries." Paper presented to the KORDI/EWC Workshop on Asia/Pacific Marine Resources and Development, Seoul, Korea, June 23-26, 1986.

COMMENTARY

Jon G. Sutinen
Department of Resource Economics
University of Rhode Island

History suggests that enforcement economics have played a major role in determining the property rights structure of ocean resources.[1] Feudal law in medieval Europe transferred to the State all property that previously had been common property, but only "utilized" fisheries were given legal status since feudal law ignored resources whose definition or enforcement were prohibitively costly. By the 15th century Scotland claimed exclusive rights to fishing within fourteen miles of shore, reflecting her strength in maritime activities and enforcement.

By the 17th century, several treaties established national claims to territorial seas. The enforcement of these claims required substantial naval resources to escort fleets, evict trespassers, and seize catches and ships. Technological and economical changes during this period stimulated political and legal debates about the appropriate structure of property rights to ocean resources. Grotius' doctrine of open access to these resources was based on the assertion that the rewards of exclusive rights were not sufficient to offset the costs of obtaining and holding these rights. Subsequent adoption of Grotius' doctrine restricted coastal States' claims to narrow bands of coastal waters.

When important fisheries were threatened with depletion in the 19th century, multilateral agreements, such as the North Sea Convention of 1882, were formed to establish and enforce rights on the open seas. Such attempts failed in their goals largely because of the high costs of enforcement. Thus, Grotius' doctrine of open access to most ocean resources prevailed well into the 20th century.

According to Eckert (1979), the surge in extended jurisdiction over ocean resources in the 1970s was induced by, *inter alia*, "new technologies which have lowered the costs of monitoring and enforcement [making] it economical for coastal nations to expand their areas of jurisdiction." However, many countries are finding that the rewards of extensive EEZs are not coming cheaply. The enforcement of fisheries law and regulations is relatively costly and often ineffective. The United States spent some $80 million on the surveillance of foreign fishing operations while collecting only $41.5 million (Sutinen, 1987). We calculated for Costa Rica that the cost of a modest enforcement program for the tuna fishery would be about 50 percent of the revenues expected under the Eastern Pacific Tuna Agreement (Lepiz and Sutinen, 1985). Regarding effectiveness, we have reports that 60 to 90 percent of the trips made in the New England groundfish and scallop fisheries involve serious violations of fisheries regulations. In the Philippines, roughly 25 percent of all fish in Manila markets are reportedly harvested using banned explosives.

While most coastal State EEZ claims are out to 200 miles, the boundaries of effective jurisdiction are in question. For many the EEZ may be in name only, not in fact. One is tempted to conclude that we are going through a shake-down period where, again, the economics of enforcement will shape the ultimate boundaries of EEZs.

Don Aldous describes the fisheries enforcement program for the South Pacific Forum Fisheries Agency (FFA), a regional body with 14 island States as members. The setting is somewhat unique, and the approach to fisheries enforcement is doubly unique. The region is characterized by a large expanse of ocean -- EEZs totalling about 20 million km^2 -- and by rich tuna resources exploited by distant-water fishing fleets. The island States do not have the means to mount a large and sophisticated enforcement program in their zones. To address the problem of monitoring foreign fishing fleets and enforcing their fisheries agreements, the FFA has developed an ingenious program with an approach that, as Aldous describes it, has been singularly rational and sensible. He notes that "the terms of a [foreign fishing] access agreement must reflect the coastal State's ability to enforce the agreement. For example, if it is not possible by any means of monitoring to verify the quantity of fish caught, then it would make little sense to limit the catch of foreign fishing vessels to a quota." In the United States, we tend to do this the other way around. Regulations are set in our fishery management system with the expectation that some way will be found to enforce them.

Another novel aspect of the FFA's program is the Regional Registry of Fishing Vessels on which a foreign fishing vessel must maintain good standing in order to be licensed for fishing in the area. Any member of the Forum can have a foreign fishing vessel removed from the register if the vessel "appeared to have contravened fisheries regulations and fled from justice." This action would remove the vessel's right to fish in any part of the 20 million km^2 zone of the Forum. In most cases only the threat of removal from the register has been enough to induce accused vessel representatives to appear in court.

The FFA has added a new wrinkle to their enforcement approach not discussed by Aldous. In the recently signed fisheries agreement with the United States, accused U.S. fishing vessels will be investigated by U.S. enforcement authorities, thus shifting a substantial portion of the enforcement burden on the government of the distant-water fishing nation. This is a novel means of minimizing the cost of enforcement borne by FFA member states.

Malaysia's approach to fisheries enforcement is more conventional than that of the South Pacific Forum. The distinguishing characteristics of the Malaysian approach is that it is both systematic and substantial. The Malaysians have studied several other countries' programs, adopted certain aspects of those programs, and are investing substantial resources into building up all essential components of a highly potent program. Unlike the FFA's enforcement program, there is no apparent attempt to integrate fisheries policy and regulations with the capabilities of the Malaysian enforcement program, and no apparent attempt to minimize the cost of the program.

Both programs, like most others around the world, are evolving and their ultimate shape is difficult to predict. A key determinant of the ultimate shape, I believe, will be economics. In Grotius' terms this means how well the rewards of holding EEZ rights compare with the costs of holding EEZ rights.

NOTE

1. The following evidence is based on Clarkson (1974), and this discussion is exerpted from Sutinen and Andersen (1985).

REFERENCES

Clarkson, K.W. 1974. "International Law, Seabeds Policy and Ocean Development." *Journal of Law and Economics* 17 (April): 117-42.

Eckert, R.D. 1979. *The Enclosure of Ocean Resources: Economics and the Law of the Sea.* Stanford: Hoover Institution Press.

Lepiz, L. and J.G. Sutinen. 1985. "Surveillance and Enforcement Operations in the Costa Rickan Tuna Fishery." *Marine Policy* (October):310-21.

Sutinen, J.G. 1987. "Enforcement of the MFCMA: An Economist's Perspective." *Marine Fisheries Review* 49(3):36-43.

Sutinen, J.G. and P. Andersen. 1985. "The Economics of Fisheries Law Enforcement." *Land Economics* 61(4):387-97.

Kenneth Sherman: May I respond to Dr. Knauss' comment made at the conclusion of our panel. His comment focused on his thought that there was imprecision in estimating stocks that would not justify the ecosystem approach. I think that the record would read quite differently. The record that we have for an ecosystem study off the northeast coast of the United States for the past 15 years has provided information that is a great improvement over earlier studies, and has allowed us to provide a whole series of options for conservation and management that could not have been provided under the single-species approach. We have a series of options now for dealing with both pelagic components and demersal components as multispecies assemblages.

In the case of the Antarctic, in less than three years (once the Scientific Committee of CCAMLR came down to business following an agreement on the protocol for the operations of the Scientific Committee), we have already set TACs for the fish species of the Antarctic ecosystem that clearly have been overexploited. We set TACs at a level which would ensure, in a short time frame, some level of recovery based on a strategy described by Tucker Scully during his presentation. We have a Commission and a Scientific Committee in CCAMLR working together on an agreed-upon recovery strategy. Now it would not have been possible given to accomplish so much in such a short period of time, given a very narrow single-species focus. I think the record is improving. I would see it getting better if we expand fisheries studies from an ecosystem approach to other regions around the globe, rather than perpetuate a very narrow single-species approach.

Bjorn Aune: The use of the marine ecosystem concept to establish regions and treaties on fisheries, is most laudable and desirable. However, I think there must be limitations in the conception and application of the concept. Man, in his pursuit of infinIte wisdom, desires to know everything about the environment. However, the realities are: (1) in all probability we will never know everything about the environment, about nature and how the latter functions, and (2) the environment is subject to dynamic fluctuations.

Therefore, I would like to ask Mr. Scully, can you truly hope to incorporate in article-form every specific factor and variable governing a given ecosystem which is based on empirical data at the time, and then hope that the resultant treaty, which is medium to long term in its application, can respond to very short term and real dynamic changes to the environment? For example, if you are going to have a treaty on a fishery which is based on everything you know about the environment, you will find that it usually takes time to realize there has been a severe change in that fishery in a given time frame. The lag time in learning of the change by waiting for the telltale but subsequent declining catch figures, or by conducting research, prevents real-time assessment and the implementation of appropriate measures (e.g., quota reductions, total bans, etc.).

Consequently, I would like to recommend that perhaps, as Dr. Morgan has noted, more arbitrary legal and political boundaries and geographic concepts must be utilized. The question to Mr. Scully is, if you could know everything about a particular marine ecosystem, would you be willing to promulgate such a comprehensive doctrine which includes

highly scientific and technical points in either domestic legislation or treaty form, and allow it to stand in the medium and long term?

Tucker Scully: That may be a metaphysical question. I'm not sure I quite understand it, with respect to the different political and ecosystem boundaries. The question of defining boundaries from a management point of view is quite a different question from how you determine what kind of information, what kind of data are necessary, for making a management decision.

Obviously, one cannot know everything about the environment. One of the things that has to go on as a basis for managing any unit is to determine what must be measured to determine the need for management and the specific techniques that would apply.

An ecosystem approach provides a basis for determining what should be measured. The ecosystem concept itself will not give you the information. It will give you the basis to apply measures, and a feedback mechanism. The objective is to have some sort of real time ability to respond to the changes that are detected based on the parameters, based on indicators that you choose to measure.

PART IV

IMPACTS ON NEW DEVELOPMENTS ON NON-RESOURCE USES OF THE OCEAN

PANEL IV

INTRODUCTION

Alastair Couper: This session is devoted to non-resource uses of the oceans. Normally, we divide resources into physical and biological, and the ocean is a basis for direct exploitation of both categories. There are also less direct environmental resource values in the satisfactions obtained, sometimes with payment, from recreation, living on and near, and viewing the ocean environment. The non-resource uses we are considering here relate primarily to the utilization of ocean space, which is seldom treated in the same way as physical and biological resources. It is generally free to users, the principal obligations being to respect the rights of others and protect the ocean environment.

The most widespread and ancient use of ocean space involves the transport of goods and people. This has seen significant changes in recent years. First, the changing economic circumstances of shipping and trade; second, the rapid design changes of ships and the restructuring of the industry in terms of ownership and flag; and third, the plethora of national and international legislation relating to the rights and oblitagions of merchant shipping in the use of marine space. Edgar Gold and Awni Behnam will pilot us through the complexities of this and will point to trends and problems.

The second paper is related to the first. One problem concerns the rights of merchant ships to ply their trade unhampered in the world ocean. This has seldom been achieved. Merchant ships have been the targets for pirates and wreckers since time immemorial, and frequently neutral merchant ships have been the innocent victims of belligerents. Seamen have generally accepted, with some resignation, that violence against them would be tolerated to a far greater extent by their governments, and the world community in general, compared with attacks on land based communities and installations.

It is with interest, therefore, that we have the opportunity to listen to Jack Grunawalt who will focus on the "tanker war" in the Gulf. He will give his opinion as to how much law there is, and how it can be enforced regarding the peaceful and military use of marine space in zones of conflict.

One very important development which is affecting merchant shipping in choice of ocean routes, accurate positioning and availability of search and rescue services, is the use of satellites. This has profound effects also on the strategic mobility of naval vessels, and implications for the management of pelagic stocks in particular, as well as the enormous possibilities for enhancing scientific understanding of interrelations in the ocean system. The third speakers, James Baker and Ralph Chipman, will deal with the developments, applications and legal aspects of remote sensing from satellites.

Finally, we come to what is likely to be a more contentious issue: the use of the deep seabed beyond the zones of national jurisdiction for the emplacement of high level radioactive waste. Kenneth Hinga will provide some of the scientific data and Clifton Curtis the legal basis for this activity. Questions will no doubt be raised relating to the ethical aspects and the possible problems for future generations.

These papers focus on the use of marine space, show current and likely conflicts in use and opportunities for spatial and other measurements using satellites as a basis for management.

International Shipping and the New Law of the Sea: New Directions for a Traditional Use?

Edgar Gold*
International Institute for Transportation
and Ocean Policy Studies (IITOPS)
Halifax, Canada

Introduction

Shipping and ship-source marine pollution have been on the Law of the Sea Institute (LSI) agenda on a number of occasions. At LSI 10 in Rhode Island, the subject was extensively examined by a panel which raised concerns about perceived restrictions to the freedom of international navigation in the Law of the Sea negotiations. I was a commentator who did not fully agree.[1] Consequently, I set out my views in greater detail at LSI 12 in The Hague.[2] At LSI 13, in Mexico City, Douglas Johnston and I developed some of these ideas further by examining the relationship between shipping and ship-source marine pollution.[3] At LSI 19 in Cardiff, navigational issues were a full agenda item, with the Secretary General of the IMO as a featured speaker.[4] In 1986, navigation, for the first time, merited its own LSI workshop.[5] Finally, at LSI 20, the subject was again presented to me in a major paper.[6]

It is thus quite appropriate that an LSI Conference devoted to the economic, legal and political aspects of change arising out of new developments in marine science and technology should, once again, examine that most traditional of ocean uses -- international shipping.

This paper will, firstly, examine international shipping as it is about to move into the final decade of the 20th century; secondly, questions underlying maritime transit and the new law of the sea will be reviewed; and, finally, IMO's principle of "Safe Ships and Clean Seas" will be revisited.

I. The Shipping Scene in the 1990s

In recent years the shipping industry has undergone a number of formidable changes in technical development, economic infrastructure, and operational procedures. Some of these changes have had negative effects, whilst others have undoubtedly strengthened the overall basis of the industry.

International shipping is presently making a weak recovery from probably the worst economic slump in its long history. Although shipping economists tell us that this slump, like previous similar downturns, has been largely self-inflicted due to overbuilding, inaccurate economic forecasts, and an over-cooperative financial lending sector, the end result was, nevertheless, an industry with a precarious economic base. As a result, a large part of the world fleet lay idle, was laid up, or taken out of service altogether, with even scrapping prices reaching all-time lows.

The Suez Canal closure arrived conveniently at a time when ship construction technology had just evolved the supertanker. The world's energy hunger quickly demanded larger and larger tankers and the Very Large Crude Carriers (VLCC),[7] and the Ultra Large Crude Carriers (ULCC)[8] rapidly followed. Oil companies and ship owners realized enormous profits, often being able to recover the cost of a VLCC in one or two

high revenue voyages. The world's shipyards, particularly those in Japan, the Federal Republic of Germany, Sweden and Spain, could not keep up with the demands even by greatly expanding their facilities. Maritime lending banks, wanting to get in on the action, developed innovative new financing arrangements and a whole new generation of shipowners were thus able to become involved in what was perceived to be a lengthy boom. Within a few years the world fleet had been swollen by the addition of a new group of giant vessels which, as will be noted later, had their own problems. Energy-economic forecasts continued to be optimistic despite the fact that overtonnaging was quickly apparent.

Then came the first oil crisis of 1973 which sent oil prices soaring within a period of a few months. Despite greatly increased costs, the shipping boom continued for a little while as a stunned industrial world examined alternative sources of energy and conservation. Strangely, even at this stage, more large tankers were being built. However, within a comparatively short time, like a house of cards, the tanker industry collapsed. There was a quickly lessening demand for petroleum cargoes and the great ships were out of work and being laid-up wherever possible. Fortunes which had been quickly made were just as quickly lost, and major lending banks suddenly became reluctant shipowners through foreclosure actions.

Despite the fact that petroleum prices have dropped considerably since the mid-1970s, the tanker industry has never recovered and the demand for oil from traditional exporting areas has decreased sharply as too many tankers continued to compete for too little cargo.

At the same time, new sources of energy had been developed, which needed less or no sea transport due to the development of overland and undersea pipelines and smaller feeder vessels. However, one new source of energy, liquid natural gas (LNG), would provide the industry with a new direction. The carriage of this substance required innovative new technology and very expensive vessels which would cost between $100-250 million. LNG was quickly seen as a viable alternative to oil, and a mini-boom in LNG carrier construction resulted. Of course, as oil prices fell, LNG became less competitive in price, and the demand for LNG vessels lessened. Further fortunes were lost. In addition, many states found LNG near their own coasts which was accessible by pipelines and thus did not require LNG to be brought from Algeria or Indonesia.

The energy crisis also resulted in considerable changes in the bulk trade. Firstly, a number of States decided to return to coal as an energy source. This led to a considerable demand for power coal, particularly from North America. The VLCC technology was quickly transposed into large bulk-carrier construction and a new generation of very large bulk carriers was developed. At the same time, the periodic demand for large volumes of food grain in China, the USSR, India, and Africa, further boosted the demand for large bulk vessels. However, this market has also disappeared to a great extent today. Cheaper oil reduced the demand for coal and China, the USSR, and India became more self-sufficient in food grain. At the same time, the decreased demand for steel and steel products had also lessened the demand for bulk vessels for ore cargoes which could have provided a viable alternative for the bulk sector.

There were also a number of positive changes in the industry. The development of the cellular container vessel, now in its third generation, totally revolutionized the carriage of general cargo at sea. Through the provision of rapid door-to-door service, with minimum handling, the freight container basically made traditional methods of

general cargo carriage at sea obsolete. On the other hand, freight containers required high capital investments -- the ships were large, fast and expensive and the container system, due to its intermodality, required very considerable infrastructure investments in ports, terminals and ancillary equipment. For most developing States the cost of entering the container trade was prohibitive and they were thus relegated to continue in the outdated break-bulk trade. However, overbuilding in the container trade was also inevitable and resulted in a number of bankruptcies, mergers and takeovers by major container lines. This problem has not yet been stabilized. The development of container technology also resulted in a number of important variations such as the LASH (lighter-on-board-ship) Vessel, the larger Ro-Ro (Roll-on/Roll-off) Vessel, the Super Car Carrier, etc.

The rise and decline of the offshore oil industry which, as already indicated, had adverse effects on the tanker industry had, however, other effects. It resulted in remarkable achievements in the construction of offshore oil rigs, such as jack-up rigs and semi-submersibles, dynamically positioned oil drilling vessels, seismic and other exploration vessels, pipe laying vessels and offshore supply and standby vessels. At the height of the first energy crisis there seemed to be no ceiling on innovative technology and investment in this area. Cheaper oil prices reduced this sector of the industry sharply and there is today a glut of supply vessels on the market, and oil rigs are laid up from Texas to Norway awaiting the inevitable next energy crisis. It might be added that the depressed state of this part of the industry has also, for the time being, sidelined the urgent need for a proper and separate international legal regime for the offshore sector.

Another interesting aspect of the modern shipping industry which must be mentioned is the growth of the recreational arm of the industry. Although concentrated in the developed world for obvious reasons, there has been a sharp rise in recreational small boating and a commensurate increase of the use of nearshore areas by such craft. Secondly, the growth of the passenger cruise liner industry has been quite extraordinary. When the great passenger liners regretfully disappeared from the seas in the 1950s and 1960s through the development of aviation and the modern jet airliner, many felt that these ships would be done forever. Instead the passenger cruise liner, providing non-scheduled cruises, evolved in response to demands for exotic recreational destinations by an evermore affluent "Northern" clientele. The growth in the cruise industry continues unabated and even predictions of overtonnaging have so far been incorrect as ships seem to be filled as fast as they are built.

A final sector of the modern shipping industry which appears to be a continuing growth area is in the ancilliary vessel sector. The world's fishing industry, which is becoming more and more sophisticated, is undergoing a building boom in the inshore, offshore and factory-trawler sector. There is no question that extended fishery zones have boosted fishing interests and commensurate technology both in the "North" and the "South". It is also one sector where vigorous vessel construction is taking place in a number of developing States. There is also a notable growth in the coastal, international, as well as inter-island ferry services in all parts of the world in response to recognition by coastal and island States that adequate passanger/cargo services stimulate such States' communication and economic services.

There are also a number of other aspects which illustrate the status of the world's shipping industry as it heads into the final decade of

this century. In the technical area vessel navigation has become much more sophisticated with the use of advanced shipboard electronic and satellite navigation systems. This is, of course, also related to Vessel Traffic Management, which will be taken up again in Part II.

In general commercial terms shipping has and is undergoing some very important changes. Despite the severe economic condition of the industry there has been a noticeable broadening of flag States. In a 1986 world fleet of just over 400 million tons, almost 40 percent is today under flags which would have not been considered "traditional" a few decades ago. In particular the growth of the Soviet merchant fleet, now in fifth place, and the steady growth of the Chinese fleet, should be noted.[9] In addition, there has been steady, if slight, growth of the fleets of a number of developing States, in particular, Philippines, Brazil, Indonesia and India. However, a major sector of the world fleet is still firmly registered in "flag of convenience" States, particularly Liberia, Panama, Bahamas and Cyprus.[10] This phenomenon, which appears to continue to remain attractive for shipowners, for a variety of reasons, is not expected to abate despite the attempt by the UNCTAD Shipping Division to impose restrictions on these registration practices through an international convention designed to phase out "open registries".

However, the open registry phenomenon is also related to the general internationalization of the shipping industry. It is today not unusual for a ship, constructed in State A, with financing arranged by financial institutions in State B, to be registered in State C, to be beneficially owned in State D, to be managed by a corporation in State E, to be operated by a company in State F, to be insured in State G, and to be crewed by nationals from another dozen States. In legal terms this has undoubted implications for placing responsibility on any particular State. Furthermore, it can be expected that this internationalization will continue, particularly in the private sector, where major transnational corporations with shipping interests engage in increasingly complex corporate merger and commercial financial security transactions. As already indicated above, many of the major maritime lending banks experienced severe losses through the "tanker boom and bust". Accordingly, shipping loans are today harder to obtain at a time when investment requirements for modern high-cost vessels are higher than ever. This will inevitably lead to further concentration of "northern" shipping in fewer but more powerful and diverse transnational corporations. There is no doubt that this may well have adverse effects on the shipping aspirations of developing countries.

This rapid and cursory overview should at least serve to illustrate that the world shipping industry enters the 1990s at a considerably more stabilized level than it entered the 1980s. The world fleet is not expected to expand greatly in overall tonnage but will increasingly diversify and specialize in areas such as container carriers, cruise vessels, petroleum and chemical product carriers, ferries and fishing vessels. It is, however, quite possible that a new energy crisis will increase the demand for tanker tonnage and rejuvenate the offshore oil sector. Specifically the shipping industry will, however, continue to be under pressure in terms of protection of the marine environment as well as from aspects related to the transit passage of merchant vessels. This will be discussed in the following sections.

II. Maritime Transit of Merchant Shipping and the New Law of the Sea

Almost on a daily basis neutral shipping is attacked by the belligerents in the Iran-Iraq Gulf conflict. Although, when compared to

the overall traffic in the area, attacked vessels are a small minority, damage cost has been considerable and there has been noticeable loss of life and personal injury. Attacks on ships have been quite indiscriminate, generally disregarding the flag of the vessel or her destination. Iraqi attacks usually utilize heat-seeking missiles fired from considerable distances away, whilst Iranian Revolutionary Guards engage in the mining of waters and attacks from small craft with smaller calibre, but often destructive, fire power. On appeal from Kuwait, the United States has re-flagged Kuwaiti tankers under the U.S. Flag and is engaged in commensurately expensive convoy and mine-sweeping duties to escort these "U.S." vessels through "belligerent" Iranian waters. The Soviet Union has also utilized its standing Gulf naval force for escort duties for its vessels, and the United Kingdom and France are engaged in mine-sweeping and limited escort duties.

This limited intervention in the Gulf dispute by the four major powers has been quite successful and vessels enjoying this type of protection have, in recent months, been able to pass unhindered. However, this has resulted in the brunt of the belligerent's attacks being concentrated on vessels which do not receive this special protective treatment. As a result, vessels flying the flags of Japan, India, Malta, Liberia, Italy, Bahamas, Yugoslavia, Panama, Cyprus, Hong Kong, Spain, and a number of other States, have been attacked, heavily damaged and, sometimes, sunk. Many of these attacks occur in areas of the Gulf which are either high seas or within navigable parts of the Exclusive Economic Zones of Gulf littoral States. Territorial waters and "exclusion zones" of the belligerents are generally avoided except when vessels are entering or leaving oil loading facilities.

It is almost incomprehensible to the commercial maritime world that this state of affairs continues unabated with hardly a flicker of interest from an apparently cynical world which depends on the Gulf oil "life line" but lives far removed from the ships and those that sail them in and out of danger on a daily basis. There is, of course, no question that the tanker industry is undergoing a "mini-boom" by sailing in these waters. Freight rates are very high but so are insurance rates and danger bonuses for ships' crews -- all costs passed along to the consumer. At the same time, the belligerents, both major oil producers, depend on oil exports to continue their war efforts. From their military standpoint, the interdiction of such exports has become a priority and neutral ships are caught in between. However, even neutral vessels bound to and from other neutral States in the region such as Saudi Arabia, Kuwait and the United Arab Emirates are frequently attacked. Yet the international attitude seems to be: if shipping interests still tolerate this state of affairs it must be worth their while and it is thus their business!

Considering the amount of time and energy expended at UNCLOS III on freedom of navigation it would seem that such an attitude is at the very least shortsighted. Is a neutral ship trading to a State engaged in an armed conflict a legitimate target for the other belligerent? Is a neutral ship transitting through belligerent waters enroute to a neutral State subject to attack? Is the only form of possible protection convoy escort from a major power? Must such escort be limited to vessels flying the flag of the escorting naval force?

Obviously, these are very complex questions which go far beyond the scope of this panel or even this conference. On the other hand, does the law of the sea simply cease to exist in times of war and armed conflict? Was the Gulf-type crisis not foreseen by UNCLOS III?

Although shipping has been characterized as one of UNCLOS III's "neglected areas",[11] there has been more concern about the transit of vessels than about the reasons such transit is made. During UNCLOS III shipping played a minor role, basically a "polluting industry" defensively fighting for an outdated *status quo*. Even the major maritime States, in carefully weighing their various maritime interests, generally placed their quickly fading shipping industries in importance below resource and strategic interests.

What actually occurred was a discernible realignment of international maritime interests which provides the background for properly viewing modern international navigation. Within the context of navigation the right of vessel transit must now be balanced against a complex number of other international, economic and ecological considerations. No longer will navigation be the prime ocean use before which all other marine interests must yield. Rather, navigation will now be one of many competing ocean uses in a more complex maritime world.

As a result there is now a clearly-established legal right, under the U.N. Convention on the Law of the Sea, permitting coastal States to take certain initiatives which serve the common interest of protecting the marine environment. As a result, many coastal States have already initiated a number of new measures designed to prevent or reduce ship-source marine pollution. As a result, shipping has and is becoming much more regulated in its oceanic movements. Yet, maritime transit was almost exclusively discussed in strategic terms in UNCLOS III.

There are specific differences between "clear" strategic maritime transit interests and traditional commercial navigation. The former always seeks to be covered by legal principles but is rarely averse to breaching these. The latter rarely needs the protection of such principles except when they are breached by the former![12] The Gulf problem is a striking example.

Shipping, as a form of international trade and commerce, has been with us from pre-history and is accepted totally as something which is truly to the common good. As a result there has been, in its three-millenia written history, relatively little interference with shipping in times of peace. Even in times of war and armed conflict neutral shipping has generally been allowed to proceed with minimal interference.

Interdiction of merchant shipping occurs only when war, armed conflict or other political expediencies prevail. At that stage even the best international legal principles are generally suspended or simply disregarded.

It thus appears that the Law of the Sea Convention provides little "real" help for neutral ships caught in the Gulf conflagration. Although the "freedom" of maritime transit, outlaws interdiction of such peaceful and legitimate navigation, the "real" world prevails. Only a U.N. directive protecting *all* shipping in the Gulf and enforced by a U.N.-backed force could put teeth into the Convention's provisions. However, such action does not appear to be politically feasible at present and thus the indiscriminate, yet selective, destruction of shipping in the Gulf continues.

Another problem facing international shipping is the increasing possibility of terrorist attacks on merchant ships. The spectre of a terrorist group taking over a large loaded tanker has been contemplated by security organizations in a number of States for some time. However, the *Achille Lauro* affair added reality to conjecture. For once, the maritime world moved relatively quickly and met to consider the possi-

bility of increasing violence against defenseless shipping. The result was the Convention for the Suppression of Unlawful Acts Against the Security of Maritime Navigation, concluded in Rome just a few months ago which, based to some extent on anti-air hijacking principles, outlaws violent and terrorist attacks against merchant ships. The instrument is, of course, not yet in force and it remains to be seen how effective it will be.

Related matters are an increase of piracy/robbery in coastal areas, particularly of West Africa and in the Caribbean and Southeast Asian waters. As the Law of the Sea Convention's piracy provisions received little revision during UNCLOS III, it is doubtful if such provisions are effective today. In particular, the international drug trade, which preys on pleasure craft, often resulting in the theft of the vessel and death of those on board, was not foreseen when the Convention's provisions in this area were drawn up.

It may, however, be much more useful to examine the U.N. Convention on the Law of the Sea a little more closely in terms of its new regulatory measures placed on merchant shipping. A number of these new measures clearly purport to exercise limited control over navigation. As the safety record of international merchant shipping is far from good, it can also be argued that more controls are needed. This appears to be the motivating principle of "Safer Ships and Cleaner Seas" of the International Maritime Organization (IMO), which is considered by the new Convention to be the "competent international organization" in the field of shipping.[13] This will be further developed in Part III below.

The Convention provides new "terms of reference" for a number of specific measures aimed at regulating navigation.[14] These are both direct as well as implied. Article 192 in a very simple, single sentence, places a heavy new responsibility on all States in stating that they "have the obligation to protect and preserve the marine environment." This gives States very broad terms of reference to protect the seas. Article 194 is somewhat more specific by setting out that measures to protect the marine environment shall be designed to minimize:

> pollution from vessels, in particular measures for preventing accidents and dealing with emergencies, ensuring the safety of operations at sea, preventing international and unintentional discharges, and regulating the design, construction, equipment, operation and manning of vessels.

This definition could, for example, easily include a number of vessel traffic control requirements involving the training and equipment necessary.

In the Convention's section on innocent passage in the territorial sea, such passage is now clearly defined. Under Article 21 the coastal State may make laws and regulations relating to innocent passage concerning the "safety of navigation and the regulation of maritime traffic", as well as relating to protection of the marine environment. Article 22 sets out new rules relating to sea lanes and traffic separation schemes, and coastal States are given the right to require vessels to comply with such rules after due consultation with IMO. It follows that non-compliance with regulations under Articles 21 and 22 could be interpreted to be non-innocent passage, resulting in criminal proceedings under Article 27. This article gives coastal States criminal jurisdiction over

foreign vessels for crimes which "disturb ... the good order of the territorial sea."

It should be noted that although Article 26 specifically prohibits the levying of passage charges on foreign vessels in the territorial sea, charges are, nevertheless, permitted for specific services rendered to vessels. It would seem that traffic separation schemes, vessel traffic control zones, and navigational aids may well be so chargeable on "user-pay" principle.

Under Article 41 States are also given the power to establish sea lanes and traffic schemes in international straits after consultation with IMO as well as other States bordering such straits. Vessels are required to respect such schemes. Article 43 empowers straits States to make laws and regulations relating to the safety of navigation and the regulation of maritime traffic similarly to coastal States in the territorial sea. Furthermore, such States are required to cooperate by agreement "in the establishment and maintenance in a strait of the necessary navigational and safety aids and other improvements in aid of international navigation."

In the Convention's Part IV, dealing with archipelagos, similar guidelines for archipelagic States are established. Article 53 empowers such States to designate sea lanes for passage through such areas as well as traffic separation schemes for the safe passage of ships through the narrow parts of such sea lanes.

In the EEZ the coastal State's competence relating to international navigation regulation appears to be more limited although it seems to be implied that any State navigating in the EEZ or the coastal State may propose schemes for ships' routing or use allocation respectively. In any case, under Article 56 coastal States have the jurisdiction with regard to the establishment and use of artificial islands, installations and structures and, as always, with regard to the protection of the marine environment. Even in the Area, the International Seabed Authority may establish similar safety zones around exploratory/exploiting installations in accordance with the Convention.

It is thus apparent that the new Convention provides a fairly comprehensive regulatory "umbrella" for complex new rules relating to the safety of navigation in the territorial sea, international straits, archipelagic waters, as well as, to a more limited extent in the international seabed area, the EEZ and ice-covered areas of the EEZ.

As a result the rights and responsibilities of coastal and maritime States can today be summarized as follows: Coastal States have the right to be protected from ship-generated marine pollution, but they have responsibilities relating to pollution prevention, port State jurisdiction, pollutant reception facilities, navigation aids and hydrography, vessel traffic systems, and the expansion of training demanded by all of these. Maritime States have the right to pursue legitimate commercial navigation in their own interest and for the common good of international trade and commerce. At a time when the shipping industry is very depressed the industry has to be particularly cost-conscious. Deviations, delays and other navigational interference are thus unacceptable. On the other hand, maritime States have the responsibility to ensure that their ships are safe, comply with accepted international standards and are adequately covered with sufficient liability insurance. Last, but not least, innocent and neutral shipping has the right to be protected from belligerent acts whether from legitimate State or terrorist origins.

The new Convention is unable to balance these interests more equitably. It provides directions, guidelines and principles but few details. It is here that a new international transit regime may well have to be created.

III. The Principle of "Safer Ships and Cleaner Seas"

Although the economic structure of the world shipping industry is still in a somewhat precarious position and maritime transit issues remain unresolved at this stage, the role of shipping as a polluting industry has drastically improved. It is probably correct to state that ship-source marine pollution has reached the lowest-ever levels. This positive fact is due to: firstly, the continuing efforts of the International Maritime Organization (IMO) under its widely-accepted principle of "Safer Ships and Cleaner Seas"; secondly, the new Law of the Sea principles which gave IMO its needed mandate; and, finally, the economic pressures on world shipping which: 1) made the deliberate spillage of expensive oil uneconomic; 2) retired outmoded tanker tonnage; and 3) resulted in innovative new anti-pollution technology in ships and shore installations. An overall factor which is, possibly, the major contributor is due to discernible raised environmental consciousness in the shipping industry.[15]

Like everything at UNCLOS III, the marine environmental negotiations resulted in a skillfully drafted compromise in the Convention's Part XII which provides new international guidelines for the control of ship-generated marine pollution.[16]

It is not necessary to provide details of all the relevant articles here. The overall admonition that "States have the obligation to protect and preserve the marine environment" says it all.

There are, of course, fairly specific provisions in the various articles. For example, Article 194 clearly sets the measures which States must undertake to prevent, reduce and control all types of pollution of the marine environment. Subsection 3.(b) includes:

> pollution from vessels, including measures for preventing accidents and dealing with emergencies, ensuring the safety of operations at sea, preventing international and unintentional discharges, and regulating and design, construction, equipment, operation and manning of such installations or devices.

On the other hand, Subsection 4 also provides protection for the rights of other States by requiring States taking preventive measures "to refrain from unjustifiable interference with activities carried out by other States in the exercise of their rights..."

Article 211 deals even more directly with pollution from ships and the controls which may be imposed on such ships. The article contains the requirement that States should act through "competent international organizations" in order to achieve international rules and standards to prevent, reduce and control pollution. It is generally accepted that this refers to the IMO and provides that organization's needed legislative "umbrella".

Section 6 on enforcement is particularly relevant. This is the new "frontline" between traditional flag-state responsibility and new directions in the international enforcement process against marine pollution.

Article 217 codifies traditional flag State responsibilities which IMO has attempted to lay down for its member States. It is also an area

with persistent problems as sovereign States cannot be forced to implement rules. As a result, flag State rules have often been nothing more than advisory admonitions which were often not followed. Article 217 now sets out clear legal responsibilities for flag States, which incorporate much of the language drawn directly from a number of IMO operational conventions. It is, for example, quite clear that allowing a sub-standard vessel to remain in operation would be an illegal act by the vessel's flag State.

Article 220 covering marine pollution enforcement by coastal States contains another very difficult compromise. The language of the article is complex and the escalation of right of action by the coastal State is almost unworkable. However, it reflects the fears of the maritime States that coastal states might interfere in legitimate navigation and that safeguards must thus be clearly spelled out.

Article 220 sets out, reasonably clearly, the different enforcement regimes which coastal States can follow for pollution incidents occurring in the territorial sea and the EEZ, with a further safeguard related to the type and magnitude of pollution damage.

Article 218, on enforcement by port States, breaks totally new ground in international maritime law. It is probably in this area that most future preventive enforcement is expected to take place. The feared spectre of coastal States' excessive zealousness in interpreting Article 217 has not, so far, arisen. This may well be due to the progress which is being made under port State jurisdiction which will be discussed further below. In any case, it appears that, with very few exceptions, States, so far, are not eager even to utilize the new powers available under Article 220.

Section 7, on safeguards against excessive regulation and interference, provides fairly adequate protection for vessels and interested parties in cases where States have exceeded their powers under Section 6 articles. The section also lays down specific rules of how investigations, penalties, restrictions, etc., by coastal States should proceed. Furthermore, coastal State liability and responsibility for delay and improper procedure is also set out in this section. Obviously, claims and other procedures under these articles might not be easy, as this would involve the normal, difficult State-to-State procedures. In private law terms it remains to be seen if a shipowner could proceed under these articles in order to make a claim for delay, etc.

The Convention also provides fairly specific rules under which coastal States may make regulations relating to navigation in offshore areas. In particular, vessel traffic regulation, seen generally as a very effective system for marine pollution control, can be developed under a number of articles which give coastal States fairly broad powers.[17]

Under Article 17, marine pollution is now clearly considered to be prohibited as an act "prejudicial to the peace, good order or security" of the coastal State, and would suspend innocent passage. Under Article 21 coastal States are permitted to make laws and regulations for the protection of the marine environment. Again, these are "umbrella" articles which must be read with Part XII and related IMO conventions.

The fact that the Convention is not yet in force has not deterred a large number of States from implementing provisions which bear close resemblance to the Convention's marine environment protection provision. For example, a recent survey of some 90 countries revealed that over half had, in recent years, implemented new legislation to protect the marine environment. A large percentage of the remainder had new legisla-

tion pending.[18] The influence of ship-generated marine pollution and the work of IMO and UNCLOS III clearly had far-reaching effects.

The completion of the Convention has had a particularly laudatory effect on IMO, the principal competent international organization in terms of marine pollution control. The former slow rate of convention acceptance and ratification has speeded up drastically as has the organization's membership. There are presently some 40 international instruments concerned directly and indirectly with marine pollution from ships. The most important of these emanate from IMO.[19] There is no question that the real catalyst has been the entry into force of the MARPOL 73/78 Convention in 1983, which has had a resoundingly positive effect on marine pollution control.[20] Its construction standards made many of the older problem vessels obsolete and its operational requirements have made deliberate pollution unnecessary.

On the other hand, there are also difficulties at IMO. Several of the important MARPOL Annexes are not yet in effect and an attempt, in 1984, to conclude a liability regime for the sea carriage of hazardous and noxious substances failed to find sufficient support.[21] This means that there is still a heavy concentration on oil pollution at the expense of pollution from substances other than oil. This could be particularly serious in case of pollution incidents involving such substances.

However, IMO is also presently developing a new international regime for marine salvage which will be more in line with law of the sea requirements.[22] Furthermore, it is hoped that the 1984 FUND and Civil Liability Convention Protocols will soon enter into force and thus raise the ceiling for compensation for pollution damage.[23]

Probably the most significant progress arising out of the Law of the Sea Convention's marine pollution from ships provisions has occurred under Article 218 on port State enforement. At this stage there is only one region where "port state enforcement" actually occurs. In 1982 a Ministerial Conference on maritime safety, held in Paris, resulted in the signing of the "Memorandum of Understanding on Port State Control" by 14 European States. This Memorandum sets out guidelines for an improved and harmonized system of port State control and strengthens co-operation in the exchange of information. Although specifically related to the implementation of IMO and ILO conventions and regulations, the Memorandum also gives effect to and, in some aspects, exceeds the port State control provisions of the U.N. Convenion on the Law of the Sea.

Under the Memorandum the signatory States have agreed to carry out substantial inspections of vessels in each other's ports to check on all safety matters. Inspection rigor is escalated in accordance with deficiencies found. Particular attention is given to vessels carrying pollutant and hazardous and noxious cargoes. The inspection authorities are given the power to demand rectification of serious problems before the vessel is allowed to proceed. In other cases, if the vessel is permitted to proceed, authorities at the next port will be notified to ensure further inspections.[24]

It appears that what has been achieved in Europe is truly preventive action and exceeds the expectations of the Law of the Sea Convention. Under the Convention, port States are given the power to take action when requested to by a State which has suffered pollution damage from a ship which is now within the jurisdiction of the port State. It was envisaged that this rule would be particularly useful in cases where the flag State fails to take action. However, under this rule the question of incentive and costs involved were never clearly answered. Accordingly,

the procedure, under the European Memorandum, is far superior. It will now, however, be necessary to establish other Memoranda elsewhere.

Conclusions

As international shipping enters the final decade of the 20th century it is very slowly recovering from the worst and, certainly, the most protracted depression ever experienced.[25] However, it is too early to judge whether this is a full recovery or simply one brought about by temporary, cyclical demands. The amount of oil moved in the world for every ton of available shipping capacity, a good measure of efficiency, is down 50 percent from 1978 according to INTERTANKO.[26] On the other hand, there has been an upturn in other areas of the shipping industry. Despite some overtonnaging the container revolution continues unabated and there is continuing technical development in the LNG, LPG, and product carrier areas. The passenger cruise vessel industry is booming and there is an increase in the construction of modern passenger ferries in all parts of the world. The offshore oil industry continues to be depressed due to lower oil prices but awaits the next, inevitable, energy crisis which is likely to be upon us before the end of the century.

The actual maritime transit of merchant vessels continues to be beset by a number of problems which are not expected to be resolved in the next decade. The indiscriminate attacks on unarmed neutral vessels by the belligerents in the Gulf graphically illustrates the weaknesses of international law in times of armed conflict. Whether re-flagging of vessels under the flags and the protection of major powers will be the answer remains to be seen. It is, in any case, not a satisfactory solution for the large amount of traffic in the area.

A recent agreement relating to action against violence and terrorism against merchant ships is a positive step forward which also plugs a void in international law.

Finally, it appears that there should still be efforts to raise interest for the development of an international maritime transit treaty, which will not only provide some overall direction for the problems outlined above, but would, at the same time, coordinate the maritime provisions in the Law of the Sea Convention which require a complementary operational instrument for proper implementation.

Very positive progress continues to be made in the area of ship-source marine pollution which has been reduced to lowest-ever levels. The Law of the Sea Convention's Part XII provides excellent overall direction for operational developments put in place through IMO Conventions which have been widely accepted. Greater marine environmental consciousness throughout the world has led to acceptance of the need to protect the marine environment with commensurate legislative action. Port State jurisdiction through the European Memorandum has shown to be an effective method of dealing with an international problem.

Continuous vigilance and improvements in the environmental area are needed. It is expected that IMO will produce, within the next few years: a new convention on marine salvage; an instrument relating to liability for pollution damage from hazardous and noxious substances; protocols to a number of pollution liability conventions raising compensation limits; and, an instrument relating to the safety standards of offshore oil rigs.

Shipping is today truly an international industry with a greater number of States participating at all levels. This trend will continue despite the economic difficulties experienced in some parts of the world. Shipping, as a vital part of international trade and commerce,

deserves the full attention and protection of the international community. It is for everyone's benefit.

REFERENCES

* B.A., LL.B., Ph.D., MCIT, ACIArb, FNI, MRIN. Master Mariner (FG) of the Nova Scotia Bar. Professor of Law and Professor of Resource and Environmental Studies, Dalhousie University, Halifax, N.S., Canada. Associate Director, International Institute for Transportation and Ocean Policy Studies (IITOPS). Vice-President, Canadian Maritime Law Association. Visiting Professor, World Maritime University, Member Executive Board, Law of the Sea Institute.

1. Gold, Edgar, "Navigation: The 'Not-so-Sacred' Freedom of the Sea." In Mines, Edward and Gamble, John K. Jr., eds., *Law of the Sea: Conference Outcomes and Problems of Implementation*. Cambridge, Mass.: Ballinger, 1977, p. 120.
2. Gold, Edgar, "The Freedom of Ocean Shipping and Commercial Viability." In Gamble, John K. Jr., ed., *Law of the Sea: Neglectea Issues*. Honolulu: LSI, 1979, p. 248.
3. Gold, Edgar and Johnston, Douglas M., "Ship-Generated Pollution: The Creator of Regulated Navigation." In Clingan, Thomas A. Jr., ed., *Law of the Sea: State Practice in Zones of Special Jurisdiction*. Honolulu: LSI, 1982, p. 156.
4. Gold, Edgar, "Marine Hazards and Casualities: The Need for Vessel Traffic Management." In Brown, E.D. and Churchill, R.R., eds., *The U.N. Convention on the Law of the Sea: Impact and Implementation*. Honolulu: LSI, 1987, p. 479.
5. Gold, Edgar, "The Future of Maritime Transit." LSI Workshop on International Navigation, Honolulu: LSI, 1988, p. 394.
6. Gold, Edgar, "The Control of Marine Pollution from Ships: Responsibilities and Rights." Miami Beach: LSI, 1988, p. 276.
7. VLCC=Very Large Crude Carrier (120,000 to 200,000 tons).
8. ULCC=Ultra Large Crude Carrier (over 200,000 tons).
9. 1986 World Fleet-404.9m GRT. OECD, *Maritime Transport 1986*. OECD: Paris 1986. The USSR had approximately 25m GRT. China had 11.5m GRT.
10. *Ibid*. Liberia in 1st place with 52m GRT; Panama in 2nd place with 41m GRT; Cyprus and the Bahamas with approximately 16m GRT.
11. See note 2 above.
12. See note 5 above.
13. Srivastava, C.P., "IMO and the Law of the Sea." In Brown and Churchill, note 4 above, p. 419.
14. See note 6 above.
15. Gold, Edgar, *Handbook on Marine Pollution*. Arendal: Gard, 1985, p. 84.
16. See note 6 above.
17. Article 192.
18. See note 13 above.
19. Gold, Edgar, "Vessel Traffic Services and the New Law of the Sea." 38 *J. Navigation* 71 (1985).
20. See note 15 above, c. 4 & 5.
21. Ibid, p. 53.
22. Ibid, c. 3.
23. De Bievre, A.F.M.

24. Draft Articles for a Convention on Salvage. IMO Doc. LEG 58/12 Annex 2, October 28, 1987.
25. See note 15 above, p. 46.
26. The Memorandum of Understanding on Port State Control. Annual Report 1985/86. In 1984/85 over 10,000 inspections were carried out on over 7,600 individual vessels of 112 states. 428 ships were detained or delayed due to serious deficiencies.
27. According to James Davis, Chairman of the International Maritime Industries Forum. See, "Tanker Slump seems to be Nearing an End as Excess Capacity and Scrappings Decline." International Herald Tribune, May 17, 1988, p. 13.
28. INTERTANKO - International Association of Independent Tanker Owners. Ibid.

Alastair Couper: To respond to Professor Gold's paper we are fortunate to have Awni Behnam, from the secretariat of UNCTAD. He was chief of the liaison between the secretariat and the Group of 77 in UNCTAD during the critical period of structural change that Professor Gold has described. During that time many economic and technical changes brought forth a number of new conventions through UNCTAD with the support of the Group of 77 and also of several countries. Dr. Behnam is now with the Office of the Secretary-General of UNCTAD. He is a graduate from Iraq and also has a master's degree in shipping economics, and his Ph.D. from Wales. His current interest is in maritime transport and the economic, legal, and technical developments, particularly as they affect the developing countries. He has devoted much of his time, research, and effort to the development of the shipping industry in the Third World.

COMMENTARY

Awni Behnam
UNCTAD Secretariat
Geneva, Switzerland

Introduction

Commercial use of the seas for maritime transport purposes remains, to date, the most valuable use. Since the Second World War, considerable expansion of international seaborne trade and shipping has taken place for both dry and liquid cargo. The volume of seaborne trade reached 3.5 billion tons in 1987, a fourfold increase since the 1950s. More than 630 million deadweight tons of shipping is plying the high seas, of which some 375 million deadweight tons consists of bulk and tanker shipping. The world average age for vessels in this category is 11 years, with 19 percent of vessels 15 years old and over.[1]

In recent years, the shipping industry has experienced a disastrous situation of overtonnaging due to the supply/demand disequilibrium. In 1987 the estimated average figure for the surplus world fleet amounted to 130 million DWT, or 20 percent of the world merchant fleet.[2]

This situation has contributed in no small measure to the corresponding rise in maritime fraud. The figures available from the International Maritime Bureau show that in 1985 the cases investigated involved 169.5 million U.S. dollars. Maritime fraud of all types including scuttling and arson have reached unprecedented proportions. Shipowners seeking employment for their vessels are taking abnormal risks. All this does not augur well for stable and safe international maritime transport.

One of the problems faced currently is the exercise of jurisdiction and control over vessels. Almost one third of the world fleet operates under flags of convenience (the fleets concerned are officially referred to as "open registry fleets"). The controversy continues as to the extent, if any, to which the flag of convenience phenomenon lies at the roots of the irrational and erratic development of the world fleet in recent years, and as to whether recycling of cash flows in the shipping industry to keep the money outside normal fiscal controls, contributed to the oversupply situation, and whether a co-relationship exists in the rise of number of alarming incidents involving shipwrecks, scuttling of vessels or other types of maritime fraud. Nevertheless, the problem of enforcing the law and the need for flag States to exercise jurisdiction and to have more than a nominal connection with shipowners who use their flags remain central to the issue.

The Issue of Open Registries and the Exercise of Jurisdiction and Control

There are numerous reasons why shipowners register vessels under flags of convenience (FOC) - including evasion of taxes, avoidance of various governmental regulations, and freedom from restrictions on the use of cash-flows. Some of the less reputable shipowners, marginal as they may be, undoubtedly use these flags with the specific aim of concealing their identities and escaping the responsibilities and law-enforcement procedures which apply under normal flags. Undoubtedly, there are also numerous transnational corporations of good standing involved in open registry operations, with the reasons why these

companies choose flags of convenience relating principally to crew costs and commercial viability.

What has aroused most public discussion is the misconduct and irresponsible conduct that can be associated with the operation of open registry vessels. There are, of course, some companies which operate FOC vessels in a responsible manner because they believe that safety promotes good business. However, the same system that permits these companies to operate with more freedom than they could achieve under their home flags also permits the operation of vessels by a marginal group of irresponsible owners. The problem arises from the fact that, whereas a country with a normal registry can exercise total authority over the owners, the crew, and the vessel, an open registry country can only exercise authority over the nominal owners who appear on its registry book. The key crew members of these vessels are non-nationals, and consequently the only real remedy which an open registry country can apply in the event of misconduct is to *de-register* a vessel. This, however, is not really an effective measure, since nominal owners can circumvent deregistration by changing their company name, and the name of the ship, and re-register.

However, one must also not equate all open registry countries. In the case of Liberia, it can be said that it has a sophisticated and competent system of maritime administration, rules and regulations.[3]

We must also not forget that certain ILO and IMO conventions are enforceable by port States. However, though this is to some extent possible in developed maritime States, can one really expect the port States in the third world to assume the responsibilities of the flag States?

While ships are considered part of the national territory and come under the jurisdiction of the flag State, on the high seas only international rules and regulations are applicable, and even then only provided they are binding on the flag State either directly (ratification) or indirectly (common use). Under these conditions, if there is no genuine link (according to the standard terminology) between the ship and the State, serious questions arise:

a. How can the State effectively exercise its jurisdiction and control over the ship flying its flag in order to face its national and international obligations in maritime navigation?

b. How can the State conceive, define, and implement a maritime policy, of which the ship is a part?

c. How can one define the responsibility of the ship, of its owner, or even of the flag State, particularly in the case of damage to third parties in operating the vessel?

This was and continues to be a challenge to the whole international community. The proper exercise of jurisdiction and control over vessels by a flag State is not only of national concern but above all of international concern. It would be futile to expect all flag States to exercise such control unless minimum requirements are laid down in an international convention.

It should be recalled that at a meeting of European and Japanese Ministers of Transport held in Tokyo in February 1971,[4] a number of decisions were taken in regard to flags of convenience. Through these decisions, the governments of the countries concerned, i.e., eleven European countries and Japan, took note of the growing tendency of shipowners in some of their countries to register under a flag of

convenience and expressed certain concern regarding this practice. They also recalled "that registration of ships under flags of convenience was not in conformity with the principle reflected in the Geneva Convention on the High Seas, 1958, which required that a State must effectively exercise its jurisdiction and control in administrative, technical and social matters over ships flying its flag."

It will be noted, of course, that the latter principle is also embodied in the United Nations Convention on the Law of the Sea, in particular with respect to the provisions relating to the nationality of vessels and the duties of flag States. These provisions are contained in Articles 91 and 94. Article 91 states that each State shall fix the conditions for the grant of its nationality to ships, for the registration of ships in its territory and for the right to fly its flag. However, there must exist a "*genuine link*" between the State and the ship. Article 94 sets forth various duties of the flag State concerning the exercise of its jurisdiction and control in administrative, technical, safety and social matters.[5]

Here, one should consider certain arguments that have been advanced with regard to the law of the sea. It is often claimed that there is no need for an international agreement on conditions for registration of ships, as this matter has been adequately covered by the Law of the Sea Convention. It is indeed clear from an analysis of the relevant provisions of the Law of the Sea Convention that, although individual States have a certain flexibility to establish conditions concerning the grant of their nationality, registration and right to fly their flags, there must exist as a very minimum in all cases a "genuine link" between the State and the ship. However, the Convention provides no definition of what is a genuine link, nor does it in any other way give guidance on what conditions of registration of ships satisfy the genuine link requirement. Article 94 deals with the totally separate question of what the duties of a State are *vis-a-vis* vessels flying its flag, and in this respect the Convention sets forth international norms for the exercise of jurisdiction and control by flag States.

The absence of a genuine link between open-registry vessels and the flag State makes it impossible for the flag State to fulfill its international obligations to exercise jurisdiction and control over vessels flying its flag. The Convention leaves unresolved the issue as to what exactly are the elements constituting the genuine link between State and vessel which is necessary to enable a State effectively to exercise its jurisdiction and control, as set forth in Article 94. In this context, it is important to note that the statement in Article 91 that "Each State shall fix the conditions for the registration of ships" is a statement of *obligation* and *not* a statement of freedom. It does not say "Each state shall *remain free* to fix the conditions for the registration of ships." Thus, the Law of the Sea text does not preclude, and is not inconsistent with, establishing minimum conditions for the registration of ships under another international agreement. In fact, such an international agreement would be *complementary* to the Law of the Sea Convention by, in effect, establishing the minimum conditions for registering ships without affecting the right of individual States actually to fix conditions for the grant of nationality, registration and right to fly its flag which are more stringent than the stated minimum. Such an agreement, by establishing minimum conditions on the basis of which vessels may be registered in a State, would result in a greater likelihood than the duties of flag States, as set forth in Article 94, would be fulfilled, and this was one of the underlying ideas

in the elaboration of the United Nations Convention on Conditions for Registration of Ships.

The United Nations Convention on Conditions for Registration of Ships was elaborated and adopted on February 7, 1986, under the auspices of UNCTAD. According to its Article 19, it will enter into force 12 months after the date on which not less than 40 States, the combined tonnage of which amounts to at least 25 percent of the world tonnage, have become contracting parties to it.[6]

When the Convention was being elaborated, it was understandable that some countries which had failed to achieve a greater involvement in shipping wanted to draw up proposals to tighten conditions of registration in such a way as to *maximize* the involvement of the flag State. However, it had to be borne in mind that any set of conditions which would maximize the flag State's involvement in ownership *and* in management *and* in manning, without any flexibility on the three aspects, would not have been feasible. Extreme proposals inevitably led to extreme counter-proposals, as the maritime countries felt obliged to defend the legislation and national practices which they had developed over the years.

The vast majority of maritime countries had laws which enabled them to identify the shipowners and operators of ships on their registers and to make such owners and operators accountable - even though their legislation did not stipulate involvement of nationals or residents in each and every aspect of ownership, management and manning. Taking that into account, it seemed that the most fruitful course was not to draw up a set of maximum conditions, but rather to examine what would be the *minimum* conditions needed to ensure a *genuine* link between a vessel and a flag State (as distinct from the so-called "links" that exist only on paper, or in the form of brass-plate companies). There was every reason to believe that it might be possible to draw up a set of minimum conditions which would *both* put an end to the practice of permitting artificial links between vessels and flag States *and* be consistent with the laws of nearly all, if not all, of the responsible maritime countries, especially if coupled with flexibility to allow for the fact that many countries place different degrees of emphasis on the separate aspects of ownership, management and manning. At the July, 1985 session of the Conference, a turning point was reached, when proposals were put forward that would allow States to opt either for the manning or for the ownership articles in addition to the management link article.

The United Nations Convention on Conditions for Registration of Ships introduces new standards of responsibility and accountability for the world shipping industry. For the first time an international instrument now exists which defines the elements of the "genuine link" that should exist between a ship and the State whose flag it flies. The Convention filled a major gap in international maritime jurisprudence, as the components of the "genuine link" had never been identified.

Articles 8, 9, and 10 - the heart of the Convention - provide for participation by nationals of the flag State in the ownership, manning and management of ships, thus establishing key economic links between a ship and the flag State. A distinctive feature is that States have an option between the two mandatory articles on ownership and manning. This element of flexibility was introduced to take account of the different conditions prevailing in flag States. Some might lack sufficient manpower among their nationals or "persons domiciled or lawfully in permanent residence" within their territory to provide for significant participation by nationals in the crews of ships flying their flag.

while others might not have sufficient capital to participate effectively in ship ownership. Among the important provisions of Article 9, on manning, is one stating that the State of registration shall ensure that the manning of its ships "is of such a level and competence as to ensure compliance with applicable international rules and standards, in particular those regarding safety at sea." Another part of that article stipulates that the State of registration shall ensure that the terms and conditions of employment "are in conformity with applicable international rules and standards" and that "adequate procedures exist for the settlement of civil disputes between seafarers employed on ships flying its flag and their employers."

A balanced approach is evident in Article 10 on management. On the one hand, the principle is set out that before entering a ship on its register of ships, a State of registration would ensure that the shipowning company or its subsidiary is established and/or has "its principal place of business within its territory." On the other hand, where this is not the case, the flag State would be expected to ensure that there is "a representative or management person who shall be a national of the flag State or be domiciled therein." The article on management is also significant in that it makes the State of registration responsible for ensuring that persons accountable for the management and operation of ships are in a position to meet the financial obligations that may arise from the operation of such ships and to cover risks which are normally insured in international maritime transportation in respect of damage to third parties.

Another important article (Article 5) on national maritime administration provides for the establishment by a flag State of a "competent and adequate national maritime administration which shall be subject to its jurisdiction and control" and which is responsible for a number of specific mandatory tasks such as ensuring that a ship flying its flag complies with a State's "laws and regulations concerning registration of ships and with applicable international rules and standards concerning, in particular, the safety of ships and persons on board and the prevention of pollution of the marine environment" and ensuring that it carries on board documents, "in particular, those evidencing the right to fly its flag and other valid relevant documents." At present a number of States or would-be open registries do not have a national maritime administration with such competence.

In addition, Article 6 on identification and accountability provides that a State of registration shall take the necessary measures to ensure that owners and operators of a ship on its register are "adequately identifiable for the purposes of ensuring their full accountability." This provision is of particular importance for identifying and punishing perpetrators of maritime fraud.

The Convention did not please everyone. It is a product of compromises necessitated by the divergent positions held by States. Some criticize the Convention, claiming that it does not greatly change the *status quo*. Others accept realities and see the Convention as a step forward in the struggle to limit undesirable side effects of flags of convenience. Some claim that open registry countries will not need to make any changes. The truth may be somewhere in between. The Convention could provide a possible international legal instrument for States to take sanctions at the national level against the more undesirable aspects of the phenomenon of flags of convenience. It also provides a policy platform for developing countries for their future planning, and perhaps most important it allows those countries which supply labor and wish to

attract vessels to their national register to adapt their standard of registration without compromising the integrity of their registers or the competence of their maritime administration and thus have their national labor manning vessels under their own flags. It therefore opens the door to competition which the traditional open registry countries could not afford to ignore as they would have to tighten their control over vessels under their register in accordance with the minimum conditions set out in the Convention.

The Convention induces greater transparency in the operations of open registry vessels through its Articles 6 and 11. It also provides the legal basis for registration of bareboat chartered vessels in its Article 12. In that connection, Maitland states that:

> were bareboat registry procedures more generally available, some of the strange "re-flagging" contortions that have recently been seen in connection with hostilities in the Persian Gulf area, would not have taken the form they have.[7]

Article 5 of the Convention deals with national maritime administration and consequently with safety standards. It states: "The flag State shall have a competent adequate maritime administration which shall be subject to the jurisdiction and control."

As Sturmey[8] admits, this is one of the strongest provisions of the Convention. Sturmey also makes a sound proposal for all to consider as an improvement on this article, namely for an appropriate United Nations agency to be set up to review the structure and performance of the maritime administration of States, upon their request, and to recommend what measures might be taken to enable them to meet the standards set in the Convention.

I also agree with him that if the Convention is to be enforced, it will not only be the present open registry countries which need to act, since plenty of "normal" registers are defective with respect to some of the provisions of the Convention, and it would render an international service if the Convention was responsible for an improvement in maritime administrations throughout the world, including parastatal and private bodies, e.g., the classification societies and surveyors which work in conjunction with administration in so many ways.

The Convention on ship registration awaits ratification. If it does no more than ensure that no more open registries proliferate subject to conditions and State obligations below the standards set out, weak as they may be, and provide sufficient guidance to national maritime administrations, it would still justify the effort expended on it. In conclusion, bringing the Convention into force is a challenge of responsibility for the international community.

The Participation of Developing Countries in World Shipping

Developing countries today own 20 percent of the world merchant fleet. At the same time, they generate 42 percent of the world seaborne trade and account for 80 percent of world tanker cargoes. In consequence, they pay annually some U.S.$40 billion in their freight bill, a sizeable outflow of scarce foreign exchange in relation to their debt burden.[9]

Developing countries perhaps have greater claims to increase their participation in maritime transport than in any other sector of the world economy. They not only provide a large proportion of cargoes moving in world seaborne trade, but they are also fast becoming the main suppliers of seaborne labor. In the maritime sector, the labor force of

developing countries is filling a gap which the industrialized countries are incapable of filling at a competitive cost.

It must also be noted that for many developing countries, as the main exporters of bulk cargoes, shipping constitutes direct involvement in downstream activities. If developing countries, given their current comparative advantage, cannot develop activities in shipping, one might well ask what activities they can develop. For these reasons, they do not regard shipping simply as "another item" on the agenda of development, but a very critical item: it constitutes a test case for the whole issue of development.

In the field of ownership, the distribution of vessel ownership among developing countries is skewed. Some 10 countries out of 127 countries, members of the Group of 77, own 69 percent of the developing countries' fleet, and this means that the years ahead will see an influx of the rest of these developing countries into shipping either as vessel owners or non-vessel owning transport operators. Thus, such countries can no longer be marginalized. This is the reality.

It also appears that these countries have made the political decision to increase their participation for economic and commercial reasons and also for non-economic reasons. Economic nationalism has been seen as the reason why these countries have striven to enter an industry which, by many commercial criteria, developed countries should have been leaving. The challenge that faces the international community is how best to ease the participation of developing countries, including their acquisition of appropriate technologies for low-cost operation.

The Policy Approach to the Maritime Sector by Developing Countries Themselves

The developing countries' objectives of promoting their maritime capabilities, including development of their merchant marine fleets, and increasing their share in the transport of seaborne trade can best be achieved by adopting specific national and international policies based also on intra- and inter-regional cooperation. In most countries, maritime transport policy as part of the total framework of ocean management either does not exist as such or is fragmented, vague and lacking in order of priorities.

At present there is an urgent need for an integrated and comprehensive maritime transport policy for the simple reason that shipping is not an activity which is completely self-contained. New technologies have penetrated the transport links, as evidenced by the development of multimodal transport operations. Furthermore, there is an element of interdependence in the transport chain.

Most developing countries view their main shipping problem as concerning the existence or absence of a national fleet. This has, in a number of cases, given rise to the adoption of policies aimed at ameliorating one part of the problem. There is no denying that developing countries, in terms of shipping services, notwithstanding cyclical fluctuations in supply, are buyers in a seller's market. Foreign shipowners wield greater economic power than the consumers of their services, the developing countries.

Because of this inherent structural disequilibrium, a policy aimed purely at reacting in a defensive manner, such as attempting to form shippers' councils, would not suffice alone. Only a policy that is cohesive, interacting and all-embracing that involves all aspects of trade, shipping and transport practice can help in bringing about the required structural change in the international shipping industry. Such

a policy can and should be evolved not only on a national but also on a subregional, regional and international basis.

Policy formulation, coordination, planning and implementation have to take place through an institutionalized national, subregional and regional machinery with the backing and support of actions taken at the international level. It is clear that the absence of a coherent base for policy formulation that takes into account the interdependence of trade and transport in the total transport chain would lead to a misallocation of scarce resources. Accordingly, in order to achieve the objectives of developing countries for the commercial use of the seas, an integrated policy approach with clearly defined objectives must be formulated and institutionalized.

If the desire of developing countries is to effect a reduction in shipping costs, then there would be a need to provide a cohesive "consumer policy" for shipping services. If one supposes that at present there are many variables which can produce a cost reduction in ocean freight rates, then these variables must interact in such a way as to give one a continuous increase in value, taking into account formulation as in a three-dimensional space with benefits accruing by extending the movement along the crest of the ridge. For example, a port may increase its efficiency, but the shippers do not consolidate their shipments, or investment in new port facilities is not made on the basis of a shippers'/carriers' dialogue and effective negotiations; what happens is that one variable changes in value but in no way has it changed shippers'/producers' bargaining position if liner carriers use blanket rates for all ports serviced by the Conference at one end of the trade route.

The question arises as to the form of shipping policy and its thrust in relation to fleet development. In the final analysis it should be a question of policy for the developing countries to determine whether the expansion of their fleet should be based purely on a commercial rate of return criterion or on a wider socio-economic criterion. Policy-makers could take into account the full long-term economic and social benefits of creating a viable shipping industry that, due to its spill-over effects, can contribute to increasing national income without necessarily showing short-term book profits at the company level. Thus, the commercial rate of return at the enterprise level may not be the sole criterion for determining the desirability of investment. In fact, it may be found that the social rate of return may be higher in shipping than in most other investment alternatives for some developing countries. This is due to the dynamic international character of shipping and its interaction with trade and economic activities.

Adopting policies that take into consideration the external benefits does not imply that maritime enterprises investment in should not be commercially viable or that they should not be efficient, even if in the infant and intermediate stages of development of the enterprises the desired rate of return may be set according to wider socio-economic criteria. Once the investment criteria are decided upon, such decisions will provide the guidelines for management operations and investment at the level of the enterprises.

The policy-makers in developing countries or "the policy-making institutions" can view the maritime transport industry in terms of pyramid-structured activities. The building blocks and the base comprise the smaller ancillary services, the coastal and regional services, medium and small-scale fisheries, shorthaul services, ship repairing,

the building of small feeder and port marine craft and trained manpower accumulation, while the apex of the pyramid represents the more sophisticated oceangoing vessels and other services. It is not necessary that all the above activities should be undertaken in accordance with a chronological symmetry, but they must inevitably be coordinated.

Also developing countries, in order to improve the economic and commercial viability and long-term competiveness of their maritime industry, should give high priority to regional and inter-regional cooperation. In order to establish the conditions which need to be fulfilled for the successful implementation of cooperative arrangements, a comprehensive information system needs to be developed which is aimed at creating the necessary awareness of potential areas of cooperation and identifying the opportunities available. This task could be undertaken by one or more of the international organizations concerned with the development of the maritime industry.

Possible Approaches by Developed Countries

In a recent lecture, J.G. Davis,[10] at the Thomas Grey Memorial Lecture, said "it is incorrect to assume that, in order to be actively involved in shipping, one has to own ships. The critical factor is to have access to cargoes, the shipping of which can then be handled by owned ships, leased ships or chartered ships."

The emphasis here is on access - free and fair access to cargoes. Trades and cargoes should not be monopolized by trading corporations, trading houses or the extractive corporations to the exclusion of other carriers. If developing countries are assured, in the practices of the industry and actions of Governments, of fair and free competition in the carriage of cargoes, then it would make redundant any policy approaches based on cargo reservation.

The second issue is access to capital for newbuildings. There is a danger at present, due to the glut in shipping and the chronic oversupply and the accompanying failure to scrap and take structural and adjustment measures, that surplus tonnage will simply be sold to third world countries. The danger lies in the fact that outmoded and obsolete tonnage would be transferred to developing countries, with all the accompanying ramifications. It would seem much more responsible to continue to provide newbuilding finance at attractive rates and to agree to extend financing terms that are more advantageous than those generally available through the OECD terms for newbuilding. This should be done in a programmed and rational manner in order to place the North-South relationship in the international maritime industry on a more realistic and cooperative basis. The third approach is to encourage joint ventures between developed and developing countries. The Convention on ship registration does provide a legal basis for joint ventures and the latter should also incorporate training arrangements.

Mr. Sturmey[11] comments in this context that the relevant provisions in the Convention on Registration are a useful reminder of one possibility of aiding third world shipping within the context of arrangements which ensure, if their spirit is respected, that other open registries are not created.

The Technological Development Perspective

The last decades have been characterized by important technical changes in shipping, and these have included operational as well as organizational changes. In an attempt to cut down the costs of shipping mainly by reducing handling costs in port and by realizing economies of

scale, unitization, and especially containerization, was introduced in international shipping in the late 1960s. After having been confined to the trades among developed countries, characterized by relatively large cargo volumes and balanced trade flows, these new methods of shipment were also introduced in developing countries' trades after a time lag of about 10 years, in spite of the fact that many developing countries were not sufficiently equipped to meet the technological requirements of containerization or face its social implications.

In reality, the major reason for the introduction of new technologies in transport can be seen in the increasing scarcity and consequent cost of labor in developed countries. The need to increase productivity of labor called for capital-intensive transport systems in which quantitative labor inputs were minimized. These technological changes not only brought about a process of capital/labor substitution, but also increased the efficiency and speed of transport, mainly by speeding up handling operations in port by greatly reducing packing requirements and by reducing handling processes at all transfer points.

In general, technological change implies higher capital intensity, with resultant changes in the capital/labor and output/labor ratios - both increasing. The technological change which the international transport industry is experiencing involves higher capital intensity with the aim of obtaining benefits through economies of scale and reducing unit costs.

International transport is by definition less influenced by purely national considerations and is therefore less amenable to control as to the degree of change which is desirable on a national level. Hence, when changes take place, technical and economic incompatibility between ends of a trade may develop - as could be the case for a trade between developed and developing countries, where the time lag constraint is prevalent.

There exists dissimilarity at the ends of trade routes between developed and developing countries. Such dissimilarity involves shipping tonnage (type and ownership), institutional and physical infrastructure, port facilities, cargo mixes, physical distribution systems, material handling methods, managerial capabilities and capital and labor factors. Such dissimilarities arise mainly from a difference in the stage of development, which creates a time/space gap. Thus, the desirable types of transport technologies to be adopted at present at each end of the trade route may be different.

Added to this is the fact that technological innovation continues to be introduced in transport fields and, if there already exists a time/space gap between the trading partners, the risk of premature technological obsolescence for those countries which are less advanced is of major importance, because this element of risk may raise the real cost of investment. However, developing countries will inevitably have to face up to technological change, at least up to a certain degree if they wish to trade with developed countries.

If the new "systems" are, economically speaking, superior, then in the long run developing countries ought to benefit from their introduction. Accepting these two arguments, the question is no longer whether developing countries' participation in new transport technologies is appropriate and desirable. The real question to be asked now is, *What is the desirable rate of change and what type of technology can be accommodated immediately so that, at both ends of the trade route, the gap is narrowed and at the same time participation in shipping services by developing countries is not adversely affected*?

Any technological innovation which increases efficiency and reduces unit costs is a form of positive change. It goes without saying that the introduction of new transport technologies has social and economic implications not all of which are positive, at least in the short or medium term. Before opting for any specific system, policy-makers in developing countries must be aware of these implications, so that decisions on new transport systems can be taken in line with overall development objectives and avoiding misallocation of scarce resources.

Technological innovation requires not only new hardware but also changes in organizational structure and human resource development. This needs to be appreciated.

As one example of technological developments, containerization forced developing countries to adapt ports and the necessary infrastructure. This meant large capital outlays, with the pace being set by industrialized nations whose institutions already had the necessary legal, financial and commercial framework. However, the container system is not as rigid as was expected in the early days of its introduction. It has developed a certain flexibility of its own. There exists, for example, a range of methods within a range of systems. At the same time it must be seen that developing countries differ in their requirements and ability to cope with the new technologies, and it is virtually impossible to designate any one system that would be appropriate to all of the developing countries at all times. The case is similar in shipping in respect of types of vessels, degree of technological sophistication and need for feeder services *vis-a-vis* main haul.

A major concern of developing countries has been the lack of consultations between foreign line operators and developing countries on the introduction of new transport technologies in developing country trades. For this reason, developing countries have insisted that the United Nations Convention on International Multimodal Transport of Goods[12] should cover this situation. Thus, the Convention now provides that States parties to the Convention:

> *Recognize* "the need to have regard to the special interests and problems of developing countries, for example, as regards introduction of new technologies..." and
>
> *Agree* "that consultations should take place on terms and conditions of services both before and after the introduction of any new technology in the multimodal transport of goods, between the multimodal transport operator, shippers, shippers' organizations and appropriate national authorities."

Another example concerns port development. Any port development project requires that port authorities should take into consideration economic and technical aspects, to which should be added environmental protection and pollution prevention.

UNCTAD[13] has defined environmental aspects as all the physical, chemical, biological and social factors likely to have an effect directly or indirectly, immediately or later on all living beings.

Developing a port can entail substantial alterations in the physical-chemical and biological characteristics of the marine medium. Consequences could be:

a) Reduction of fishing stocks through the destruction of spawning grounds and nurseries;

b) Contamination or destruction of shellfish breeding beds;
c) Deterioration of the bacteriological content of the sea.

By way of an example of operational hazards, spills or uncontrolled release of dangerous and harmful substances carried in bulk or in packaged form, such as LNG, LPG, oil, toxic substances and radioactive substances, would give rise to serious safety and health hazards, as well as harm to the marine environment. Ports should be provided with adequate equipment and materials for combatting pollution in the case of emergencies. Thus, an analysis should be carried out on pollution risks in the port area arising from maritime casualities. The analysis will also determine the selection of berth sites to minimize the environmental impact arising from accidents to ships.

Port planners should take into account the requirements of the International Convention of 1954 for the Prevention of Pollution of the Sea by Oil and of the International Convention of 1973/78 for the Prevention of Pollution from Ships. Regarding the provision of adequate facilities to receive and treat waste from ships, planners should ensure that the necessary installations are supplied; an IMO publication on the provision of reception facilities in ports could be used as a guide for assessing such needs.

It is all well and good to say that ports should comply with applicable rules and standards, etc., but with the increased sophistication and technological developments of vessels, can we afford to continue to treat port development in the third world as a national problem? It is not only impractical but also unfair to take such an approach. This has become an international problem which requires an international response.

Thus, port development raises questions of financing, availability of expertise and pursuit of development objectives. Ports are a service to the international community, and the time has come to treat port development in an international context. Proliferation of national ports in countries of the developing world can only lead to duplication, waste of scarce resources, lack of technological concentration and lack of critical mass in such areas as research and planning.

Greater attention should be given to development and promotion of trans-shipment services in ports, port facilities and feeder services.[14] There are many areas where cooperation between ports would appear beneficial. Such cooperation will be successful if there is support at the international level, particularly in the areas of finance and training. Furthermore, a model international agreement could be developed as a guideline for foreign investment in ports and for development of dedicated port facilities to foreign operators in and out of ports of developing countries.

Assessment

Developing countries cannot afford not to modernize their transport systems or defer the adoption of unitized and containerized methods in the transport of their goods. Systems which provide a mixture of conventional and advanced methods of transporting and handling cargoes may be economically and socially more suited to the majority of developing countries. It is in the interests of developing countries to ensure flexibility and adaptability, particularly in the field of ports and connected inland transport facilities.

Developing countries need to acquire a planning capability for the introduction of international modern transport operations based on a

phased and gradual adaptation, with advanced planning on a long-term scale. The needs of the majority of developing countries for technical assistance is equal to their needs for financial assistance.

Emphasis must be placed on training and retraining labor and management in ports, shipping and inland transport operations. Emphasis must also be placed on job creation schemes for alternative employment of labor within the port vicinity and in the downstream activities of containerized shipping and related activities. Port development must be rationalized through such means as joint ventures in ports facilities, regionalization of ports, and development of transport facilities in developing countries.

Maritime Fraud

In the last two decades, maritime fraud has increased to an alarming proportion. It has become a major problem in the shipping industry, affecting both developed and developing countries.

The latest estimate puts maritime fraud costs at U.S.$7 billion.[15] Such fraud includes documentary fraud, deviation and cargo theft, scuttling, arson, charter-party fraud and marine (cargo and hull) insurance fraud. In 1987, the International Maritime Bureau dealt with cases involving $156.5 million, which the Bureau believes is only 2 percent of crimes actually reported.[16] The highest incidence of scuttling and arson occurs during times of depressed freight markets, and these types of crimes often lead to pollution and present a danger of life and living resources.

Prevention of maritime fraud requires efforts and cooperation on the part of all parties concerned with the orderly conduct of international trade and maritime transport. UNCTAD addressed this problem for the first time in 1984. A resolution adopted by an Intergovernmental Group on means of combating all aspects of maritime fraud recommended that "States members of UNCTAD should examine and, if appropriate, tighten their respective legislation to ensure that effective measures are available to prevent maritime fraud and to investigate such fraudulent acts and to prosecute persons who commit such acts of fraud... ."[17]

The most significant step that Governments can take at the international level would be to negotiate an international convention designed to deal with the problem of maritime fraud, and specifically with the problem of jurisdiction and extradition. Such a convention could expand the jurisdiction of States and list those acts of maritime fraud to be covered. The expansion of the jurisdictional capabilities of States should be linked to extradition requirements, so that a State must either prosecute an offender in its custody or extradite him to a requesting State. Governments have not found the elaboration of an international legal instrument to govern maritime fraud offenses appropriate so far. Crimes which lead to destruction of living resources, endanger safety of life and result in pollution are not "extraditable crimes" governed by international treaty. It seems to me that the time has come for the international community to address this issue seriously, just as it stood up to the challenge of air piracy and drug trafficking.

In the meantime, consequent to an initiative by UNCTAD to be implemented by the private sector, a Maritime Fraud Prevention Exchange (MFPE) has now been established. The MFPE is to provide a focal point through which information relevant to combating maritime fraud can be easily obtained. The availability of shipping information is the key for the prevention of maritime fraud. The current system of collecting and disseminating information is inadequate for fraud prevention purposes.

While there are numerous organizations involved in providing shipping information and a large amount of information is available, there is no overall collecting point or system from which information could be obtained. It is hoped that as of July 1988, this situation will be corrected.

The MFPE is founded by the following organizations, in association with UNCTAD:

1. Baltic and International Maritime Council (BIMCO);
2. International Chamber of Commerce (ICC);
3. Lloyds of London Press Ltd.

The operating companies which will provide replies to individual enquiries include: BIMCO, the IMB, and Lloyds Maritime Information Services. Other organizations already engaged in providing shipping information will be invited to join the scheme. The MFPE will have a board of management and a secretariat and it will provide the following services:

a. Information on the standing and background of companies or individuals;
b. Information on cases of confirmed or suspected fraud;
c. Requests for investigations;
d. Information on ship characteristics, ship movements, ownership details and casualties.

Further areas of activity which will also assist the MFPE in achieving financial self-sufficiency will include:

a. Education: organization of seminars, presentation of papers;
b. Publication: manuals, newsletters and brochures.

The MFPE will be a non-profit-making entity, with its main objective the "prevention of maritime fraud through better information." It is of vital importance that the services of the MFPE are made available to shipping interests throughout the world, and it is essential that it should attract as many enquiries as possible so as to ensure that its basic objective is met.

The provisional start-up date of the MFPE has been set for July 1988. During the initial six months of operation, straightforward enquiries will be answered by the operating companies free of charge.

NOTES

1. *UNCTAD Review of Maritime Transport 1986* (United Nations publication, Sales No. E.87.II.D.6), 1987, Geneva, and *UNCTAD Review of Maritime Transport. 1987*, TD/B/C.4/319, 1988, Geneva.
2. *Ibid.*
3. "When the Liberian register was started 40 years ago it had an appalling reputation for registering old, unsafe ships which had been rejected elsewhere. In recent years, however, U.S. managers have made it more respectable by applying higher standards of inspection, rejecting old ships, rejecting bad owners, opening offices around the world and, unlike all other flags of convenience, investigating casualties. Liberia has a casualty record which is

better than the world average, and it sits on the council of the International Maritime Organisation." *South Magazine*, June 1988, London.

4. Meeting of Ministers of Shipping 2-3 February 1971, Tokyo, MMS/4/4, *CSG Ministers Press Release. Tokyo, 3 February 1971.*
5. *United Nations Convention on the Law of the Sea* (United Nations publication, Sales No. E.83.V.5).
6. "United Nations Convention for Registration of Ships", *UNCTAD, TD/RS/CONF/23, 13 March 1986, Geneva.*
7. Guy E.C. Maitland, "The Bareboat Charter Registry in Operation: The Liberian Experience", *ICC Symposium on Bareboat Charter Registration* (ICC, Paris, October 1987).
8. S.G. Sturmey, "United Nations Convention on Conditions for Registration of Ships", *Lloyds Maritime and Commercial Law Quarterly*, February 1987.
9. UNCTAD, *Review of Maritime Transport 1986*, 1987 *op cit.*
10. J.G. Davis, "How should Britain maintain its maritime industries", *Fairplay*, 5 May 1988.
11. S.G. Sturmey, *op cit*, p. 14.
12. United Nations Convention on International Multimodal Transport of Goods, *UNCTAD, TD/MT/CONF/17, 1981, Geneva.*
13. UNCTAD, "Port Development" *(TD/B/C.4/175/Rev. 1), 1985, Geneva.*
14. Ambassador Amir H. Jamal, Permanent Representative of the United Republic of Tanzania to the United Nations, on the occasion of the 25th Anniversary of the OAU., on 25 May 1988, stated: "... Africa may well reflect on the unique opportunity offered by the Law of the Sea Convention of including, in the provisions of an African code on environmental conservation, the protection and enhancement of the marine resources of Africa ... What about the fact of about 30 African countries having more than 50 ports? These do not need a highway to be constructed and maintained. They have a natural waterway which connects them all. Should there not be a deliberate strategic decision to develop the transport mode of Continental Africa around this critical fact of comparative advantage? This will, of course, not eliminate road and rail construction. But it may well make all the difference between on the one hand saving 100 billion dollars in 25 years to be reinvested in productive development in critical areas of need ..."
15. "Marine Fraud up to $7 billion and growing", *Lloyds List London*, 18 January 1988.
16. *Ibid.*
17. UNCTAD *Ad hoc* Intergovernmental Group to Consider Means of Combatting All Aspects of Maritime Fraud, resolution 1(I), para. 2.

Alastair Johnston: Both Professor Gold and Dr. Behnam mentioned the attacks on merchant shipping in the Gulf area, and the problem of flags and flag protection. The next speaker, Professor Richard Grunawalt, is the Charles H. Stockton professor, chair of international law at the Naval War College. He is a graduate in history from the University of Michigan and then from the Michigan Law School. Most of his life has been spent in the United States Navy, where he has had a very distinguished career. He retired from the Navy in 1985 and joined the faculty of law at the Naval War College.

New Legal Issues Resulting from the U.S. Global Military Commitment: A Naval Perspective of the Persian Gulf Tanker War

Richard J. Grunawalt
Naval War College
Newport, Rhode Island

Before I begin, I would like first to make it clear that my comments are the product of my own thoughts and observations and do not necessarily reflect the official views of the Department of the Navy or the Naval War College.

I will begin with the premise that all of us concerned with the law of the sea are keenly interested in the preservation of the freedoms of navigation and overflight in, under and over the world's oceans. There is not a conferee in this room that does not represent a nation whose security and economic well-being are not inextricably linked to those freedoms. I would also venture to say that advances in marine science and technology will be of little utility to mankind if those fundamental freedoms are extinguished. And, of course, we are all dependent upon sea lines of communication to provide access to world markets and to sustain the flow of our commerce. Similarly, and with few exceptions, we are dependent upon those sea lines of communication to ensure the vitality of our collective defense arrangements, whether as members of the United Nations or of regional security organizations.[1] Although most of you may not often have occasion to view the law of the sea in terms of the freedoms of warships and military aircraft to use the world's oceans with minimal interference by coastal and island nations, I would hope you will agree that the international community is best served by an oceans law regime that facilitates such use without the necessity of recourse to confrontation. For it is self-evident that in today's imperfect world, the task of preserving the freedoms of navigation and overflight upon which all uses of the oceans are premised, depends upon our individual and collective will to defend those freedoms against unlawful encroachment. In short, it is my thesis that the balance of interests reflected in the navigational articles of the 1982 United Nations Convention on the Law of the Sea underpin the vitality of all peaceful uses of the oceans. It is also my view that all nations of the free world have a vested interest in preserving the mobility of naval and air forces upon which maritime commerce must ultimately depend.

That assessment leads me to the topic I have chosen to discuss with you today: the Persian Gulf tanker war and the efforts of the United States Navy to ensure that the Straits of Hormuz and the sea lanes within the Gulf remain open to international navigation and to demonstrate that unlawful depredations on neutral shipping in the Persian Gulf and Northern Arabian Sea cannot be tolerated. In concert with the warships and military aircraft of other nations, the United States Navy has accepted that responsibility; a responsibility not without great sacrifice, witness the attack on *USS Stark* by an Iraqi-air-to-surface missile and the damage to *USS Samuel B. Roberts* caused by an Iranian-laid mine. Today, U.S. French, British, Italian, Dutch and Belgian forces, in coordination with the nations of the Gulf Cooperative Council, patrol the sea lines of communication to and from the neutral

nations of the Gulf. It is those sea lines upon which much of the flow of Gulf oil to Europe, to Japan and to the United States depends.

In order to comprehend fully the role of the United States Navy in preserving navigational freedoms in the Persian Gulf, it is first necessary to examine the tanker war in terms of the reciprocal rights and duties of belligerents and neutrals with respect to neutral commerce. Historically, maritime warfare has witnessed a struggle between belligerent States and neutral powers, with belligerents seeking to isolate their enemies economically from the rest of the world and neutrals maintaining that they are free to conduct commerce with all nations, including belligerents, notwithstanding the existence of protracted hostilities.[2] The resolution of these largely irreconcilable interests -- that of belligerents to wage war at sea and that of neutrals to engage in maritime commerce -- has traditionally taken two forms, i.e., visit and search, and blockade. These belligerent remedies are designed to permit the interdiction of the flow of goods to and from enemy territory but with minimal interference in purely neutral maritime commerce. In the Persian Gulf, Iran effectively closed Iraq's access to the sea early in the war and, exercising visit and search, has seized contraband goods carried in neutral bottoms. Iraq, in turn, has sought to interdict the flow of Irani oil as it is being shuttled from Kharg Island in Iran as well as neutral flag tankers.

While the two belligerents have availed themselves of traditonal interdiction strategies recognized as generally consistent with the law of naval warfare, Iran has also embarked upon widespread, indiscriminate attacks on neutral shipping not involved, in any way, in the movement of goods of any description to or from Iraq. I do not wish to imply that Iraqi targeting practices in the Gulf comply fully with the law of armed conflict. They do not. However, it seems to me that it is the Iranian attacks on neutral shipping that are without justification under any interpretation of law. These attacks take the form of air strikes and warship assaults but more often are accomplished by small, high-speed craft -- the ubiquitous Swedish-built Boghammer motorboat -- and the inherently indiscriminate naval mine. These unlawful incursions directed against purely neutral shipping are not only totally at odds with the law of neutrality, they also pose both an immediate and a long term threat to the freedoms of navigation that underpin the 1982 Law of the Sea Convention. In the short term, the vitally important sea lines of communication into and out of the Gulf, upon which so much of the Free World's economy depends, are under great stress. In the longer term, the vitality of the law of the sea as well as the law of armed conflict will be affected by the resolve, or lack thereof, of the international community in enforcing the rule of law. If nations, individually and collectively, lack the resolve to protect freedoms of navigation in the Persian Gulf, how can we realistically anticipate that those freedoms will be preserved in less critical waters?

Let me now turn to what the United States Navy is about in the Persian Gulf. The United States considers that the Straits of Hormuz may not lawfully be closed by the belligerents of either side, even though those waters are overlapped, in part, by belligerent territorial seas. It is the view of the United States that this result is entirely consistent with the law of the sea as well as the law of neutrality. You will recall that the Khomeini regime has repeatedly threatened to close the Straits of Hormuz. In response to that attempt to intimidate the international community, U.S. Navy warships have regularly patrolled the length of that waterway. Adhering strictly to the rules pertaining to

transit passage of international straits as set forth in Part III of the 1982 United Nations Convention on the Law of the Sea, U.S. Navy warships proceed through the Straits of Hormuz in continuous and expeditious transit, refraining from any activities other than those normal to such transit. Although those naval units carefully refrain from any threat or use of force against Iran's territorial integrity or political independence, they are, of course, prepared to exercise the inherent right of self-defense as reflected in Article 51 of the U.N. Charter and defend themselves and accompanying U.S. flag merchant vessels against unlawful attack.

The United States Navy is also actively engaged in the protection of U.S. flag merchant shipping transiting through the Persian Gulf enroute to neutral ports. While the United States considers that Iran may exercise the belligerent right of visit and search anywhere beyond neutral territorial seas (to include neutral waters in international straits), that right does not extend to the visit and search of neutral merchant shipping accompanied by a neutral warship of the same flag.[3] This traditional rule of the law of neutrality is premised upon the constructive presence of the neutral sovereign (in the form of the warship) to vouch for the non-contraband carriage of those merchant vessels. Of course, if that shipping is in fact engaged in the carriage of contraband to a belligerent, the neutral warship is obliged to stand aside and allow a lawfully conducted visit and search to proceed. In the context of the Persian Gulf, however, the latter problem does not arise with respect to U.S. merchant vessels since U.S. flag shipping is not involved in such carriage -- a fact of which Iran is well aware.

The principal hazard to neutral shipping in the Gulf is, as I have outlined above, indiscriminate and unlawful Iranian attack. Some 230 merchant vessels flying the flags of over 30 different neutral nations, consisting of tanker, dry cargo, breakbulk and container ships, have been subjected to such depredations over the past several years. These attacks have all occurred well outside of the proclaimed "exclusion" or "war" zones established by the two sides at the beginning of the conflict. While the loss of life has been relatively low, the material cost has been great. A more invidious threat is that posed by naval mines laid by Iran in the high seas athwart navigational routes utilized by neutral shipping. While the emplacement of mines in the high seas by a belligerent in time of war is not, *per se*, unlawful, the law of naval warfare restricts that practice to ensure that neutral shipping is not intentionally targeted and to ensure that notice of the hazard of naval mines is promulgated to the international community as soon as military exigencies permit.[4] Iran, however, is not only targeting neutral shipping (there is no Iraqi shipping in the Gulf -- warship or merchant), she has consistently refused to even acknowledge that she is laying mines, let alone warn the international community of their location. And, perhaps most telling as to Iran's regard for the law is the fact that the mines being laid by Iran do not comply with the rudimentary requirement that they become harmless as soon as they have broken their moorings, a design requirement mandated in Hague Convention VIII of 1907 Relative to the Laying of Automatic Submarine Contact Mines.

U.S. Navy warships, in coordination with warships of other neutral powers, have been engaged in the difficult and hazardous task of locating and removing or destroying Iranian-laid mines in the high seas of the Gulf. You will also recall the role of U.S. Navy units in capturing the Iranian naval vessel *Iran Ajr* caught red-handed laying mines in the shipping lanes utilized by neutral vessels.[5] U.S. Navy warships have

also been actively engaged in escorting U.S. flag shipping to and from neutral ports. These operations have not been without substantial costs in lives, material and dollars. The attack upon *USS Stark* by an Iraqi warplane, albeit inadvertent, alone took the lives of 37 U.S. Navy men. The severe damage incurred by *USS Samuel B. Roberts* when she struck an Irani-laid mine in international waters is yet another case in point.

The United States has recently announced that U.S. Navy warships and military aircraft are prepared to respond to calls for assistance by ships of other neutral powers that come under unlawful attack in the Persian Gulf. That policy of distress assistance, is, in my view, wholly consistent with the tradition of all mariners to render assistance to persons in danger of being lost at sea, a tradition reflected in the 1982 Law of the Sea Convention not as a right, but a duty. The below is an excerpt from a description of this policy provided in a memorandum for correspondents by Secretary of Defense Frank C. Carlucci on April 29, 1988. Secretary Carlucci stated,

> The President has decided to provide assistance under certain circumstances to ships in distress in the Persian Gulf and Straits of Hormuz in keeping with longstanding, time honored Navy and maritime tradition. Such aid will be provided to friendly, innocent neutral vessels flying a non-belligerent flag, outside declared war/exclusion zones, that are not carrying contraband or resisting legitimate visit and search by a Persian Gulf belligerent. Following a request from the vessel under attack, assistance will be rendered by a U.S. warship or aircraft if this unit is in the vicinity and its mission permits rendering such assistance. ..
>
> We are not the policemen of the Gulf, nor do we wish to be. For over 200 years U.S. policy has been to help protect freedom of navigation in international waters. This assistance is a logical and humanitarian outgrowth of recent events in the Gulf which further strengthens our adherence to this principle. We cannot stand by and watch innocent people be killed or maimed by malicious, lawless actions when we have the means to assist, and perhaps prevent them. ....
>
> With regard to mines, I have consulted with our allies.... We [are] agreed that we should provide each other mutual support and cooperation in the interest of keeping international waterways free from this threat.
>
> Finally, this policy should not be construed as a tilt in either direction in the war. Our policy has been and will continue to be one of strict neutrality. ....

It should be readily apparent that this policy statement was carefully crafted to reflect a strong commitment to preservation of the freedoms of navigation and overflight reflected in the 1982 Law of the Sea Convention but to avoid any abandonment on the part of the United States of its obligations as a neutral power. The thrust of the policy is clearly humanitarian. (I have had the opportunity to talk to our commanders returning from the Gulf and it is clear that they, as pro-

fessional mariners and naval officers, take this obligation very, very seriously.) The policy also respects the right of the belligerents under the law of armed conflict to interdict, through proper means, the flow of contraband to their enemy, even if that flow is in neutral bottoms. Consequently, assistance will not be extended to vessels carrying contraband or resisting legitimate visit and search. Nor will U.S. naval units extend their assistance to vessels that have, for whatever reason, chosen to steam within Iraqi- or Iranian- declared war/exclusion zones.[6] Again, what the United States Navy is about in the Persian Gulf is the protection from unlawful attack of innocent neutral shipping engaged in the freedoms of navigation as reflected in customary and conventional international law. Article 51 of the Charter of the United Nations provides that nothing in the Charter shall impair the inherent right of self-defense of member nations. It is upon this basis that the United States and other affected maritime powers are responding to unlawful armed attacks in the Persian Gulf.

In closing, I would like us to bear in mind as we go about our important business at this year's Annual Conference of the Law of the Sea Institute, and as we examine exciting new developments in marine science and technology, that the lives of countless mariners, both civilian and military, are in continuing jeopardy in the Persian Gulf. Those seamen, be they British, Indian, Filipino, Dutch, American or nationals of any one of the scores of other nations who have put themselves in harm's way in the exercise of the freedoms of navigation in the Gulf, are quite literally on the cutting edge not only of the law of neutrality, but of the law of the sea as well. They warrant our admiration and they most certainly deserve our support.

NOTES

1. Grunawalt, "United States Policy on International Straits", *Ocean Development and International Law*, Vol. 18, No. 4, pp. 445-458 (1987).
2. Rousseau, *Droit International Public* (1953), at 700-701, cited in Whiteman, *Digest of International Law*, Vol. 11, p. 139.
3. This has been the consistent position of the United States and, while it was not always universally recognized (see Tucker, *The Law of War and Neutrality at Sea*, U.S. Naval War College, International Law Studies, 1955 at 334), has come to be generally accepted.
4. Hague Convention VIII of 1907 Relative to the Laying of Automatic Contact Mines, 36 Stat. 2332; T.S. No. 541; Bevans 669.
5. The *Iran Ajr* was seized by U.S. naval forces on September 21, 1987. Captured Iranian sailors were subsequently repatriated through the Red Crescent Society. The ship itself was scuttled.
6. So-called "war zones" or "exclusion zones" have been utilized for a variety of purposes by belligerents in the two World Wars and since. Whether, and to what extent, a belligerent may purport to place restrictions on neutral shipping in portions of the high seas is unsettled. *See* Tucker, 296-301. However, neither the Iraqi- nor Iranian-declared zones lies astride sea lines of communication to or from neutral ports. Shipping within the two zones may therefore reasonably be assumed to be bound to or from belligerent waters. Reference to the zones in Secretary Carlucci's statement is not intended as a recognition of their legal viability but as a convenient and understood demarkation between neutral shipping serving neutral ports and those with belligerent ports of call.

Burdick Brittin: I have two brief comments; the first one is to Professor Grunawalt. In his commentary about the law governing naval warfare, he indicates that our future is dictated by the degree with which the world clearly abides with the rules of naval warfare. About 2,000 years ago, the Roman emperor Antonius, while not very skillful, did have this one perception and I think it fits into what you were saying. It is simply this:

I am the master of the earth. But the law is the mistress of the sea.

Dr. Behnam, you mentioned the problem of extradition for people involved in piracy and terrorism. Just two months ago the IMO completed work on a convention dealing with unlawful acts at sea. One of the major elements in the convention is the operative articles on extradition of people who have conducted unlawful acts at sea.

Awni Behnam: Yes, I am aware of that. I was talking on maritime fraud in its economic and commercial aspects which are not acts of piracy. Such economic and commercial maritime fraud might lead to scuttling of a vessel. In this case, the question of extradition may not be fully covered by the IMO Convention.

Burdick Brittin: If you look to the definition of the kinds of crimes they are considering, I think it is Article 3 of that IMO convention that covers a lot of what you are talking about, as defined; none can be confused with piracy and/or barratry.

Unknown male: I have a question for Dr. Gold. You mentioned at the beginning of the talk that the world shipping industry is experiencing a slow and weak recovery. Is it a very general recovery or is a certain part of the shipping industry recovering faster than the other parts? And, what is the evidence of the recovery?

Edgar Gold: The evidence at this particular stage is not very clear. There is still, as I mentioned, a boom in the passenger shipping industry. There is a leveling off in the container industry, but container technology is continually advancing. We are already in the third generation of the container ship and the fourth generation is now on the building blocks in some parts of the world, so there is adjustment there. There is some evidence that there is recovery in the bulk trade but only in specific commodity areas. The bulk trade, to a great extent, has always depended very much on the food-grain exports, and to some extent also dependent on famines or shortages in parts of the world. This was always a problem, for example, in China, India, and the Soviet Union. Those countries have all made considerable advances in their agricultural policies and there have been fewer food shortages there in recent years.

Because of the general industrial slump in the world there has been very slow recovery in the area of ores because of lack of steel production in the world. There seems to be an increase in coal exports, mainly because of the energy crisis, which sent the world back to coal as a fossil fuel. Now some of those power stations which were conceived at that particular time are now coming on line. So now despite the fact

that the other fuel prices are lower, these power stations are now dependent on coal. It is very much a sectoral thing. Did I overstate the facts of this recovery, Alastair?

Alastair Couper: No, I don't think so, though I think it is reflected in the freight rates. There is a very substantial increase in the last few weeks. They fluctuate as they go up, but they are going up. I think the worry of the shipping industry is that this will result in new orders for ships. There are great pressures in certain countries for people to order ships because of the political importance to them of the ship-building industry, and therefore, subsidies and support will be given. But I think Edgar's summary was very accurate.

Unknown speaker: I have a question for Dr. Grunawalt. You referred a number of times to the 1982 Law of the Sea Convention. Of course, the United States has decided, at least for the moment, not to sign or ratify that convention. My understanding of international law is that a country that is not party to a treaty cannot call on other countries, even those that are parties to the treaty, to abide by its provisions. Do you regard that it is in the U.S. interest to continue to stay out of the Law of the Sea Convention?

Jack Grunawalt: Of course, as we are all aware, the 1982 Convention is not now in effect. I think it is certainly in the United States' interest to regard the navigational articles as being reflective of the current state of the law, and to abide by it, and that basically is the U.S. policy and practice. With respect to eventual U.S. ratification of the 1982 Convention, if and when it ever does come into effect, obviously that is a very advantagous result in my view, from a navigational perspective. But, of course, as you are well aware, the U.S. has continuing problems with the deep seabed regime, and the political nuances associated with that are beyond my ken.

I certainly feel that it behooves all of us to utilize the navigational articles as the clear blueprint for our conduct. I think it behooves all of us to do what we can to bring the domestic legislation of our respective countries into compliance with that balance of interests that is reflected in the 1982 Convention.

I think in some sense then, you might argue that whether or not the Convention itself ever comes into formal effect may be largely irrelevant. Even if it came into full force and effect, it is still the practice of nations that will determine whether we have a viable regime or not. Not signatures on a line. I am much more interested in seeing the progress in the practice of nations as they bring their domestic legislation and their practices at sea into compliance with that balance within the navigational articles. To me that's a lot more interesting and important than focusing on the latest countdown of ratifications.

Unknown speaker: My question is directed to Mr. Behnam. Coming from UNCTAD, should there be an appeal for international cooperation, and the question of transfer of technology, investment or so on?

Awni Behnam: That's a difficult question to answer but I suppose that we can continue to have faith in the interest of the international community to cooperate. I think the realization will dawn that the future of the north is in the south, that the markets of the north are in the south,

and that the growth and development of the south is the interest of the north. I assure you that with that realization sinking in something will move.

And here, in shipping, we have seen there is a very direct link, in the sense that any benefit that happens to an operator would cut across boundaries. It doesn't happen to benefit just someone operating from the south and operating from the north. A ship from the north carries the trade of the south. When it comes in at the port in the south, the ship owner of the north benefits if the port in the south is in a position to assist it to turn around quickly. So there is mutual interest there, and hope that this could also be the motivation.

David Larson: My question is for Jack Grunawalt. Between March 1941 and December 1941, we provided limited convoy for lend lease and other materials going to Europe. We characterized that behavior as nonbelligerency, not neutrality, nonbelligerency. And, having recently heard an Iranian discuss our naval presence in the Persian Gulf which he feels decidedly tilts against Iran, I'm just wondering, might nonbelligerency be a more appropriate characterization of our role in the Persian Gulf, as well as protecting neutral ships, neutral goods, etc.?

Jack Grunawalt: Dave, I don't agree with that for a variety of reasons. I think that from a very practical deckplate point of view for a naval officer, it's confusing enough to figure out who are the belligerents and who are the neutrals without throwing in another category called "nonbelligerents" to clutter up his radar scopes. But, in direct answer to you, I prefer the thesis that Professor Tucker has advanced and that is to recognize that there has been a practice among neutral nations during the two world wars of not adhering that closely to their responsibility under the law with respect to impartiality. But that does not necessarily render them non-neutral, although the practice they are engaged in may become nonprotected.

As a matter of fact, sitting up in the back of the room is Commander Frank Russo of the Naval War College who has just written a paper on that topic which I think you would find very interesting. I don't have a real answer for you because there are a lot of differences of opinion, but from a practical point of view, I don't see too much utility in getting off into this fuzzy area of nonbelligerency as opposed to neutrality. I'm just not sure it helps.

New Developments and Impacts of Ocean Remote Sensing

D. James Baker
Joint Oceanographic Institutions, Inc.
Washington, D.C.

Oceanographers have always known the difficulty of making measurements *in situ*. Waves, currents and various biological elements always conspire against successful measurement from ship or buoy. Typically we spend a long time collecting a small precise set of data, then study that for a long time. But now with a growing interest in understanding global processes at work we have a different problem -- that of trying to use such measurements to construct a global view. As we look to problems of increasing carbon dioxide, acid rain, and other such processes, we see that we need to have measurements on a global scale. We need global measurements and averaging techniques. And we need to recognize that all disciplines are important.

What is the solution? We have and are developing averaging techniques: chemical tracers and acoustic tomography are good examples, and sea level itself is an average of large-scale processes. But I would like to focus on another solution that is new on the scene: satellites. The data is, on the whole, less accurate than traditional ground measurements, but the relative loss of precision is more than made up by the improved sampling grid. This is like the conductivity-temperature-depth (CTD) instrument that gives a continuous measure of temperature and salinity with depth -- less accurate than a cast of Nansen bottles, but much more data.

With satellites today we are on the verge of a new age for ocean measurements. Operational satellites are in place for weather prediction, and are provided by several countries: U.S., Japan, Europe, the Soviet Union, and India. These are also useful for ocean measurements. A good example is the measurement of sea surface temperature.

Research satellites developed since 1978 (Seasat and Nimbus-7) have led to a new generation of satellite measurements. We are poised at the beginning of a new era that began with Seasat, Nimbus-7, and the early Polar orbiting satellites. Today, in addition to the Polar and geostationary meteorological satellites operated in the U.S. by NOAA and the Department of Defense, there are a number of other satellites that give useful ocean data. We have the U.S. Navy's Geosat, The French Space Agency's SPOT, the U.S. Landsat, various USSR satellites, and the Japanese Marine Observation Satellite (also known as Peach Blossom).

We can look forward to the European Space Agency's ERS-1, The Japanese JERS-1 and Advanced Earth Observations Satellite (ADEOS), the joint U.S./France mission TOPEX/POSEIDON, the Canadian Radarsat, and others to come. Combining this with global positioning, navigation, communciation, and search and rescue, it is clear that we are in the satellite age.

The international aspect is highly significant today. It is generally recognized around the world that satellite measurements are the key to describing and understanding the ocean. Both Japan and the European Space Agency will be major players in earth-looking satellites in the future. The growth of the ability of countries around the world to make satellite measurements is a major factor in the development of

this powerful technique, and one that will require us to maximize use of our international coordination mechanisms.

A good example of this is the recent French gravity experiment that flew on a Chinese satellite. The offer of the Soviet Union to sell land remote sensing data to the U.S. of higher quality than the U.S. can collect itself, should lead to major reconsideration of the U.S. position on Landsat, for example.

What have we learned, and where are we going? The scatterometer on Seasat showed that by measuring back-scattered radar pulses it was possible to determine certain wave characteristics which are reasonably unambiguously related to surface wind speed and direction. We have from those data the first global synoptic maps of surface winds.

The altimeter on Seasat showed that by measuring the travel time of radar pulses it was possible to determine the shape or topography of ocean and land; the sea surface topography is related to bottom topography and to gravity as well as to waves and currents. Repeat passes of the altimeter were used to determine variability of the ocean; in the Antarctic, changes in sea surface height were used to determine kinetic energy. The comparison with *in situ* measurements by drifting buoys is reasonably good.

An altimeter satellite flying today is the U.S. Navy's Geosat, launched in March 1985 to map the marine geoid with a resolution of 10 km. That mission is complete, but the satellite continues to fly a 17-day repeat orbit which began in October 1986. It is likely that a data set for more than two years will be available. Orbit accuracies are expected to be on the order of 1 to 2 meters, but changes should be more accurate than that.

The results of Cheney and others show that the altimeter measurements are in good agreement with the sea level changes observed at the equator in the Pacific. Sea level change is a typical part of El Nino; thus altimeters may be an important component of an El Nino warning system.

The success of the Seasat altimeter and scatterometer led to the development of a precision altimeter mission, the joint U.S./France TOPEX/POSEIDON, scheduled to fly in mid-1991, and to the development of a new scatterometer. The altimeter mission will have a precision of a few centimeters, by careful design and accurate measurement of the orbit and the correcting factors of the ionosphere, drag, and water vapor.

With the precision altimeter, we have for the first time an opportunity to measure the general circulation of the ocean. With the new scatterometers, both U.S. and European (ERS-1), we will have the major driving force for the ocean. These two measurements form the core of the design for the new World Ocean Circulation Experiment.

The measurement of ocean color is another powerful tool for understanding physical and biological processes in the ocean. The multi-wavelength passive radiometer carried on Nimbus-8, the Scanning Multichannel Microwave Radiometer (SMMR), has given some very tantalizing views of both regional and global phenomena. But difficulties in dealing with such a large data base have meant that it is only recently that we are seeing the results from this satellite, which provided data from 1978 to 1986.

There are a variety of interesting phenomena that can be observed with ocean color. For example, data have been collected that show the northern extent of anchovy spawning off the California coast, and the correlation with chlorophyll concentration. Ocean color has also been used to determine flow patterns and biological productivity in various

regions around the world. Examples include measurements off the east coast of South America showing the highly productive Rio de la Plata and upwelling regions off the coast in 1978. A productive region being brought out to sea by southward flowing currents off Honshu, Japan in 1981 can also be seen. The seasonal change in color in the Gulf of California, with an evident spring bloom, and plumes of chlorophyll-rich water on the seaward side of Baja, California have also been observed.

On a larger scale, there are dramatic examples of the chlorophyll-rich continental shelf waters off the U.S. east coast contrasted with less productive off-shore water. Gulf Stream rings have been observed. These measurements were the first synoptic view of the Gulf Stream and its eddies and showed how they form, how long they last, and where they go during their lifetime.

On the practical side, satellite sea surface temperature data are the major source of information used in preparing eddy forecasts for offshore oil exploration and production. The utility of thermal-infrared sea surface temperature measurements deteriorates seriously in the summer in the Gulf of Mexico and generally in the tropical oceans. During these months the surface conditions are relatively isothermal, and humid atmospheric conditions cause attenuation of the thermal bands.

Sea surface temperature measurements show only the northern boundary of the Loop current in the northeastern Gulf. In contrast, the color image shows more features: the continuous boundary of the loop current can be seen as it enters through the Yucatan Channel and meanders to its eastern extent. Eddies can be observed in the western Gulf, and mixing can be seen in the frontal regions off the U.S. coast.

The recent widespread distribution of ocean color data has stimulated ambitious plans for large-scale studies in the 1990s. For example, a Joint Global Ocean Flux Study is proposed to better quantify the ocean's role in the global carbon cycle and other major biogeochemical cycles. Such cycles include the emission of dimethyl sulfide from phytoplankton metabolism, a major source of radiatively important gas in the southern hemisphere. The ocean color data are the only global measure of ocean biota that can be obtained within a relatively short period (days).

Important data for planning here includes the composite Coastal Zone Color Scanner images from Nimbus-7 showing the distribution of chlorophyll in the global oceans during December 1981. This image makes equatorial upwelling regions in the Pacific and Atlantic extremely clear. With a time series of such data, we could begin to move the field of oceanography toward a new global perspective on the couplings between atmosphere and ocean and the special role of phytoplankton primary production in the biogeochemical cycles. This will be an important part of the new International Geosphere-Biosphere Program to understand global environmental change.

Not all the satellites we need are yet approved. One of the important areas is the earth's gravity field, where an independent geoid measurement is required if we are ever to determine mean circulation from sea surface topography measurements. The mean circulation is the difference between the actual sea surface shape and the level surface, or the geoid. The U.S. and France are jointly considering a mission based on flying a proof mass inside a satellite, but no mission is approved as yet.

A second area is that of precipitation over the ocean -- fresh water flux can drive the circulation, yet we have only very sparse data. A new Tropical Rainfall Measurement Mission, based on microwave measurements

of precipitable water, is also in the planning stages, but is not yet approved. This is a crucial set of data for understanding monsoonal and El Nino-Southern Oscillation processes.

To recap with the schedules, we stand today at the beginning of a revolutionary new age, where many countries will have a major stake.

Yet the new data brings a problem because there is so much of it. We find general agreement that ocean users are neither prepared nor equipped for the influx of remotely sensed data. This is a fact around the world, but the picture is not bleak; there is a solution. Computers blend traditional, precise but undersampled observations with the new, less precise data, and do it objectively. The fact is that the cost of computers and data management equipment is going down exponentially (35 percent/year).

There is a ten-fold improvement every seven years. For example, the IBM 370 sold for $1 million in 1980 and will cost about $1,000 in 1991. IBM 360 is coming down to the cost of a pocket calculator; today's Cray-2 is tomorrow's desk calculator. Workstations (32-bit) that provide mainframe computing power for individuals have become almost commonplace. The costs today are coming down to a price level that is beginning to compete with the more expensive PCs.

At the same time, we see a dramatic increase in performance. Processor speed and memory are expected to increase rapidly by the end of the century. The first generation workstations are now being superseded. Next is a 10x-improved processor, memory, and display -- 10x by 1993 with CMOS or gallium assembler, moving images in real time; by the year 2000, it will be $15,000.

Thus we have the tools. Several countries will have the capabilities to be in the business of satellite measurements in the 1990s, and the computing technology will be available. But will we use it? The question is one of institutions, resources, and education. Our international coordination mechanisms will be stretched with national issues of priorities, security, and data exchange. The costs of these new facilities is high, and this means that marine priorities complete with other priorities. A strong educational effort is called for. We need to develop priorities, and then to ensure that we meet this challenge of the new opportunities ti describe, understand, predict, and sensibly use our environment.

TABLE 1: Satellite Mission Periods

Satellite(a)	Date: 1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
NIMBUS-7	==========	==========	==========	==========	==========	==========	==========	==========										
SEASAT	=====																	
TIROS-N/NOAA	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
LANDSAT	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
GOES	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
DMSP	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
GEOSAT							==========	==========										
SPOT (F)							==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========	==========
IRS-1 (I)								==========	==========	==========	==========	==========	==========					
MOS-1 (J)								==========	==========	==========	==========	==========	==========					
ERS-1 (E)										==========	==========	==========	==========	==========	==========	==========	==========	==========
TOPEX/POSEIDON													==========	==========	==========	==========	==========	==========
RADARSAT (C)														==========	==========	==========	==========	==========
GRM														==========				
ERS-1 (J)														==========	==========	==========	==========	==========
Polar Platform														==========	==========	==========	==========	==========

(a)Blank -- U.S.: (I) -- India: (J) -- Japan: (E) -- European Space Agency: (F) -- France: (C) -- Canada.

COMMENTARY

Ralph Chipman
Outer Space Affairs Division
United Nations, New York

I strongly agree with Dr. Baker's observations on the potential of satellite remote sensing for ocean observation, and I believe that the prospects arising from the plans now being developed for new systems are very exciting. However, I think we need to be aware of the problems that will arise from the vast quantity of new data that will be generated and what can happen if these data are not effectively used. It is not yet clear what the actual applications of these new systems will be.

We have seen very exciting data from past ocean remote sensing satellites such as Seasat and Nimbus, but these data have been used almost entirely for research; the operational uses are still largely undeveloped. I believe that this situation poses certain problems that are going to have to be dealt with if satellite remote sensing for ocean applications is going to meet its potential. There are two questions that I would like to raise here: one relates to the economics of satellite remote sensing on a broad scale and the other to the applications and to international co-operation for global observations.

If the data from the planned ocean observation satellites are not used effectively and do not generate results - idealy operational results - there may be a loss of political support for the satellites and hence a loss of funding for follow-on systems. There has been a move, in recent years, in the United States and in other countries towards a commercialization of space activities, towards an expectation that these activities are self-financing. This has been particularly true with respect to land remote sensing satellites.

Remote sensing satellites cost several hundred million dollars to build, launch, and operate. An on-going system, given a lifetime of several years per satellite, will cost about $100 million a year to build, maintain, and operate. To provide that level of funding in the long term, governments will want to see results - that is, demonstrations of economic benefits - that will justify the expenditure of $100 million dollars a year. While this is a fairly modest sum for operational resource management and development programs with generally recognized benefits, it is becoming more and more difficult to obtain such sums for research programs.

The problems in obtaining funding for satellite remote sensing programs are illustrated by the Landsat program, which, as I have indicated, costs about $100 million per year to maintain and operate. Under the current policy of trying to commercialize the program, i.e., to make it financially self-supporting, sales of data have run about $10 million per year. There are, clearly, no prospects for the system becoming self-supporting in the foreseeable future. Dr. Baker noted that the Landsat system is supposed to continue in operation until 1995, and while that is true in theory, the debates about commercialization have blocked continuing funding so that there will inevitably be a gap between the end of operations of the current Landsat satellites and the launch of the next satellites in the series, which will still be government-funded. I believe that the financial situation of ocean remote

sensing satellites will be reasonably similar to that of land remote sensing satellites.

An alternative model for the financing of ocean observation satellites is provided by meterological satellites, such as the United States polar-orbiting NOAA satellites and the geostationary GOES satellites. These satellites, along with similar satellites launched and operated by the Soviet Union, the European Space Agency, Japan, and India, form a coordinated, global, operational system for satellite weather observations. Each satellite is funded, owned, operated and controlled by the launching country. By general agreement, the data rare made available free of charge to anyone who wants to use it. The system, therefore, constitutes a sort of international cost-sharing, with a number of countries sharing the cost and all countries enjoying the benefits of the entire system.

There seems to be general acceptance of the fact that meteorological data are useful to everyone, but that it cannot be funded on a commercial basis, that is from the sales of those data. The more people who use the data, the greater the benefit, without any added cost to the sytem from the additional users. The system is, therefore, most economic when it is funded by society as a whole - i.e., through taxes - with the data available at the minimum cost possible. This seems to be the only viable way for oceanographic satellite remote sensing to develop.

Thus, government funding and international cooperation will both be essential to the development of ocean remote sensing. A number of international cooperative plans are currently under development, including the French-U.S. Topex-Poseidon mission and the ERS-1 satellite of the ten-member European Space Agency, which I understand will cost about $400 million to develop, launch, and operate. Japan recently launched the Marine Observation Satellite (MOS) and Canada is developing its Radarsat satellite. All of these systems will have ocean observations as a primary mission.

Ocean observations are an ideal field for international cooperation. Satellite orbits, by their nature, cover the entire world, and much ocean data is of interest to a number of countries. Certainly one of the most exciting developments in space observation in recent years has been the monitoring of global climatic factors, such as the ozone layer, the greenhouse effect and related phenomena, many relating to oceanography. Monitoring and understanding these phenomena and their causes and relationships may be vitally important in the coming decades. International cooperation will be essential both in monitoring the climate and in taking action to control harmful anthropogenic changes. And yet it is not clear that these programs will receive the political and financial support that they need and deserve.

Satellite systems for ocean remote sensing do not yet have the sort of international coordination that exists for satellite meteorology. The various systems are quite different and will require different receiving and processing systems. Considering that satellite ocean observations are still in the research process, it is probably too early to try to standardize the systems, but oceanographic agencies in different countries might be wise to begin considering ways to make their systems as compatible as possible and to coordinate systems to provide maximum results for the available money. In fact, such coordination is already going on between the space agencies developing the new satellite systems. My point here is simply to emphasize the importance of that process and the importance of users of oceanographic data participating in that process.

International cooperation is not only financially advantageous, but it may be operationally essential in certain cases. While some remote sensing satellites have tape recorders on-board for recording data for later transmission to a ground station, other satellites must transmit data to ground stations as it is collected by the sensor. Satellites in the most commonly-used orbits can transmit directly to a ground station over an area about 2,500 km. in diameter around the ground station. In the absence of on-board recording systems, it may be impossible to get any data for parts of the world where there are no ground stations. Even when satellites have on-board recording systems, those systems often have limited capacity and are prone to failure. An international network of ground stations, therefore, provides the best method for ensuring global collection of satellite data. International coordination of the design of satellite sensors and transmission systems will help to ensure that the ground stations can be used in the most economical and effective manner.

As Dr. Baker mentioned, some of the planned ocean observation satellites are civilian satellites while others are military ones. In the past, the civilian space program has been considerably larger than the military programs, but in the last five years or so, the military space budgets have been growing much faster than civilian space budgets. Obtaining access to data from military satellites may be another strategy for ensuring adequate and continuing sources of satellite ocean data.

Another limitation on satellite remote sensing has been space policies that emphasize large space projects such as moon landings, shuttle development, and manned space stations. These big programs have greater public visibility and often more political appeal, but they tend to take funds away from smaller applications projects which produce more useful results.

To establish and maintain a continuing program of satellite ocean observations in the present economic climate it is essential to collect the most data at the least cost and to insure that these data are used to generate the maximum possible results. It is also essential that, in addition to the scientific research, work be done on commercial applications where there are direct and immediate economic benefits, including such areas as fisheries or ship routing. It is these direct economic benefits that can often convince politicians to provide funding necessary for maintaining the systems.

Finally, I might mention that the United Nations has been active in developing an international legal and political framework in which international satellite remote sensing can take place in a cooperative and harmonious manner. In 1986, after many years of negotiations, the United Nations Committee on the Peaceful Uses of Outer Space reached agreement on international principles for remote sensing. The developing countries and socialist countries had been very concerned about the use of remote sensing to their detriment. This was primarily, of course, referring to land remote sensing, but to a certain extent also applied to coastal and marine remote sensing. The 1986 agreement provided that there should be a freedom to collect such data on a global basis and that all countries would be guaranteed right of access to the data collected over their territory. While this agreement perhaps merely formalizes what was already being practiced, I believe that it provides a solid basis for a large-scale, continuing, cooperative, global ocean remote sensing effort that will benefit everyone.

Subseabed Disposal of High-Level Radioactive Wastes; Transition from a Hare-Brained Idea to a Feasible Technology

Kenneth R. Hinga
Marine Ecosystems Research Laboratory
University of Rhode Island

Introduction

One of the environmental problems the world faces is the disposal of high-level radioactive wastes produced in nuclear power plants.[1] Twenty-six nations presently utilize nuclear power for generation of electricity and some have plans for continued expansion (*Table 1*). However, the need to develop permanent repositories for high-level radioactive wastes does not depend on the future of nuclear power. Current inventories of wastes are already sufficient to pose a serious human health hazard if permanent repositories are not eventually found. From an environmental protection perspective, one may be concerned that some of the nations listed in *Table 1* may not have appropriate geology, the fiscal resolve, or environmental conscience necessary to individually develop their own domestic repositories.

Since the advent of nuclear power, the nuclear industry and governmental agencies have assumed that high-level wastes could be safely disposed of by burial in appropriate land-based mined repositories. In spite of the continued reassurances from agencies and industry, development, proof of safety, and siting of a repository have proven to be formidable tasks. One may suspect that the task has been made difficult by stiffening safety standards, local political opposition, proper or improper public perceptions, scientific and technical inadequacies, mismanagement, etc. Regardless of the causes, it is clear that the development of a high-level waste repository will not be an easy or inexpensive task for any nation. In the U.S., for example, many hundreds of million dollars have been spent on repository research and development each year for the last decade. One may easily worry that all nuclear nations may not have the fiscal resolve and the technical capacity to develop repositories that would be judged safe globally.

In the early 1970s the concept of burial of high-level wastes in selected geologic formations beneath the deep-ocean floor was introduced as an alternative to mined repositories. The areas of the oceans thought most likely to yield suitable sites are under international waters, so the subseabed option offers the potential for multinational or international repository. However, implementation of this novel concept would probably require new agreements, or at least clarifications of existing agreements between nations.

Before any major effort is expended to develop an international framework for the regulation of subseabed disposal, the concept must show sufficient merit to justify such effort. When the concept was first addressed in the mid-1970s it was clear that existing knowledge of nearly all relevant aspects of marine science and engineering were inadequate to provide an authoritative evaluation of the concept.[2] A great deal of work would be necessary to determine the feasibility of the concept and, if feasible, to develop the technical capability to operate a subseabed repository. For many years, the rationale for research, into what appeared to many a contrary and hare-brained idea, centered around arguments of geological stability and very low probabil-

ity of accidental intrusion into a subseabed repository.[3] The actual risks which would result from a repository, the methods of emplacement, and proof of the geological stability all had yet to be shown. This paper provides a brief look at the results of the 15 years of subseabed research.

TABLE 1

World Nuclear Power (as of December 31, 1987)

	Operating Reactors	Capacity MWe	Under construction or planned >50% complete	<50% complete
Argentina	2	935	1	
Belgium	8	5488		
Brazil	1	626		2
Bulgaria	5	2585		3
Canada	18	12064	2	2
P.R. China			1	2
Cuba			1	1
Czechoslovakia	8	3207	2	5
Finland	4	2310		
France	53	49378	10	3
German D.R.	5	1694	3	3
F.R. Germany	21	18885	2	3
Hungary	4	1645		2
India	6	1154	2	6
Italy	3	1273	2	3
Japan	36	26877	5	10
R. Korea	7	5380	2	2
Mexico			1	1
Netherlands	2	507		
Pakistan	1	125		
Philippines			1	
Poland				6
Rumania			1	5
South Africa	2	1842		
Spain	8	5599	7	3
Sweden	12	9646		
Switzerland	5	2932		
Taiwan	6	4918		
United Kingdom	38	10214	4	
United States	106	92982	19	3
U.S.S.R.	54	31966	21	3
Yugoslavia	1	632		

SOURCES:

Number of operating reactors and capacity are from International Atomic Energy Agency statistics cited in *Nuclear News*, 1988, V.31 (No. 3) p. 86.

The number of reactors under construction are from World List of Nuclear Power Plants in *Nuclear News*, 1988, V.31 (No. 2) p. 63-82.

Where the percent of construction completed was not listed, reactors with completion dates in or before 1990 were counted as 50% complete.

The Seabed Disposal Concept

Subseabed disposal, like mined repositories, is a geologic disposal option. The geological formations being considered for subseabed disposal, however, are overlaid by a few kilometers of seawater and have somewhat different physical properties than media considered for mined repositories. Wastes[4] would be incorporated into a solid form and placed in durable packages. The waste packages would then be buried in selected deep-ocean floor sediments.

The waste packages would be transported to a site or sites with 4,000 to 6,000 meters of water depth. Methods of land and sea transportation would be similar to those in use today. Packages would be implanted about 50 meters into the sediments if a penetrator were used. Penetrators weighing a few tons would be positioned above the desired burial location, then allowed to fall through the water to gain sufficient momentum to imbed themselves into the sediments to required depths. Penetrators would be placed about 200 meters from each other. At that spacing, a repository capable of accepting wastes for 11 years at the current world production capacity would only require an area of about 500 square kilometers.

Wastes could also be implanted using drilling equipment based on that in use in the deep ocean for about 20 years. By this method, stacks of waste-filled packages would be placed with the uppermost package about 300 meters below the ocean floor.

The waste package would protect and contain the wastes during transportation and emplacement operations, and for a minimum of about 1,000 years after emplacement. Long term containment, for many thousands of years, would be provided by the barrier properties of the sediment.

Sites would be chosen for the ability of their sediment formations to contain radionuclides after the waste package fails. Suitable sediments would be made up of very fine-grained particles with the ability to adsorb and impede the movement of most waste radionuclides. Sites need to be free from erosion which could uncover the waste packages during the repository lifetime. Sites would be located away from the edges of tectonic plates where seismic or volcanic movements could disrupt a repository and expose the waste packages. Sites would also be located away from continental margins to avoid areas containing potential mineral and biological resources and away from areas of active pore water migration which would speed the movement of radionuclides through sediments.

Subseabed Disposal Research Programs

Research in the U.S. to determine the feasibility of subseabed burial of high-level waste has been managed since its inception in 1973 by Sandia National Laboratories. The Subseabed Disposal Project (SDP) was initially funded through the Atomic Energy Commission, then through the Energy Research and Development Administration, and the Department of Energy. Most of the research has been conducted by scientists at universities, oceanographic institutions, and other laboratories. A major computational effort, and parts of the research, have been conducted at Sandia National Laboratories. Seagoing research sponsored by the SDP has usually been conducted by charter of university- or oceanographic-institute-operated research vessels. Funding for the SDP has generally been between five and ten million dollars per year which is about one percent of DOE expenditures for mined repository research and development.

The SDP has practiced a number of policies to promote the quality and credibility of the research.[5] A wide participation of scientists drawn from the oceanographic community has been encouraged. This has been accomplished both by selection of researchers outside the nuclear development community, and by invitation of non-SDP scientists to participate in workshops to plan and review the research. As far as possible, university principal investigators were funded to a maximum one-third of their annual research support. This approach was intended to help assure that scientists would remain willing to identify possible problem areas which could disqualify the concept. Project scientists were strongly encouraged to publish the results of their research in peer-reviewed journals of their respective fields and to present their research at professional meetings. In addition, many program scientists have presented overviews of the subseabed concept and research at scientific meetings and given briefings to interested organizations.

In 1975 the Radioactive Waste Management Committee of the Organization for Economic Cooperation and Development's Nuclear Energy Agency decided that a workshop should be organized to determine the interest, nature, and scope of possible international cooperative activities in the field investigation of waste disposal options. A workshop was held in 1976 to consider disposal of reprocessed high-level radioactive wastes or spent fuel in geological formations beneath the ocean floors. Based on that workshop, and subsequent interest, the Seabed Working Group (SWG) was formed. The SWG is hosted by the Nuclear Energy Agency. SWG membership is limited to countries conducting research on seabed disposal.

The objective of the SWG is to provide scientific and technical information to enable international and national authorities to assess the long term safety and engineering feasibility of seabed disposal.[6] To this end, members have used the SWG to promote information exchange, coordinate research efforts, and facilitate cooperative research. The membership of the SWG has grown from four nations in 1977 to ten, plus the Commission of European Communities, in 1987 (*Table 2*).

The SWG has been organized into a series of task groups, each addressing an area of study pertinent to evaluation of seabed disposal. Task group members are scientists and engineers conducting active research programs. Each individual's participation is funded by his or her national research program.

Each task group outlined the objectives and necessary research in its respective scientific and engineering discipline to complete a comprehensive feasibility assessment. The Executive Committee responded to financial requests from the task groups through commitments to individual national programs. In 1983 a 5-year plan was drawn, that with sufficient support would have completed a thorough feasibility assessment, and was adopted by the SWG. A Coordinating Bureau was established to serve as liaison between task groups and the Executive Committee.

In 1986, the U.S. Department of Energy terminated funding for subseabed research in fiscal year 1987. This action, and independent action by a number of other SWG nations, reduced subseabed research to a near stand-still. It is fortunate however, that the timing of the action was near enough to planned major synthesis reports in the U.S. and in other SWG nations that many of these reports will be completed and should be available in the near future.[7] These reports should include an eight-volume synthesis assembled by SWG participants and published by the Nuclear Energy Agency.[8]

TABLE 2: SEABED WORKING GROUP PARTICIPATION
A -- Attended the annual meeting.
M -- SWG member.

Country	76	77[a]	78	79	80	81	82	83	84	85	86	87
Australia	A											
Belgium					A	A		A	A	A	A,M	A,M
Canada	A		A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M
CEC(b)	A		A	A	A	A,M	A,M	A,M	A,M	A,M	A,M	A,M
FRG(c)	A			A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M
France	A	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M
Italy							A	A	A	A	A,M	A,M
Japan	A	A,M	M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M
Netherlands				A	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M
Sweden										A	A	
Switzerland					A	A	A,M	A,M	A,M	A,M	A,M	M
U.K.(d)	A	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M
U.S.(e)	A	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M	A,M

(a) The Seabed Working Group was formed in 1977.
(b) The Commission of European Communities.
(c) Federal Republic of Germany.
(d) United Kingdom.
(e) United States.

In 1987 Congress expressed the intent to have subseabed research restarted.

> (4)(A) Within 60 days of the date of enactment of the Nuclear Waste Policy Amendments Act of 1987, the Secretary [of DOE] shall establish a university-based Subseabed Consortium involving leading oceanographic universities and institutions, national laboratories, and other organizations to investigate the technical and institutional feasibility of subseabed disposal.
>
> (B) The Subseabed Consortium shall develop a research plan and budget to achieve the following objectives by 1995:
>
> a. demonstrate the capacity to identify and characterize potential subseabed disposal sites;
> b. develop conceptual designs for a subseabed disposal system, including estimated costs and institutional requirements; and
> c. identify and assess the potential impacts of subseabed disposal on the human and marine environment.

Other stipulations in the Act included the creation of an Office of Subseabed Disposal Research within DOE and the preparation of a report assessing the current state of knowledge regarding subseabed disposal to be issued 270 days after the enactment of the Act. The DOE has been slow to comply but has established an Office of Subseabed Disposal Research within the Office of Energy Research and appointed an acting director to the office. Some funds were committed for FY 1988 to establish the Consortium and develop program plans.[9] However, no new funds were appropriated by Congress for FY 89 for subseabed research. Hence, the future of subseabed research by the U.S. is still very much in doubt.

Approaches Used to Assess the Feasibility of Subseabed Disposal

An evaluation of the feasibility of subseabed disposal can be divided into three questions:

1. Are there locations in the oceans which have the geologic stability and barrier properties suitable for disposal?
2. Is it possible to implant waste-filled canisters in the seabed sediments and what effect does this have on the barrier properties of the system?
3. What are the radiological consequences of subseabed disposal?

The approach to answering each of these questions is quite different. The geologic stability of a site and its overall suitability must come from an understanding of the geologic processes which have acted to create the site and of the processes which will act on the site in the future. Methods for emplacement can be directly tested using simulated waste packages. The radiological consequences of a repository must be calculated (modeled) from a compilation of the individual processes which will act on the wastes and eventually extract them from a repository.

Site Assessment Studies

The fundamental assumptions that provided an incentive for investigations into the subseabed concept were that the ocean contains areas that offered the most stable geology on earth, that deep ocean sites would be the least likely sites on earth to be disturbed by human activities, and that the sediment formations would be relatively simple

and therefore relatively easy to model. Sites where these properties co-exist with sediments having good characteristics for adsorbing radioactive wastes should be suitable for a repository. These assumptions were based on the knowledge of ocean geology as it was in the early 1970s.

The U.S. SDP and the Site Assessment Task Group of the SWG set out to see if sites with such promising features can in fact be located in the oceans. A set of evaluation guidelines and study procedures was prepared and used by the SDP and a similar set later adopted by the SWG.[10] The evaluation guidelines are a set of working assumptions which define what were thought to be desirable properties for seabed disposal. These guidelines must be considered working assumptions, since results from barrier or engineering subseabed research could indicate that some of the guidelines are unnecessary or that others should be added. The guidelines cover features including, size, seafloor slope, sediment thickness, stratigraphy, volcanism, seismicity, plate tectonics, pore water movements, radionuclide adsorption properties, oxidation state, presence of erratic boulders, sand layers, and bioturbation. The study procedures outline the techniques and studies necessary to adequately characterize a site.

The North Pacific and North Atlantic oceans have been considered. Other areas of the oceans may also yield suitable sites. Five locations in the North Pacific and ten in the North Atlantic have been evaluated (*Figures 1* and *2*). Some locations have been studied in detail, while for others only one or two reconnaissance cruises were conducted to supplement archived data.

For the last few years efforts have been concentrated on three of the most promising sites: two in the Atlantic, called the Great Meteor East and the Southern Nares Abyssal Plain, and one in the Pacific called E2. These sites have been studied by most of the study procedures, but not necessarily with the desired density of coverage or precision of measurement. Each of these sites have been mapped and studied with acoustic techniques to determine their sedimentary structures. Cores have been taken at each site to study the chemistry of the pore waters and sediments and to determine the history of sedimentation. The E2 site has been sampled by drilling to below proposed burial depths. Futher work, necessary to complete the study procedures, includes: sampling to proposed burial depths at all sites; additional studies of pore water advection; and, *in situ* measurement of sediment properties. The two Atlantic sites were used as reference sites for the radiological assessments discussed later.

Based on available data, the Site Assessment Task Group of the SWG has concluded tha the Great Meteor East and E2 sites each meet all but one of the guidelines. Some sand layers are present at Great Meteor East and a hard chert formation lies just below the expected penetrator burial depth at E2. Although both these features were considered undesirable in the original site evaluation guidelines, their actual impact on the barrier properties and suitability of the sites does not appear to be significant.

Emplacement and Engineering Studies

Program plans for the U.S. SDP assigned most engineering study and development to later phases of the project.[11] It was felt prudent to determine if emplaced wastes would be effectively isolated before developing the systems to implant the waste. However, some studies were conducted to determine if it would be possible (although not necessarily

practical) to implant wastes to sufficient burial depths. During the last few years the Engineering Studies Task Group of the SWG has greatly accelerated the evaluation of the feasibility of emplacement and of the practicality of developing systems for reliably handling and transporting wastes.

The feasibility of penetrator emplacement has been clearly shown by actual emplacement of test penetrators in deep-sea sediments. Instrumented penetrators, smaller than those which would carry waste, have been dropped into sediments under about 5000 m of water. Thirty meters of penetration was achieved with some of the penetrators, which were able to transmit data back to the ocean surface. But more importantly, the tests confirmed models developed to predict burial depths were correct (*Figure 3*). The models predict that larger penetrators could reach up to 70 meters depth in these same sediments.

Based on past experience, drilled emplacement is also thought to be possible. Although there is no commercial drilling in deep-ocean sediments (greater than about 4,000 meters of depth) due to a lack of oil reserves, scientific drilling has been conducted for the last 20 years. The scientific drill ships, the Glomar Challenger and the Sedco Resolution, have drilled in water up to 7,000 meters of depth. Routine operations include re-entry of drill holes and placement of instruments in drill holes.

A variety of modeling studies have indicated that the hole created by penetrator passage would immediately close in behind the penetrator. A preliminary verification of those models has been achieved. A number of penetrator scars have now been observed. Other than a small depression at the surface, the sediments appear to have completely resealed. Cores taken within the sediment scars and in unaffected sediments show no difference in measured properties. Drilled holes would need to be deliberately filled as part of the emplacement process.

Design studies have been conducted to see if there are any major development problems to be foreseen for seabed disposal. Ship designs, penetrator designs, and suitability of materials for disposal systems have been looked at in some detail. Very preliminary estimates indicate that the costs of subseabed disposal should be a small, less than one percent fraction of the cost of generation of the electricity which produces the waste. However, well-developed designs for a complete transportation, emplacement, and monitoring system have not been prepared.

Radiological Assessment

A high-level waste repository will need to be effective for many thousands of years to allow time for the wastes to decay. Hence the ability of a repository to contain wastes cannot be evaluated by building a model or pilot repository and in a few years testing its performance. The evaluation of any high-level repository must be based on an understanding of processes which would act on the wastes far into the future. These processes are translated into mathematical models which, when coupled together, can predict the performance of a repository. Many of the individual processes can be measured, and our ability to model them can be tested in reasonably short periods of time. Others, such as the likelihood of a seismic event in the distant future must be inferred from an understanding of geological processes which are presently acting on the site and from the history of those processes.

Confidence in an evaluation based on modeling is limited by two different factors. First, there is the uncertainty in the measured rates and properties which are used to make predictions with the models.

Second, there is the uncertainty that all-important processes may not have been included in the models.

The procedure adopted by the U.S. SDP for finding all processes critical for modeling a waste disposal option is to:

1. Assemble all known processes into mathematical models;
2. Collect the data necessary to run the models;
3. Generate predictions using each model; and,
4. Test the results of the predictions against results from field experiments, or where more appropriate, from laboratory experiments.

If the model is able accurately to predict the experimental results, it may be assumed that no other important processes need to be incorporated into that model. If, however, the results differ from model predictions, then the number of processes included in the model needs to be expanded or the data must be improved. Care must also be taken to not extrapolate models beyond the ranges over which they have been tested.

For the first decade of the SWG the major activity of the Task Groups was to identify and quantify the processes within their areas of expertise which could conceivably be important to subseabed disposal. During this period of time, the task groups also collected data necessary to model those processes. The processes considered include:

Near-field processes (in the heated zone near the canister)
- Effects of heat and radiation on the sediments and pore waters
- Canister sinking and sediment buoyancy
- Canister corrosion
- Leaching of radionuclides from the waste form
- Chemical form of leached radionuclides

Far-field processes (in sediments unaffected by waste heat)
- Radionuclide migration rate (as a function of sorption properties of each radionuclide, of pore water velocity, and oxidation state of the sediments)

Water column processes
- Ocean circulation and dispersion (small scale to global)
- Scavenging and settling with particles
- Biological processes (uptake by organisms, redistribution by organisms, and effects on organisms)

Transport from ocean to man
- Seafood harvesting
- Beach exposure, sea salt, desalinated water.

Dose models

Research on subseabed disposal has now progressed to the point where at least some experimental or observational data are available on all the above aspects of subseabed disposal. This makes possible a much more authoritative evaluation of the subseabed concept than was previously possible. However, testing the models against appropriate experimental data is a task which has only just been started. Confidence in the present evaluation of subseabed disposal is limited less by uncertainty in the magnitude of the processes included in the models, than by concern that important processes may have been missed. Although a great deal of effort has been expended to consider all relevant processes, without the rigorous testing against experimental or field data, significant doubts will persist.

Radiological assessments of subseabed disposal were conducted by a number of SWG participants including the U.S. SDP. These analyses centered around a base case which describes a subseabed repository with correctly implanted wastes. The approach used was to adapt or develop models for the sediment and ocean processes which were identified as important (in affecting the overall repository performance) through sensitivity analyses. Models of important processes were coupled with existing radiological dose models in order to permit the effects of subseabed disposal to be predicted. The list of processes which are included in the base case, or normal burial, assessment are;

1. Corrosion of the waste package,
2. Leaching of the waste,
3. Diffusion of radionuclides through sediments,
4. Transfer in the bottom boundary layer (the area near the sediment-water interface),
5. Transport and dispersion in the ocean,
6. Scavenging from ocean water by settlement of particles,
7. Resuspension of particles from the ocean floor and mixing of particles into sediments,
8. Doses for various routes including consumption of seafood, sea salt, and desalinated water and external exposure by beach occupancy.

In order to investigate the consequences of transportation accidents, the effects of uncertainties in the rates of some processes, and some geologic processes, specific processes were eliminated from or added to the base case. For example, the effects of ship accidents were studied by eliminating sediment transport. Pore water advection was added to study its effect.

There are two concerns in the execution of the radiological assessment calculations themselves. First is the possibility that the results are an artifact of the computation. This might occur by an incorrect coding of the computer programs that comprise a model. Second is the concern that the results are very sensitive to some components of the data sets. If this were the case the results could change substantially with other reasonable choices for input data.

The concern that the results are an artifact of the models themselves was addressed by the development of more than one model for each major process. Through the cooperation of the various SWG participants, the models were run using identical data sets on test problems. From this process imperfections in the models were identified so they could be corrected. In addition, two completely different modeling approaches were used; deterministic analysis and stochastic uncertainty analysis. In deterministic analyses, fixed values of data are used to predict the consequences of a given set of conditions. Four independent deterministic and one stochastic uncertainty modeling efforts were conducted by SWG participants.

The concern of the sensitivity of the results to input data was addressed in the deterministic modeling by conducting sensitivity studies for the scenarios. All parameters were simultaneously set to their potentially least or most favorable values and the models run. In the stochastic modeling, each parameter used is described not by a single value but by a range of possible values and a probability function for taking those values. The stochastic model is run hundreds to thousands of times for each scenario with the probability functions

selecting the data. The multiple runs generate a histogram, or distribution, which shows the probability of various doses.

The base case calculations described here predict the effects which would be expected from the subseabed burial of wastes produced by the present global nuclear energy production capacity operating for 11 years (3,333 reactor years). This would produce 100,000 metric tons of heavy metal. The wastes would be reprocessed, held in storage 50 years, placed in 14,667 penetrators, and buried 50 meters deep in a single Atlantic repository. Two volatile elements which would separate from the wastes during reprocessing (iodine and carbon) have been included in the calculations, since these will also need to be disposed of, although in a different waste form.

Figure 4 shows the total doses expected versus time, and the radionuclides responsible for the dose, for disposal at the Southern Nares Abyssal Plain site using a deterministic analysis. Very similar results were found using a separate deterministic analysis for Great Meteor East. The stochastic analysis also generates a histogram of the probabilities of the maximum dose (*Figure 5*). *Table 3* summarizes the maximum individual and population dose results from the SWG calculations and from two other independent studies conducted by Seabed Working Group participants. The other two studies (U.K. and PAGIS) used data bases which were compiled independently from a SWG standard data base and were not identical to those used in the SWG analyses. The maximum doses and the time at which the maximum dose will occur are all similar. The least and most favorable cases for the deterministic calculations are very similar to the maximum dose rates for the stochastic calculation.

In many cases, conservative assumptions or data were used in this assessment, so it is likely that future research will show that the consequences of the base-case, or correct burial, may be even smaller than those described here.

Radiological Results Compared to Health Protection Standards

Subseabed disposal is a relatively new concept for high-level waste disposal, so no national or international authority has set specific performance standards. Hence, there is no simple and accepted set of numerical criteria by which the results of this assessment can be used to declare subseabed disposal safe or unsafe, acceptable or unacceptable. The results of the radiological assessments will be compared to a variety of standards to judge whether or not the risks of subseabed disposal would be acceptable by present health protection practices.

Comparisons are made both for maximally-exposed individual risks and for collective, or population, risks. Both types of standards are used in regulation of human risks. In some health protection practices both types of risks are considered together. For example, a certain level of risk to an individual might be judged acceptable if relatively few persons are exposed. However, if many persons will be exposed, the total effect on the population may not be acceptable, and a lower individual limit, or other approach, may be used to protect the population.

The health effects of concern when considering low doses of radiation are premature deaths from cancers and genetic defects of offspring (premature deaths from cancers are about 95 percent of the effects). There is no direct evidence that the very low doses predicted by these assessments will have any detrimental effects on health. However, it is generally considered prudent for radiation protection purposes to assume that all doses of radiation give rise to some additional risk. The con-

TABLE 3: MAXIMUM INDIVIDUAL DOSES RESULTING FROM A SEABED REPOSITORY

Analysis	Peak Individual Dose[a] (Sieverts per year) Best Estimate	Most Favorable	Least Favorable	Time of Peak Dose (years after disposal) Best Estimate	Most Favorable	Least Favorable
Deterministic, SNAP site, SWG[b]	5 x 10[-10]	2 x 10[-13]	7 x 10[-8]	1 x 10[5]	7 x 10[6]	7 x 10[4]
Deterministic, GME site, SWG[c]	2 x 10[-9]	2 x 10[-15]	8 x 10[-8]	1 x 10[5]	7 x 10[6]	5 x 10[4]
Probabilistic, GME site, SWG[c]	10[-9]	10[-14]	10[-8]	1 x 10[5]	7 x 10[5]	1 x 10[5]
Deterministic,[d] GME site, UK	1 x 10[-9]			2 x 10[5]		
Deterministic,[e] GME site, PAGIS	6 x 10[-10]			2 x 10[5]		

[a] For the determination analyses the most and least favorable cases are determined by simultaneously setting all parameters to the most and least favorable numbers from the standard data set. In the probabilistic analysis, the most and least favorable cases represent the extreme of the histograms (see Figure 6).
[b] Seabed Working Group analysis for southern Nares Abbysal Plain site using standard data set.
[c] Seabed Working Group analysis for Great Meteor East site using standard data set.
[d] Assessment by United Kingdom using independent data set. In this assessment most canisters were between 30 and 70 meters burial depth, but some are less than 30 meters.
[e] Assessment by PAGIS group using an independent data set.

sensus of experts generally supports a linear relationship between dose and health effects, with about 10^{-2} health effects per man-sievert (Sv).

Comparison to Background Radiation

All living things on earth are constantly exposed to the same types of ionizing radiation that are emitted by radioactive wastes. Natural sources of radiation include the decay of radionuclides which have been present since the earth was formed, the decay of their radioactive daughter products, cosmic rays, and radionuclides produced by cosmic ray interaction with the atmosphere.

The amount of background radiation an individual is exposed to depends on many factors, including altitude, type of local rocks and soils, water sources, and type of housing. Background radiation for humans is typically 10^{-3} Sv per year, but may be ten times greater at certain locations.

The dose to the most exposed individual from a seabed repository, which would occur about 100,000 years after burial, would be about 10^{-9} Sv per year. This would be about 1/1,000,000 of average background radiation. Even using results based on the least favorable data, which predicted individual dose 100 times higher than the base case, the expected doses are still very much smaller than background. Either case is very much smaller than the increased dose one may receive from other normal activities. For example, maximum annual individual exposures based upon best estimate data is equivalent to the extra dose one receives from cosmic radiation in one-fifth of a second of airplane flight at normal altitudes on commercial jet aircraft.

The current population of the earth, about 5,000,000,000 people, receives 5×10^6 person-Sv per year from background radiation. Based on the best-estimate, base-case scenario, the maximum total population dose rate is 10^{-2} person-Sv per year or about 1/500,000,000 of background. Expressed another way, the maximum predicted population dose rate is equivalent to the annual background dose to about 10 persons.

International Commission on Radiological Protection Recommendations

The International Commission on Radiological Protection has recommended that individuals receive no more than 10^{-3} Sv per year from all sources of radioactivity other than from background and medical practice. Since this level is equivalent to the average background radiation, exposure from the base case seabed repository would be the same fraction (1/1,000,000) of the recommended dose limit as calculated above for background radiation.

U.S. High Level Repository Standards

The U.S. Environmental Protection Agency (EPA) has prepared draft standards which may eventually be applied to land-based, high-level waste repositories in the U.S. The draft standards state that a repository the size of that used for the seabed assessment may cause in the affected population no more than 1,000 health effects in the first 10,000 years after burial. For a seabed repository, the total population exposure in this period of time would be 10^{-3} person-Sv, 1/10 of the dose expected to cause a single health effect, or 1/10,000 of the limit.

The maximum population dose rate which would result from seabed disposal would occur about 100,000 years after disposal. Hence, the 10,000 year period of the draft EPA standard does not provide a very difficult test for subseabed disposal. For the purposes of comparison, the EPA draft standard may be viewed as an annual dose limit of one

health effect per 10 years. At its maximum, the population dose rate from a seabed repository would be 1/500 of the effective EPA rate.

Health Protection Decisions of U.S. Regulatory Agencies

Figure 6 shows a record of decisions by various regulatory agencies in the United States where both individual risk and population risk estimates were available. The decisions concerned the risks of cancer-causing chemicals in consumer products, food, the workplace, or wastes. The points fall into three regions. For risks which at the time of the regulatory decision fell above line A in *Figure 6*, a decision was made in every case to regulate the agent to reduce either the individual or population risk. For risks which fall below line B, the agencies have decided the risk was not great enough to require regulation to reduce the risk. Between lines A and B is a region where the risk may or may not have been regulated. As can be seen from the graph, the effects expected from a seabed repository are well below the risks the agencies have decided were unacceptably large.

Transportation Accident Scenarios

The consequences of damaged or undamaged waste packages containing 50-year-old waste sitting on the sediment surface on either the continental shelf or deep ocean have been estimated. These consequences, as expected, have been found to be large compared to those from an equal number of correctly implanted waste packages (*Table 4*). This implies that deliberate disposal of waste packages on the sea floor would be not nearly as safe as burial of the same waste packages in sediment formations below the sea floor. It also implies that losses of large numbers of waste packages through transportation accidents will not be acceptable. It will be necessary to develop reliable transportation systems for the concept.

TABLE 4

Location	Ratio for peak individual dose	Ratio for population dose
Continental Shelf	6×10^7	1×10^3
Deep Ocean	1×10^3	2×10^2

Ratio of dose of undamaged waste package lying on sediment surface to dose from same waste package with normal burial (base case, best estimate).

One study was conducted, through the U.S. SDP, to see if the risks associated with transportation could be made low through good engineering practice. The assessment was based on a conceptual penetrator emplacement ship specifically designed to avoid accidents, survive if

there is an accident, and facilitate recovery if there is a loss of cargo. The risks of transportation associated with this design are lower than those found for normal, base-case emplacement (*Table 5*). (Risk is defined as the probability of an event occurring times the consequence of the event if it does occur.)

TABLE 5

Probable Doses from Sea Transportation Accidents While Fitting a Repository Using Safe Ship Designs

	Peak Individual Dose (Sv per year)
Shelf Accidents	
Most Favorable Data	2.5×10^{-16}
Best Estimate Data	4.4×10^{-15}
Least Favorable Data	8.3×10^{-13}
Deep-Ocean Accidents	
Most Favorable Data	5.3×10^{-20}
Best Estimate Data	1.0×10^{-18}
Least Favorable Data	1.3×10^{-16}

Other Post Emplacement Scenarios

Radiological assessment models have been applied to a number of scenarios in addition to the base case (*Table 6*). These scenarios are useful in determining which events or processes require more detailed study, address some of the uncertainties in the data, and add to the overall picture of the subseabed concept. Insufficient work has been done to apply probabilities to these scenarios, which would be necessary to calculate their risk. Hence, these scenarios cannot be compared to standards in the same manner as the base case.

Changes from the base case scenario were not generally large (*Table 6*). Except for the case of high pore water velocities and a damaged waste package, the change relative to the base case was small enough that the entire repository inventory could be affected and the individual dose rates would still be below the International Commission on Radiological Protection recommended dose limit of 10^{-3} Sv per year. For the case of pore water velocities of 1 meter per year and damaged waste packages, only 0.25 percent of the waste could be subjected to this condition before the International Commission on Radiological Protection recommended dose limit would be exceeded. These calculations point out the importance of locating a repository where it can be shown unequivocally that the sediments have a very small pore water velocity.

TABLE 6

	Ratio for peak individual dose	Ratio for population dose
Shallow, 10 m, emplacement of penetrator,		
with undamaged canister,	70	5.1
with damaged canister.	136	7.3
Effect of upward pore water movement with undamaged canister.		
.001 m per year velocity	6	3
0.01 m per year velocity	230	7.2
0.1 m per year velocity	430	10.5
1.0 m per year velocity	2310	370
with damaged canister		
0.001 m per year velocity	7.2	3.3
0.01 m per year velocity	495	10.8
0.1 m per year velocity	2.2×10^4	17.3
1.0 m per year velocity	3.5×10^6	386
Instantaneous leaching after canister falls.	1.02	< 1.02
Instantaneous corrosion of canister.	1.1	1.09
Harvesting of deep-sea fish near a repository.	up to 100	
Ten times faster ocean circulation and slower sedimentation.	< 10	< 1.2
No scavenging from surface waters.	1.0	1.0
No sorption to sediments for any radionuclide.	170	82
No scavenging from water and no sorption to sediments.	177	82
Deep emplacement (Drilled Option)	6×10^{-4}	10^{-3}

List of post emplacement scenarios and ratio of dose expected relative to that expected for the same amount of waste for base case, best estimate, scenario.

Assumption of instant failure of the canister, or of instantaneous leaching, increased predicted maximum individual doses by only a few percent. Shallow, 10-meter, burial of wastes, with and without damaged waste packages, increased individual doses over the base case by about 100 times. Direct harvesting of deep sea fishes from the most contaminated waters immediately over the repository increases the predicted individual dose by about 100 times. Assuming all ocean circulation processes occur ten times faster than in the base case increases the predicted dose by about ten times. If no sediment adsorption is allowed for any radionuclide, the predicted dose increases by about 100 times. The increase in population doses are smaller in each case than for the maximum individual dose.

These processes, especially those which would not affect an entire repository, are not enough to increase the predicted doses to above the levels judged acceptable (as illustrated in *Figure 6*). Hence, improvements to the data used in the base case, likely to be much smaller than the extremes presented in these scenarios, are unlikely to substantially change the base case predictions.

Deep burial, as would occur with drilled emplacement, reduces the predicted doses by about 1,000 times over the 50-meter burial of the base case.

Summary and Conclusions

There are now real and appropriate data to support the steps leading to dose calculations, geologic characterization of a few promising locations, and demonstration of emplacement techniques. A great deal of effort has been expended to assure that all significant processes have been considered in the evaluation. But further work is necessary to evaluate the possible importance of other processes. It is especially important that the models upon which assessments are based be tested under realistic conditions to see if they provide accurate predictions. Further research is definitely required to achieve the level of confidence desired before activation of a subseabed high-level waste repository.

Techniques are available to evaluate the long-term geological processes relevant to containment of high-level wastes in deep-sea sediments. Results from geoscience investigations suggest that sites with characteristics thought desirable for seabed disposal may be found in two of the areas studied. Only the North Pacific and North Atlantic oceans have been considered. Suitable sites might also be found in other regions.

Implantation of packages has been demonstrated feasible for both penetrator and drilled emplacement. Drilling has been conducted at deep-sea depths for about 20 years. Modeling and sea trials have shown that sufficient burial depths can be reached by penetrator emplacement and that barrier properties of the sediment are not reduced by the passage of a penetrator.

Models have been assembled which describe the transport of radionuclides from a seabed repository to man. These models may also be used to assess accident scenarios and doses to marine biota. Radiological risk assessments were performed for a single repository holding the equivalent of 11 years of high-level waste at the current global production capacity. These calculations indicate that seabed disposal would be highly effective in protecting man and the environment.

There would be no releases from a repository containing correctly implanted waste packages for about 10,000 years. The maximum dose experienced by any individual would occur about 150,000 years after burial. That dose is estimated to be about 10^{-9} Sv year^{-1}, which is about 10^{6} smaller than normal background radiation. The maximum collective dose rate to the entire world population would be 10^{-2} man-Sv year^{-1} and would also occur about 150,000 years after burial. This is about 10^{8} times smaller (at a present population of 5 billion) than the population dose rate from background radiation. The maximum total population dose rate would be equivalent to the average background dose to about ten individuals.

Radiological predictions based on independent models were similar. Results do not substantially change, even assuming conditions much more pessimistic than the data presently indicate. It would require conflicting evidence, not just refinements of existing data, to substantially change the emerging picture of subseabed disposal. Unless other processes are found important (such as water movement through the sediments), seabed disposal should easily meet radiological standards presently in use.

NOTES

1. The research into the subseabed disposal concept has dealt entirely with wastes from civilian nuclear reactors. Wastes from military operations have not been considered. From a scientific viewpoint the source of the wastes is irrelevant, but the use of an international repository for wastes generated for military purposes would probably have severe political repercussions. The wastes from civilian reactors represent the vast majority of the high-level radioactive wastes needing disposal. As of December 31, 1981, high-level wastes from weapons production in the U.S. was 10 percent of that from civilian reactors (by the amount of radioactivity represented) with the fraction from the military decreasing with time (Nuclear News 25(10) p. 58).
2. Bishop, W.P., ed. (1974) *Seabed Disposal Program - A First-Year Report*, SAND74-0410. Sandia Laboratories, Albuquerque, NM: 511 pp.; Anderson, D.R., D.G. Boyer, D. Deese, H. Herrmann, J. Kelly, and D.M. Talbert (1980) *The strategy for assessing the technical, environmental, and engineering feasibility of subseabed disposal*, SAND79-2245. Sandia Laboratories, Albuquerque: 29 pp.; Anderson, D.R., D.G. Boyer, H. Herrmann, J. Kelly, D.M. Talbert, and D. Deese (1983), *The strategy for assessing the technical, environmental, and engineering feasibility of subseabed disposal.* In: P.K. Park, D.R. Kester, I.W. Duedall, and B.H. Ketchum (eds.): *Wastes in the Ocean*, Volume III, *Radioactive Wastes in the Ocean*. Wiley, New York: pp. 327-344; Seabed Programs Division (1982) Subseabed Disposal Program Plan, Volume I: Overview SAND81-0007/1. Sandia National Laboratories, Albuquerque, NM: 67 pp.
3. Bishop, W.P., and C.D. Hollister (1974) "Seabed disposal - where to look," *Nuclear Technology* 24: 425-443.; Hollister, C.D. (1977) "The Seabed Option." *Oceanus* 20: 20-25.; Hollister, C.D., D.R. Anderson, and G.R. Heath (1981) "Subseabed disposal of nuclear wastes?" *Science* 213: 1321-1326; Hinga, K.R., G.R. Heath, D.R. Anderson, and C.D. Hollister (1982) "The disposal of high-level radioactive wastes by

burial in the sea floor." *Environmental Science & Technology* 16(1): 28A-37A; Heath, G.R., A.J. Silva, C.D. Hollister, D.R. Anderson, and M.S. Leinen (1983) "Why consider subseabed disposal of high-level nuclear waste?" In P.K. Park, D.R. Kester, I.W. Duedall, and B.H. Ketchum (eds.): *Wastes in The Oceans*, Volume III, *Radioactive Wastes in the Oceans*. Wiley, New York: pp. 303-325; Hinga, K.R., and J. Lipkin (1983) "High-level radioactive waste disposal in the ocean floor: An introduction," *Sea Technology* 24(2): 36-39; Hinga, K.R. (1983) "The conflicts between deep-ocean mining and subseabed disposal of radioactive wastes," *Marine Mining*, 4, pp. 109-122.

4. The scientific evaluations of high-level waste disposal cover both spent fuel and reprocessed waste. Although there are some important differences between these waste forms, they are similar enough in characteristics relevant to long-term isolation in the sea floor that the analyses can be applied to both.
5. Seabed Programs Division (1981) Program Criteria for Subseabed Disposal of Radioactive Waste, Part 1: Subseabed Research Strategies and Review Processes SAND80-2384. Sandia Laboratories, Albuquerque, NM: 19 pp.; Seabed Programs Division (1982) Subseabed Disposal Program Plan, Volume 1: Overview SAND81-0007/1. Sandia National Laboratories, Albuquerque, NM: 67 pp.
6. Seabed Working Group (1984) Seabed Disposal of High-Level Radioactive Waste. Nuclear Energy Agency / OECD, Paris: 244 pp.
7. Hinga, K.R. and D.R. Anderson (in press) *Subseabed Disposal of High-Level Radioactive Wastes: A Review of Feasibility Assessments*, Sandia National Laboratories, Albuquerque; Shephard, L.E., G.A. Auffret, D.E. Buckley, R.T.E. Schuttenhelm, and R.C. Searle (1988) *Feasibility of Disposal of High-Level Radioactive Wastes Into the Seabed: Geoscience Characterization Studies*, SAND87-1913, Sandia National Laboratories, Albuquerque, 303 pp.; Klett, R.D. (in press) *Waste Disposal Performance Assessment Using Attenuation Factors*, SAND84-2624, Sandia National Laboratories, Albuquerque; Klett, R.D. (in press) *Interim Radiological Safety Standards and Procedures for Subseabed High Level Waste Disposal*, Sandia National Laboratories; Klett, R.D. and E. Hertel, Jr., (in press) *Preliminary Geologic and Waste Package Sensitivity Study for Subseabed High-Level Radioactive Waste Disposal*, SAND86-1471, Sandia National Laboratories.
8. The participants of the Seabed Working Group are working on a series of volumes to condense and describe their research on subseabed disposal. This feasibility report series will be published by the Nuclear Energy Agency in 1988. The volumes in the series are to be: Feasibility of disposal of High-Level Radioactive Wastes into the Seabed.

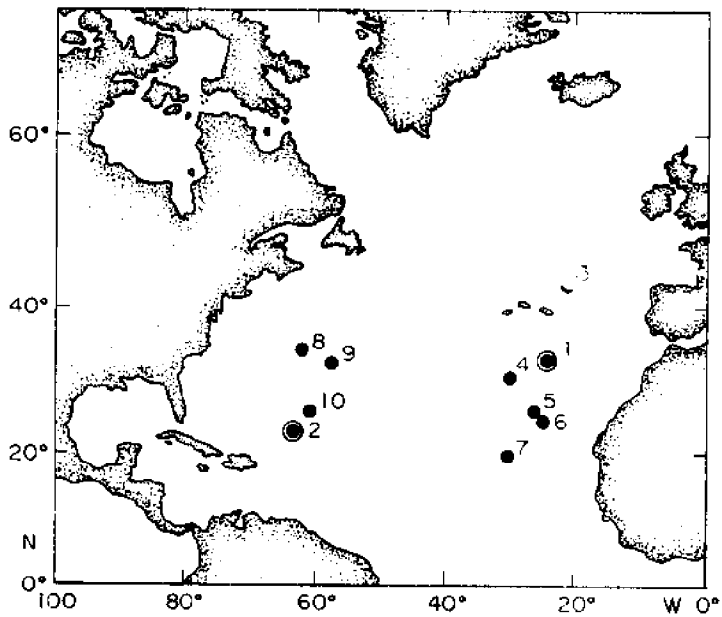
   Volume 1. Overview of Research and Conclusions (Approx. 80 pages).
   Volume 2. Radiological Assessment. de Marsily, Berhendt, Ensminger, Flebus, Hutchinson, Kane, Karpf, Klett, Mobbs, Poulin, and Stanners (Approx. 300 pages)
   Volume 3. Geoscience Characterization Studies. Shephard, Auffret, Buckley, Schuttenhelm, and Searle (Aprox. 300 pages).
   Volume 4. Engineering. Hickerson, Freeman, Boisson, Gera, Nakamura, Niewenhuis, and Schaller (Approx. 200 pages).
   Volume 5. Dispersal of Radionuclides in the Oceans; Models, Data Sets, and Regional Descriptions. Marietta and Simmons (Approx. 250 pages).

Volume 6. Deep-Sea Biology, Biological Processes, and Radiobiology. Pentreath, Hargrave, Roe, and Sibuet (Approx. 150 pages).
Volume 7. Review of Laboratory Investigations of Radionuclide Migration through Deep-Sea Sediments. Brush (Approx. 100 Pages).
Volume 8. Processes Near a Buried Waste Canister. Lanza (Approx. 100 pages).

9. Letter from Joseph F. Salgado, Under Secretary, to Senator Claiborne Pell, May 31, 1988.
10. Laine, E.P., D.R. Anderson, and C.D. Hollister(1983) "Site qualification plan for the Subseabed Disposal Program," In P.K. Park, D.R. Kester, I.W. Duedall, and B.H. Ketchum (eds.): *Wastes in the Oceans*, Vol. III: *Radioactive Wastes and the Ocean*. Wiley, New York: pp. 345-358; Laine, E.P., D.R. Anderson, and C.D. Hollister (1982) *Program Criteria for Subseabed Disposal of Radioactive Waste: Site Qualification Plan* SAND81-0709. Sandia National Laboratories, Albuquerque, NM: 16 pp.; Seabed-Working-Group (1984) *Seabed Disposal of High-Level Radioactive Waste*, Nuclear Energy Agency / OECD, Paris: 244 pp.
11. Seabed Programs Division (1982) *Subseabed Disposal Program Plan*, Volume I: Overview SAND81-0007/1. Sandia National Laboratories, Albuquerque, NM: 67 pp.

FIGURE 1

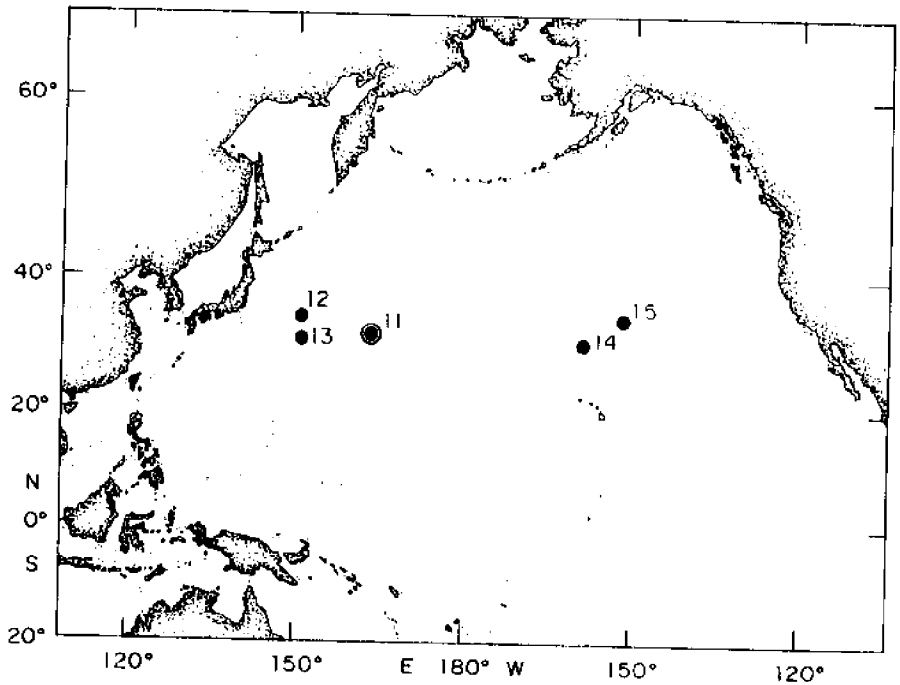
Atlantic Sites Studied by the Seabed Working Group



1. Great Meteor East (This site was used for radiological assessments and appears to have desirable geologic characteristics for subseabed disposal.)
2. Southern Nares Abyssal Plain (This site was used for radiological assessments.)
3. King's Trough Flank
4. Great Meteor West
5. Cape Verde Three
6. Cape Verde One
7. Cape Verde Two
8. Northern Bermuda Rise
9. Sohn Abyssal Plain
10. North Nares Abyssal Plain

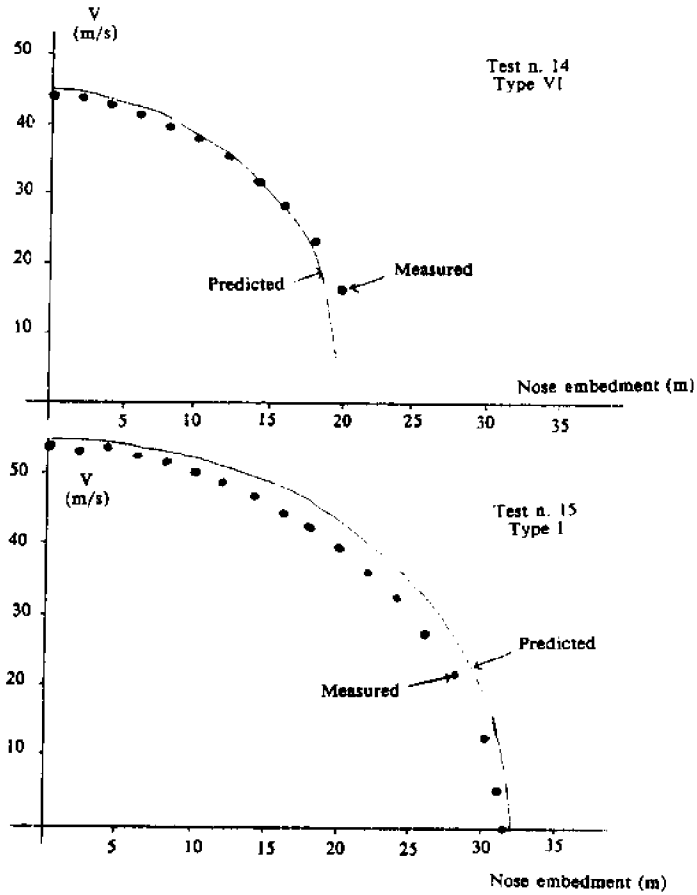
FIGURE 2

Pacific Sites Studied by the Seabed Working Group



11.E1 (This site appears to have desirable geologic characteristics for subseabed disposal.)
12.B1
13.C1
14.MPG-1
15.MPG-2

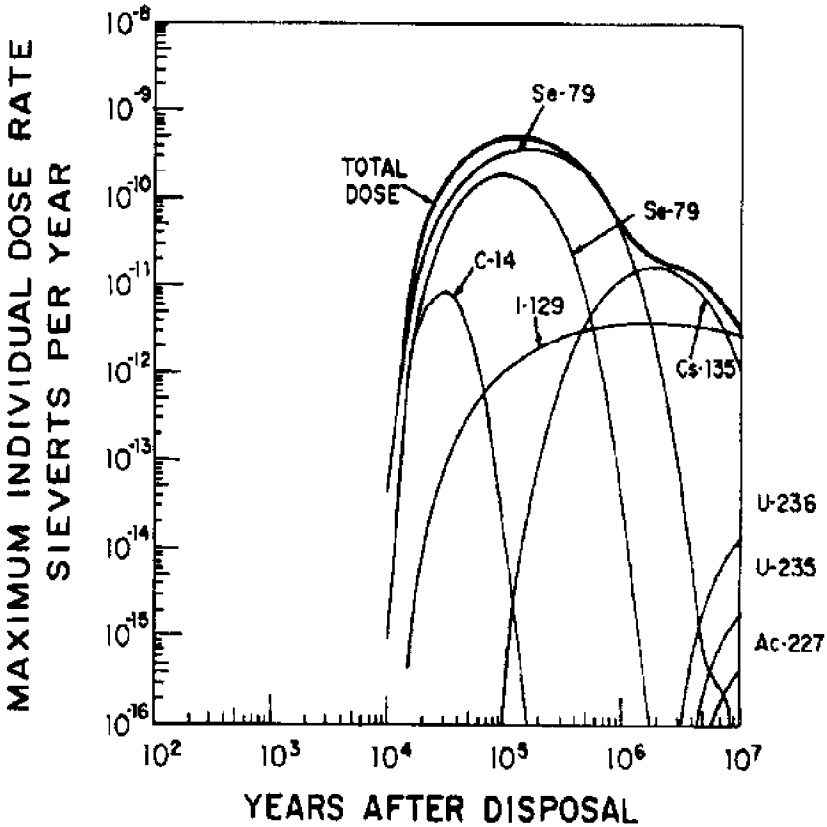
FIGURE 3



Measured and predicted deceleration histories for two test penetrators in deep sea sediments.

From: Feasibility of Disposal of High-Level Radioactive Wastes into the Seabed: Volume 4. Engineering. Hickerson, Freeman, Boisson, Gera, Nakamura, Niewenhuis, and Schaller, Nuclear Energy Agency, Paris, (in press).

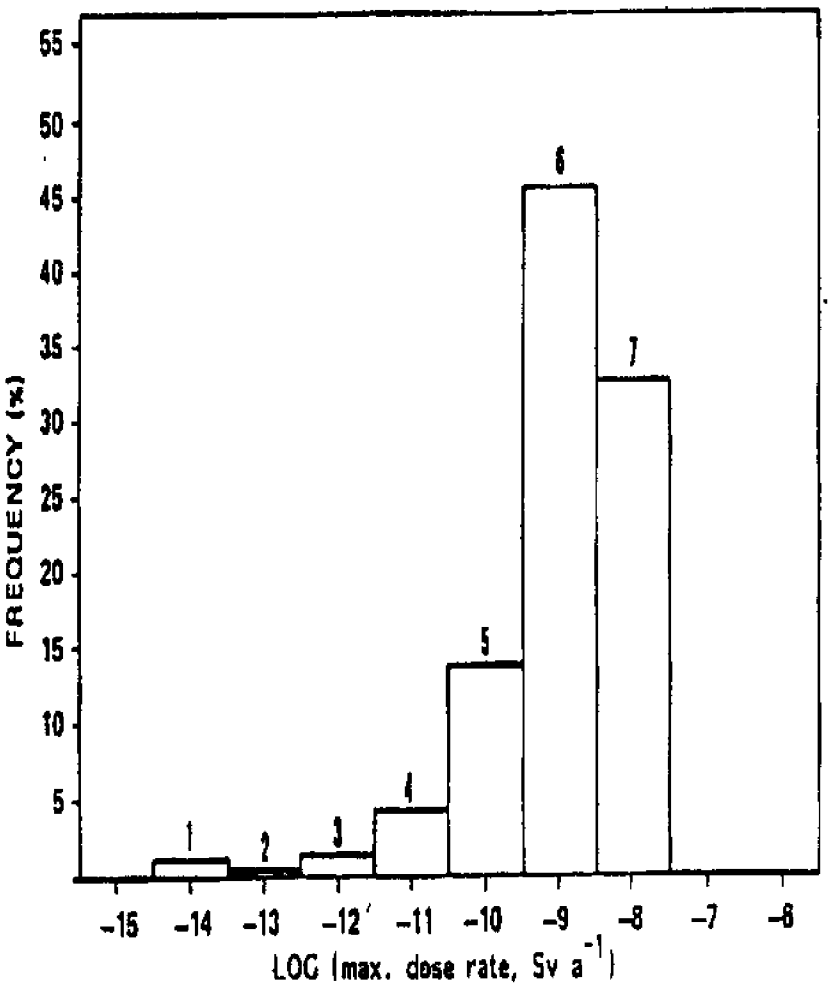
FIGURE 4



Maximum individual dose rate for the base case using a deterministic analysis and best estimate data for the Southern Nares Abyssal Plain site. The curves below the total dose curve represent the doses contributed by individual radionuclides.

From: Feasibility of Disposal of High-Level Radioactive Wastes into the Seabed: Volume 1. Overview of Research and Conclusions, Nuclear Energy Agency, Paris, (in press).

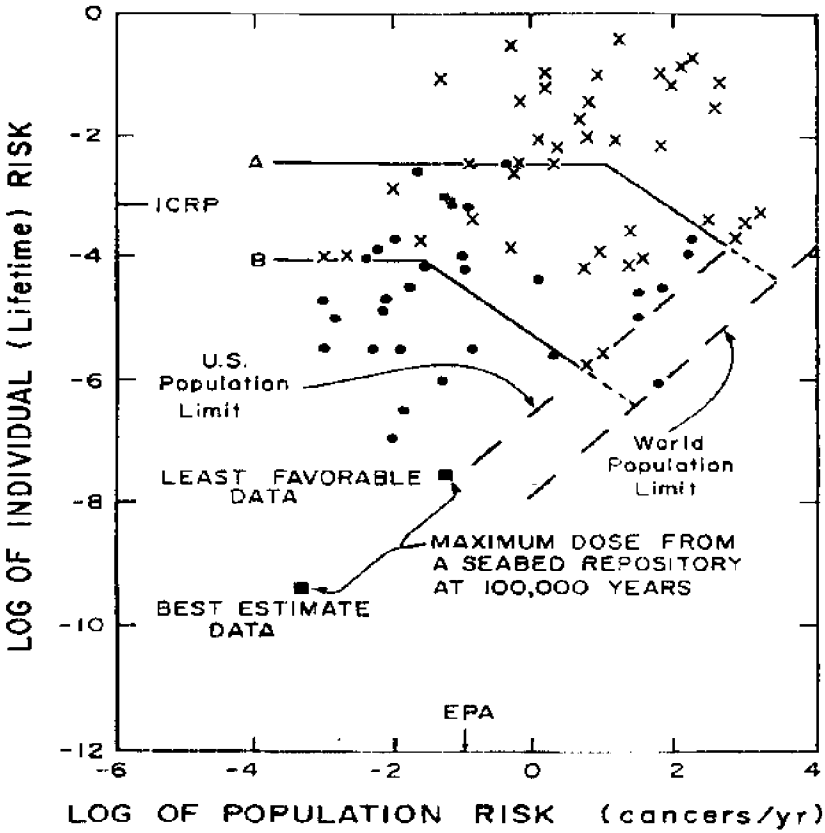
FIGURE 5



The distribution of maximum individual dose predictions from the stochastic model for the Great Meteor East site.

From: Feasibility Radiological Assessment. de Marsily, Berhendt, Ensminger, Flebus, Hutchinson, Kane, Karpf, Klett, Mobbs, Poulin, and Stanners, Nuclear Energy Agency, Paris, (in press).

FIGURE 6



Record of U.S. regulatory agencies decisions on the regulation of carcinogens and the risk of a subseabed repository. An -X- indicates where agencies have decided that the risk was sufficiently high to regulate. Filled circles indicate where the risk was not further reduced through regulation. Above line A the risk was always considered too great and regulations were put in place to reduce either the individual or population risk. Below line B the risk was never judged to be great enough to further regulate. The dashed diagonal lines on the right side of the figure represent the limits where the entire U.S. and world populations are exposed at the ICRP limit, and the population risk equivalent to the U.S. EPA dose limit expressed as an annual dose, are also shown.

The figure is modified from Travis *et al.*, 1987, "Cancer Risk Management," in Environmental Science and Technology, Volume 21, pages 415-420.

Emplacement of High Level Radioactive Waste: Comparison of LOS, LDC and Domestic Law

Clifton Curtis
The Oceanic Society
Washington, D.C.

Seabed disposal of high-level radioactive wastes (HLW) is a prime example of one "new" use of our oceans that has been the subject of considerable research and development attention since the 1970s -- both within the United States and by several Western European countries and Japan. As a complement to technical considerations being addressed by Kenneth Hinga, my remarks will focus on the legal and policy considerations that are pertinent to HLW seabed disposal.

I would like to highlight some of the key laws, principles, and trends in the existing laws and policies that are pertinent to this scientific concept. Towards that end, I will describe those legal provisions and principles that exist at the international level, generally, including the Law of the Sea Convention; in U.S. domestic law; in the London Dumping Convention, including pertinent deliberations and actions in that forum during 1983-85; in the South Pacific Regional Seas Convention; and I will conclude with several observations as to the import of those laws and policies.

Global Agreements Other Than the London Dumping Convention

None of the global agreements which more generally address ocean dumping make specific reference to seabed disposal of HLW. Those instruments do reflect, however, a special and growing concern since the late nineteen-fifties with the potential harm of ocean disposal of radioactive wastes. Collectively, they support a strong presumption favoring extreme caution and restraint where there is any possibility that wastes as toxic as HLW might harm the marine environment.

The First U.N. Conference on the Law of the Sea (UNCLOS I) met in Geneva in 1958. Included among the four separate conventions that were adopted was the Convention on the High Seas. Article 25 of that Convention imposes on every State the obligation to "take measures to prevent pollution of the seas by dumping of radioactive wastes," and to cooperate with the competent international organizations in preventing pollution of the seas by "any activities with radioactive materials."

That Convention on the High Seas is the first formal global pronouncement on the question of ocean disposal of radioactive wastes. In response to its call for national cooperation with competent international organizations, the IAEA established its Brynielsson Panel, which, among other things, made the important distinction between types of radioactive wastes. As one of the Panel's recommendations made in 1961, it stated that the release of "highly radioactive wastes from irradiated fuel cannot be recommended as an operational [dumping] practice."

A new impetus to the development of international rules applicable to ocean dumping resulted from the work of the United Nations Conference on the Human Environment held in Stockholm in June of 1972. In anticipation of that conference, a preparatory Intergovernmental Working Group

on Marine Pollution drafted several articles dealing with ocean dumping, one of which prohibited the dumping of high-level radioactive wastes.

While that 1972 conference did not address specifically the issue of radioactive waste dumping, Principle 7 of the "Stockholm Declaration" obligated all States to "take all possible steps to prevent pollution of the seas by substances that are liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea." That Declaration also gave special to ocean areas beyond national jurisdiction, stating in Principle 21 that "States have...the responsibility to ensure that activities within their jurisdiction or control do not cause damage to ... areas beyond the limits of national jurisdiction."

Of the numerous recommendations emanating from the Stockholm Action Plan, special reference was made to the need for "an overall instrument for the control of ocean dumping" (Rec. No. 88). Although the Stockholm principles and recommendations were not directly binding on States, they represented a significant backdrop and prelude to the adoption of the London Dumping Convention late that same year.

In 1973, as participants in this conference well know, negotiations at the Third U.N. Conference on the Law of the Sea (UNCLOS III) formally began for the codification of a comprehensive treaty concerned with protection, conservation, sustainable use and development of the marine envornment. In its completed form, that 1982 Convention sets the groundwork for a comprehensive system of protection of the ocean ecosystem. Part XII is entirely devoted to provisions detailing the broad environment" (Art. 192), with States required to take "all measures ... that are necessary to prevent, reduce and control pollution of the marine environment from any source" (Art. 194), and with a very broad definition of "pollution" (Art. 1(4)) that was consistent with language contained in the 1972 Stockholm conference principles and recommendations.

Several articles in the 1982 LOS Convention address specifically the issue of dumping. As part of the necessary measures which States must take to prevent, reduce and control pollution of the marine environment, Article 194 provides that:

> [t]he measures shall include, *inter alia*, those designed to minimize to the fullest possible extent:
>
> (a) the release of toxic, harmful or noxious substances, especially those which are persistent, from land-based sources, from or through the atmosphere or by dumping;....

In addition, the Convention contains specific provision for the implementation of internationally agreed rules, standards and recommended practices and procedures, and enforcement measures relating to the dumping of wastes (Arts. 210 and 216). While the Convention does not mention radioactive waste disposal specifically, no one would dispute the fact that HLW represents a "toxic, harmful or noxious substance" which is one of the most "persistent" materials known to man.

More generally, as several commentators on the LOS Convention have noted since 1982, one of its most important features is its dynamic, evolving status. Articles 237 and 311 establish a symbiotic relationship between the Convention and other issue-specific environmental agreements -- like the London Dumping Convention. As long as those agreements are consistent with the Convention objectives, the adoption of issue-

specific international rules and standards are considered universally applicable under the LOS Convention. Thus, while the Convention has not entered into force, its environmental obligations and duties are the subject of ongoing revision -- and future application to all states -- through members' actions under special agreements like the LDC that address marine environmental concerns.

Pertinent U.S. Laws

In 1970, the newly established Council on Environmental Quality (CEQ) issued a report (*Ocean Dumping: A National Policy*) which concluded that ocean dumping of radioactive wastes presented a serious and growing threat to the marine environment. While also calling for the termination of low-level radioactive waste dumping, the CEQ report stated that "[t]he current policy of prohibiting ocean dumping of [HLW] should be continued."

Soon after the CEQ was published, the Marine Protection, Research and Sanctuaries Act ("Ocean Dumping Act") of 1972 was enacted. Pursuant to Title I of the Act, no permits may be granted for dumping any HLW into the ocean, and permits for low-level wastes were permitted only upon a determination that "such dumping will not reasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities" (Sec. 1412).

In 1976, special Congressional hearings were held to examine the question of radiological contamination of the oceans. At that time, lawyers within the U.S. government were asked whether seabed burial of HLW was "dumping" under the Ocean Dumping Act, and therefore prohibited. In a legal opinion issued by the EPA -- the lead agency responsible for administering the Act -- the agency specifically concluded that HLW seabed burial was dumping under the Ocean Dumping Act, and therefore prohibited. As a result, while U.S. officials have disagreed with the dominant international legal view that HLW seabed burial is prohibited under the London Dumping Convention, as discussed below, the consensus legal view within the U.S. is that the Ocean Dumping Act prohibits such HLW seabed disposal, and that the Act would need to be amended before such a practice could be permitted under U.S. law. (Oversight Hearings before the Interior and Insular Affairs Committee, House of Representatives, 94th Congress, 2nd Session, July 26-27, 1976, Serial No. 94-69, pages 816-817.)

As my co-panelist has discussed, the U.S. Department of Energy carried out a multi-year research and development program on HLW seabed disposal from 1974-1986. That program was directed towards assessing the technical, engineering and environmental feasibility of the seabed disposal option. However, in 1986 the Department of Energy (DOE) terminated that program, stating that further assessments were unnecessary given the agency's preference for land-based disposal of HLW.

Consistent with that decision, legislation passed by the U.S. Congress in 1987 (as part of a larger appropriations package) terminated U.S. consideration of any HLW disposal option other than Yucca Mountain, in Nevada, which was selected as the preferred approach. At the same time, though, that legislation (without the benefit of any hearings) included language directing the creation in DOE of an Office of Sub-Seabed Disposal Research and called for a university consortium to run the program, with reports on scientific and technical feasibility due in 1990 and 1995. The DOE and the President's budget proposals, however, requested no funding for that program; Congress has provided no funding for the program; and it is a non-operational, paper law.

The London Dumping Convention

The London Dumping Convention (LDC) is the only global agreement concerned solely with the disposal of wastes in the marine environment by dumping. Written in 1972, that agreement represented a significant step forward in the international management of our oceans. Having come into force in the summer of 1975, to date, the LDC has been ratified by 62 nations, including the United States.

The basic philosophy of the LDC is that the nations of the world will work together to ensure that the marine environment becomes safe from the dangers of dumping. Protection of the marine environment, broadly defined, was and is the foundation of the Convention. In its preamble, articles and annexes, the LDC repeatedly emphasizes this concern as the driving force.

The LDC was written before the concept of seabed disposal received any serious consideration, and several scholars of the LDC have stated that there was no specific reference to that disposal option prior to or at the time it was written. The "legality" of HLW seabed disposal was never discussed at any of the consultative meetings prior to 1983, at which time the issue was raised with a request that the matter be addressed at their next meeting, in 1984.

The principal focus of the LDC consultative meeting in 1984 was the issue of the legality of HLW seabed disposal. A key consideration pertinent to the parties' interpretation of the Convention in relation to seabed disposal is the definition of dumping. Article III(1)(a) defines "dumping" as "any deliberate *disposal at sea* of wastes or other matter from vessels, aircraft, platforms or other manmade structures *at sea*..." (emphasis added). because of the double use of the "at sea" phrase, this language can arguably mean either that the LDC covers all disposal operations that take place from a boat or structure *at sea*, or only such operations in which the final resting place of the waste is *at sea*.

Two principal blocs of delegations at the 1984 meeting expressed notably different views on the legality issue. The dominant coalition of seventeen nations -- a large majority of those who stated a position -- stated that HLW seabed disposal is covered by the LDC and, therefore, prohibited. These nations coalesced as sponsors of a "Nordic" resolution. While the express langage of the LDC may be unclear, those nations agreed that protection of the marine environment under the LDC requires an interpretation that views seabed disposal as "disposal at sea." In addition to their basic position that such disposal is covered and prohibited, they agreed that their interpretation applied to experimental as well as operational activities. Some of those nations discouraged further study of that disposal option, while others felt it could or should continue.

A minority bloc of nations, including the U.S., took the position that HLW seabed disposal is not covered by the LDC as now written and, therefore, is not prohibited. Several variations on this theme were put forward during the meeting, but by the end of the week six nations coalesced around a "U.S." resolution which enunciated that view. That resolution focused only on future regulation of operational activities, left unclear how such disposal might be permitted and regulated under the LDC and encouraged further study.

A number of delegations at the 1984 meeting were concerned about forcing the HLW legality issue to a formal vote. Several felt that if consensus was not possible it would be better to wait, focusing efforts on strengthening support/consensus in relation to the Nordic resolution,

and/or by monitoring any future HLW seabed disposal research before devoting more time to the legal issue. At the same time, though, two very important basic points were agreed upon, by consensus, by the proponents of both the "Nordic" and "U.S." resolutions and other participants in the 1984 meeting, i.e., that:

> (1) The Consultative Meeting of the Contracting Parties to the [LDC] is the appropriate forum to address the question of the disposal of [HLW] into the seabed, including the compatibility of this type of disposal with the provisions of the LDC; [and]
>
> (2) No such disposal should take place unless and until it is proved to be technically feasible and environmentally acceptable, including a determinitation that such waste can be effectively isolated from the marine environment, and a regulatory mechanism is elaborated in accordance with the provisions of the [LDC] to govern the disposal into the seabed of such radioactive wastes.

Since that meeting, there has been no significant discussion of HLW seabed burial -- either from a legal or technical perspective -- at the formal meetings of the LDC parties in 1985 or 1986 (with no meeting held in 1987), and it is unlikely that this issue will receive much attention at the upcoming meeting scheduled for early October, 1988.

In order to provide a context for the LDC parties' action on HLW at their 1984 meeting, I would like to mention briefly the LDC's actions related to low-level wastes (LLW). As many of you may know, since 1983 there has existed an international moratorium on LLW dumping at sea under the LDC. At the 1983 and 1985 meetings of the parties, the major issue was whether ocean disposal of LLW should be immediately banned, phased out over several years, stopped pending scientific studies, or allowed to continue under stricter controls.

Without going into the details of their deliberations, a "Spanish" moratorium resolution was adopted at the 1983 LDC meeting, calling for an immediate suspension of LLW dumping pending a review of the scientific risks of such activities to be carried out by the LDC parties. A review of those risks was initiated, with "terms of reference" and other attention devoted to those studies at the 1984 meeting, and at two intersessional experts meetings held in October 1984 and June 1985.

At the 1985 meeting of the LDC parties, the respective views of the delegations with respect to the scientific risk review were discussed at length. While there appeared to be growing support for amending the LDC's annexes to ban LLW dumping, the required two-thirds majority needed for such action was not certain. Moreover, several delegations expressed the view that a continued moratorium would be perferable, given unresolved questions surrounding LLW dumping and/or the desire to garner further support for an amendment to the LDC. By the end of the week, a new "Spanish" *indefinite* moratorium resolution was adopted, calling for the completion of further scientific risk reviews, as well as "additional studies and assessments of the wider political, economic and social aspects" of LLW dumping at sea.

At the 1986 meeting of the LDC parties the "terms of reference" for those ongoing studies were further elaborated; an intersessional panel of LDC experts met to discuss those studies in September, 1987, with a follow-on panel meeting scheduled for late September, 1988; and the next formal LDC meeting in early October, 1988, is likewise expected to

further discuss the status of work related to carrying out the studies mandated under the 1985 moratorium resolution.

My mention of the LDC deliberations and actions related to LLW is for two reasons: it is indicative of that body's interest and concern over radioactive waste dumping, generally; and reflects a strong linkage between support for the 1984 "Nordic" HLW resolution and votes in favor of the 1983/85 LLW moratoriums, and conversely, support for the 1984 "U.S." HLW resolution and votes against the 1983/85 LLW moratoriums. As shown in *Table 1*, all nations supporting the "Nordic" HLW legality resolution voted for one or both of the LLW moratorium resolutions; and all nations supporting the "U.S." HLW legality resolution voted against one or both of the LLW moratorium resolutions.

South Pacific Regional Seas Convention

One of the most important results of the Stockholm Conference, mentioned earlier, was the impetus it gave to the creation of the United Nations Environment Program (UNEP). Among other work of UNEP, its principal approach to the oceans has been a regional one, primarily because the nature of environmental problems varies from region to region, as do cultural, socio-economic and political factors.

Of the eleven Regional Seas programs involving over 120 nations that have been created under UNEP's leadership since the mid-1970s, one, in particular, merits special mention in relation to HLW seabed disposal. In November, 1986, after several years of negotiations, the Convention for the Protection and Development of the Natural Resources and Environment of the South Pacific Region was completed, and opened for signature and ratification. As written, the Convention prohibits radioactive waste dumping within the area covered by the Convention (including the 200-mile EEZs of the Pacific island countries), as well as in "contiguous" high-seas beyond national EEZs that are completely enclosed by those national zones of jurisdiction. (Art. 2(a)(ii)). Most importantly, for purposes of my paper, the Convention's ban on dumping explicitly includes HLW or LLW seabed disposal (Art. 10(1)).

While it is impossible to say whether the South Pacific Convention represents a trend that might be followed in other region-specific UNEP conventions, such action, in my view, is fully compatible with the London Dumping Convention's admonition that "[p]arties with common interests to protect the marine environment in a given geographic area shall endeavor, taking into account characteristic regional features, to enter into regional agreements consistent with [the LDC] for the prevention of pollution, especially by dumping" (Art. VIII).

Concluding Observations

The above considerations provide grist for several general observations that are directly or indirectly pertinent to HLW seabed disposal. At the same time, I'd like to take this opportunity to present some other thoughts concerning the protection, conservation and wise use of the oceans that are relevant not only to this panel, but to the conference's broader focus.

(1) *Radioactivity Risk Assessments.* While the LDC treaty parties' deliberations on HLW centered on the "legality" of such a practice under the Convention, their concern with the "risks" of radioactive waste dumping at sea -- whether HLW or LLW -- will necessitate an examination of diverse disciplines. As stated in the indefinite moratorium on LLW that the parties adopted at the 1985 LDC meeting, those disciplines

include not only the scientific and technical, but also the "wider political, legal, economic and social" aspects of such dumping.

As those studies have begun to unfold, this broadly defined look at risks has included requests for examination of such matters as public perception; a comprehensive assessment of benefits and risks (including net detriment concepts, and proximity to the risk -- e.g., the South Pacific Islanders' concern over Japan's potential interest in radioactive waste-dumping in the Pacific Basin); consideration of differing national economies; differing national or regional waste management philosophies; and liability requirements.

In my view, the LDC parties' decision to examine LLW "risks," broadly defined, represents a positive trend -- one that is likely to continue for radioactive and other hazardous wastes. It's an approach that was recently endorsed in the U.S. in the context of a study undertaken by the Keystone Center, based in Keystone, CO. The conclusions of that study, titled "A Decisionmaking Process for Evaluating the Use of the Oceans in Hazardous Waste Management" (April 1987), stress the importance of undertaking comprehensive socio-economic risk assessments, broadly defined, on an equal footing with scientific-technical assessments of both ocean disposal and other waste management options (including waste reduction).

(2) *Scientific Uncertainty*. More often than not, for major policy issues involving the environmental implications of waste management, we are faced with substantial scientific uncertainty. As a general statement, the ability of policy-makers to understand, access and use science appropriately in developing environmentally sensitive public policy is poor. Public policy options typically are derived out of "objective research" into a problem and its potential solutions. However, almost all research implies a host of value-laden decisions. The most basic process of choosing and defining variables to be analyzed or of interpreting raw data requires a researcher to make a variety of judgements and assumptions about the nature of a problem and the factors that are relevant to its solution. The form and quality of the data collected determine the validity of any subsequent analysis and policy choices.

This is especially true with respect to the marine environment. Because of the practical difficulties in gathering data, and the enormous gaps in the existing body of scientific knowledge about the ocean ecosystem, much marine policy is advanced on the basis that no proof exists that a particular practice *will* harm the marine enviroment. When the implications of toxic contamination of marine ecosystems will extend for decades, and even hundreds of years, it is imperative that policies involving such substances be grounded in much more caution and restraint that is now the case.

For these reasons, I would like to suggest a couple of approaches that merit much more attention and use in marine-related environmental policy making.

A. *Ecosystem Management.*

Another speaker at this conference, Martin Belsky, has examined this issue in detail, and I strongly endorse his findings that an "ecosystem" approach is required by law. Complementing the legal imperative for such an approach, effective management of ocean and coastal resources requires, practically, the institution of an ecosystem approach whereby international, federal, state and local authorities undertake cooperative efforts to regulate and otherwise address all activities impacting on an identified ecosystem.

In contrast with this approach, far too much credence has been given to the scientific concept of "assimilative capacity," which tends to legitimize inappropriate use of the ocean for waste disposal by setting arbitrary upper limits in situations where there is insufficient information about the adverse impacts. Standard setting in such situations can then more easily be geared to the industry's needs, rather than focusing on what is needed to protect, preserve and restore marine systems.

B. *Shifted Burden of Proof.*

Traditionally, those who want to use the ocean as a waste bin for toxic wastes have pretty much been allowed to do so unless and until critics prove convincingly that those actions are harmful. As a general principle, such an approach is inadequate, because all too often it is only the proponent of the activity that is in a position to perform the needed studies and assessments. But it is especially inappropriate when the activity at issue involves substances as highly toxic and persistent as HLW or LLW. For activities involving disposal of toxic wastes, those who pollute must bear the responsibility for proving, convincingly and *in advance*, that what they want to do is safe.

This concept is of special note, here, because it has met with substantial approval in relation to both LLW and HLW within the London Dumping Convention. In the context of the 1985 LDC moratorium on LLW, one of the preconditions to lifting that moratorium addressed this issue, albeit in rather unclear language, by requesting "that studies and assessments examine the question of whether it can be proven that any dumping of radioactive wastes and other radioactive matter at sea will not harm human life and/or cause significant damage to the marine environment." As studies pursuant to that moratorium go forward, it is likely that this issue will be revisited in the context of any decision as to future LLW disposal practices.

As mentioned earlier in my paper, the "legality" debate on HLW seabed disposal at the 1984 LDC meeting concluded in the adoption of a consensus resolution that stated, among other things, that "no disposal should take place unless and until it is proved to be...environmentally acceptable, including a determination that such waste can be effectively isolated from the marine environment ...." While there was no express mention during the meeting of the fact that this wording embodied the shifted burden of proof approach, it is highly likely that such an interpretation was intended by many of the participants, and will be called for, in the context of any HLW seabed disposal decisions.

(3) *Ocean Commons.* The concept of the deeper ocean as being *res communis*, the property of all humankind, is very much alive in forums like the London Dumping Convention on issues such as HLW seabed disposal. While the *res communis* concept was the subject of differing philosophies in the context of the Law of the Sea Convention -- in relation to such issues as revenue sharing and technology transfer -- global treaties like the LDC, and MARPOL, reflect an ongoing (and likely increasing) commitment of political will and support for cooperative, international measures involving the protection, conservation and wise use of our oceans.

(4) *Liability Procedures.* The London Dumping Convention makes explicit reference to the need for the treaty parties to develop "procedures for the assessment of liability..." (Art. X). In relation to the LLW moratorium that was adopted at the 1985 LDC meeting, one paragraph of that resolution calls for the development of procedures for

the assessment of liability. Mention of that issue, in the Convention and in the moratorium resolution, as well as in the LOS Convention (Arts. 232 and 235) are examples of a both long-standing and growing support for developing liability procedures -- especially in relation to areas beyond national jurisdiction.

Over the years, it has been widely debated whether nations causing damage beyond limits of national jurisdiction are liable upon a showing of fault, or liable strictly (regardless of fault). In general, it is felt that the duty of a nation to prevent extraterritorial damage is based upon fault, but there is evidence of a trend toward strict liability when the damage arises from an ultrahazardous activity -- such as radioactive waste disposal at sea. As current deliberations on this issue in the context of the LLW moratorium go forward, it is likely that any procedures developed would (1) adopt such a strict liability approach, and (2) be applicable to HLW seabed disposal, if not all forms of waste disposal.

(5) *The Need for Widespread Ratification of LOS Convention.* Earlier today, one of the participants in this conference made a statement to the effect that entry into force of the LOS Convention is "largely irrelevant." Though a response is beyond the scope of my formal presentation, I feel compelled to express my strong disagreement with that view. Broadly stated, the 1982 LOS Convention represents the most ambitious and significant agreement affecting the oceans ever adopted. U.S. interests, and those of others, particularly in relation to the protection of the marine environment, are well served by the Convention. Moreover, important parts of the LOS Convention -- such as its dispute resolution provisions that would be applicable to environment and other disputes -- will only be available once the Convention is in force. For these reasons, among others, when viewed as a whole, the benefits of that Convention -- for all nations -- far outweigh any real or theoretical disadvantages.

With regard to the seabed mining provisions of the Convention (Part XI), rather than remain outside the Convention framework and wait until it enters into force (when it may be much more difficult to reach a new consensus on the requirements for a seabed mining regime), the U.S. should take a leadership role in seeking to amend Part XI. One approach would be to narrow the scope and detail of Part XI and provide for a "skeletal" agreement on the general principles that should be followed. Alternatively, Part XI could be disjoined from the Convention and renegotiated under a separate protocol. However, given the "package nature" of the Convention, the former approach seems the more likely route.

There have been signals from various parties involved in the UNCLOS III negotiations that Part XI's provisions may not be cast in stone. However, if the U.S. continues to chart is own course there is little likelihood that either the U.S. or any other nation will make the effort to come up with an agreeable alternative. It is time to make a concerted effort to reshape Part XI, to examine options that might accommodate the key concerns of the U.S. and other parties.

TABLE 1

London Dumping Convention Consultative Meetings
(1983-1985)

1983 LDC Mtg LLW Moratorium	1984 LDC Mtg Legality of HLW Burial	1985 LDC Mtg LLW Moratorium
In Favor (19)	**Nordic Res. Sponsors** (17)	**In Favor** (26)
Argentina	Argentina	
		Australia
	Brazil	Brazil
Canada	Canada	Canada
Chile	Chile	Chile
	Cuba	Cuba
Denmark	Denmark	Denmark
	Dominican Rep.	Dominican Rep.
Finland	Finland	Finland
	FRG	FRG
		Haiti
		Honduras
Iceland	Iceland	Iceland
Ireland	Ireland	Ireland
Kiribati		Kiribati
Mexico	Mexico	Mexico
Morocco		
Nauru	Nauru	Nauru
		Netherlands
New Zealand		New Zealand
Nigeria		
Norway	Norway	Norway
		Oman
	Panama	Panama
Papua NG		Papua NG
Philippines		Philippines
Portugal		
		Saint Lucia
Spain	Spain	Spain
Sweden	Sweden	Sweden
Against (6)	**U.S. Res. Sponsors** (6)	**Against** (5)
	France	France
Japan	Japan	
Netherlands	Netherlands	
South Africa		South Africa
Switzerland	Switzerland	Switzerland
U.K.	U.K.	U.K.
U.S.	U.S.	U.S.

TABLE 1 (cont'd)

Abstaining (5)	**Abstaining** (7)
	Argentina
	Belgium
Brazil	
FRG	
France	
Greece	Greece
	Italy
	Japan
	Portugal
USSR	USSR

REFERENCES

Convention for the Protection and Development of the Natural Resources and Environment of the South Pacific Region, adopted and opened for signature in November 1986.

Convention on the High Seas (as part of UNCLOS I), 450 U.N.T.S. 82, 96, T.I.A.S. No. 5200 (29 April 1958).

Convention on the Prevention of Pollution by Dumping of Wastes and Other Matter (the "London Dumping Convention" or "LDC"), 26 U.S.T. 2403, T.I.A.S. 8165 (1972).

Convention on the Law of the Sea and Resolutions I-IV (UNCLOS III), adopted 30 April 1982, opened for signature 10 December 1982.

Decisionmaking Process for Evaluating the Use of the Oceans in Hazardous Waste Mangement, report prepared by the Keystone Center, Keystone, CO, USA (April 1987).

Marine Protection, Research and Sanctuaries Act of 1972 (the "Ocean Dumping Act"), Pub. L. 96-572, 33 U.S.C. 1401, *et. seq.*

Ocean Dumping: A National Policy, A Report to the President prepared by the Council on Environmental Quality (1970).

Radioactive Waste Disposal Into the Sea ("Brynielsson Panel"), IAEA (1961).

Report of the Seventh Consultative Meeting of the LDC, LDC 7/12, IMO (9 March 1983).

Report of the Eighth Consultative Meeting of the LDC (including draft "Nordic" and "U.S." resolutions on the legality of high-level radioactive waste seabed burial, at Annex 5), LDC 8/10, IMO (8 March 1984).

Report of the Ninth Consultative Meeting of the LDC, LDC 9/12, IMO (18 October 1985).

Report of the U.N. Conference on Human Environment, U.N. Doc. A/CONF. 48/14 (1972).

Resolution LDC 14(7), Disposal of Radioactive Wastes and Other Radioactive Matter at Sea (low-level radioactive waste moratorium), IMO (17 February 1983).

Resolution LDC 21(9), Dumping of Radioactive Wastes at Sea (low-level radioactive waste indefinite moratorium), IMO (26 September 1985).

1987 Budget Reconciliation Act (including Sec. 7(a), which establishes the Office of Seabed Research within the Department of Energy), Pub. L. 100-203, (22 December 1987).

DINNER SPEECH

Technology Footnote

James J. Griffin
Graduate School of Oceanography
University of Rhode Island

It seems appropriate to make a few comments to our LOSI colleagues regarding the role of technology in the scientific and policy-making processes so important to this assembled group. First, with the substantial and critical global change effects coming downstream -- increases in CO_2 and other gasses (with their potential sea level rise problem), escalating atmospheric methane, and South Polar ozone depletion -- we have for the first time some critical fixed end dates to deal with. These effects are going to occur regardless of whether we understand things scientifically, whether we agree to significant policies, or whether we implement ameliorating change. We do not know exactly when these events will take place, but as time goes on we will become more knowledgeable, and, of course, we will be getting closer to the date when things are going to happen.

Secondly, if we decide, as I believe we have, to try energetically to resolve these problems, the process is exceedingly long and complex. For each identified case, we have to define the problem and its solution from both a scientific and a policy standpoint. We must put together, agree on and implement national and international protocols (i.e., Montreal Protocol, September, 1987) and actions. As was pointed out in prior papers, we must substantially discount the effectiveness of those policies for real compliance, allowing for the realities of people's behavior. The time, therefore, for any change to be effective is going to be extensive, and, let's face it, we do not know that our cures will work. We may find that we have made mistakes -- we may not have considered the whole problem or there may be new factors or interactions appearing that require downstream adjustments. While "strategic hedges" can buffer some effects, they only provide brief time extensions and not cures.

It is obvious from the majority of the LOS discussions in this forum that scientific information provided from both ocean and atmospheric disciplines is a critical input to defining and implementing rational policies. The needed scientific information, however, is very closely interrelated with technology, a fact that really has not been discussed directly. Technology can, in some cases, drive science. While I am not the first to present this thesis before a major group, I certainly believe in it very strongly.

Science and technology, as represented in the model (*Figure 1*) by the labelled rectangles, are more or less in relative scale in terms of national resources. Technology, which includes industrial and military activities, is by far the larger.

Science develops a certain amount of its own technology -- technology that is essentially invisible to the outside world. That technology, often highly innovative, is used internally by scientists, is given sketchy honorable-mention, well after the fact, in peer-reviewed journals, and then drifts into obscurity. A small segment of that science-driven technology, however, does get out through a variety of informal routes into the commercial field, and at times proves useful

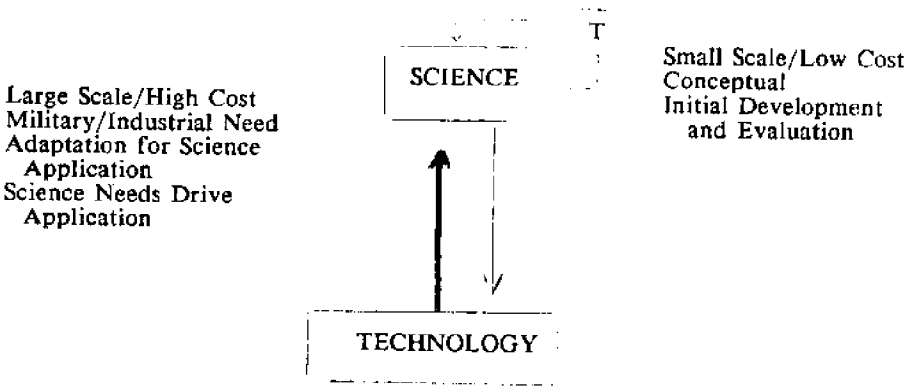
to professional technological interests, contributing substantially to the development of certain new technological tools.

FIGURE 1

SCIENTIFIC PROGRESS IS STRONGLY INTEGRATED WITH TECHNOLOGICAL DEVELOPMENT

TECHNOLOGY DRIVES SCIENCE

* Somewhat
* Sometimes



Opportunistic, innovative applications

Some of the total pool of these devices, developed and field tested at great expense by military and commercial interests, eventually -- by some kind of murky processes -- get released into the view of the scientific community. And when they do, they have proven to really dominate a major portion of ocean science for considerable periods of time.

Two cases that come to mind are multi-beam sonar (Sea Beam) and oceanographic satellite remote sensing. These tools have allowed much greater spatial and/or temporal views of areas or processes previously only spot sampled. They have promoted ancillary equipment development and utilization (i.e., bottom echo-sounders, submersible samplers, and water mass drifters) to provide both ground truthing and quantifiable sampling. New complex, theoretical circulation models have been established and confirmed through their symbiotic interaction.

While these new technologies provide links among present investigations and suggest new ways to research phenomena of interest, they also consume segments of available scientific funding. Even though their use proves highly beneficial, they do replace other research initiatives, especially small-scale ones. Additionally, they attract graduate students about to enter the most productive period of their scientific careers and thereby become somewhat self-perpetuating. Therefore, careful review, selection, and encouragement among potential techniques is critical.

Additionally, development of more effective use of the whole process is required to maximize our national and international return-on-investment and minimize elapsed time to application. There are a number of factors that affect this process. The first is that no one is making *new* resources available. We are talking about competing for resources already programmed. So we, as an ocean/atmospheric advocacy group, have to have our whole story together, and it has to be a very well thought-out, efficient story strongly related to a firm schedule of events. Secondly, we have to be much more cost-effective in producing and introducing new technology. One of the best ways to do this is to maximize our use of the technology already out there. This means improving industry's visibility into what science is doing at the earliest practical time and in the most useful framework we can devise. Right now we are, at best, marginally effective. Additionally, many academic institutions have first-class specialized design, development and test capabilities that can assist industry in the development of initial concepts, product evaluation and problem solving (i.e., WHOI's Deep Submergence Laboratory, URI's Equipment Development Laboratory).

We should be doing other things to make heavy use of academic/industrial cooperative development both nationally and internationally. For instance, there has been a lot of interest by the U.S. government and in some states in trying to set up cooperative programs, such as the federal Small Business Innovative Research (SBIR) programs and its state counterparts. Massachusetts' Centers of Excellence and Rhode Island's Partnership are representative examples. These activities require both academic and industrial participation and must demonstrate some eventual hope of economic benefits. They provide some fairly easy-to-obtain start-up funds through relatively red-tape-free processes. With any real demonstrated progress, they give a timely and substantial second monetary contribution to push the new developments into well-researched expanding markets.

Markets, of course, are the reason that most businesses get involved. Therefore anything that can expand the potential market for the technology into new arenas is perceived as beneficial. Providing standards, as is the case with computer interfaces and computer software and ships, can be highly beneficial in the process. Cooperative industrial participation in joint programs has been pursued recently, and in a much more aggressive and interested posture than in the past, but there is far to go. (United States/Canadian Ocean Technology Exchange

Conference, June 1-2, 1988, held at URI; Marine Instrumentation Panel, June 7-8, 1988, held at WHOI.)

Historically we find that the process for developing new technology and bringing it on-line in science seems to be full of both delays and voids. Some of the delays are simply because of funding unavailability. However, others occur because a real need for the device has not been laid out and there is no interested communication to argue for the program. The net effect is very inefficient in producing timely science with state-of-the-art equipment.

Additionally, there seem to be cases where the process has a gap with no way to get there from here. For instance, small-scale, low-cost submersibles, ROVs and autonomous vehicles are appearing in the market right now and have great promise for nearshore (EEZ) work in the shallow water biosphere and geological regimes. They have been demonstrated as a type. That is, scientists has been shown to be capable of driving a one-person submarine and doing some useful science; however, many scientists who have expressed a strong desire to do work in their respective disciplines have not been able to demonstrate whether or not their particular work can effectively be done using these devices. As such, they are not in a position to make any sort of a defensible proposal that their peers will take seriously. So the technology sits on the shelf. The need is there, but the present process does not allow it.

Enough hand-wringing. I think we, as policy makers, should become more interested and involved in the process of bringing technology to bear on the questions that we must face and deal with. Improvements in the technological development process are critical for science to give us all a rational basis for policy actions -- while there is still time. Let's not wait for the inevitable disasters to strike.

PART V

SCIENTIFIC ISSUES: LAW OF THE SEA CONFERENCE AND ACCESS; TECHNOLOGY AND DATA MANAGEMENT

PANEL V

INTRODUCTION

John Knauss: It is simplistic to say that ocean policy, and therefore the law of the sea is driven by science and technology, but it is worth remembering. Without offshore oil technology, there would have been no need for a Continental Shelf Convention. In the absence of refrigeration, I doubt if there would have been as much demand for an EEZ, since I expect there is even less market today for salt cod and pickled herring than there was 150 years ago when ice was first introduced on fishing boats and distant water fishing fleets began to grow to meet the demand for fresh fish.

Much of this conference has been devoted to problems and issues that new technology may raise -- from salvage and underwater archaeology to using the deep-seabed for emplacement of high-level radioactive waste. It seems clear from the discussion that our present conventions are equipped to handle some issues better than others.

This session is a bit different. We are going to consider issues that affect, and sometimes constrain, marine science. The first of these is the process of access -- what impediments do scientists face in carrying out their research in the ocean? The second is data, information and transfer -- how does one cope with, let alone maximize the value of the relatively recent extraordinary explosion in data and information?

For most marine scientists, most of the time, access to the ocean to do science is limited by either funding or appropriate technology, or both. But a bit over 20 years ago with the entering into force of the 1958 Continental Shelf Convention, access to certain areas of the ocean for marine science was limited by the law of the sea. My original interest in the law of the sea was triggered by contemplating what the 1958 Continental Shelf Convention implied for marine scientific research in negotiations for a new convention in which one had to assume that there would be extended national and international jurisdiction over ocean resources. The fact that the United States, along with France, had played a leading role in giving the coastal State wide discretion to control marine scientific research on its continental shelf did not bode well for the future. As some of you may know, the United States science community was eventually able to overcome the concern of the oil industry and it became U.S. policy to advocate maximum freedom of marine scientific research on the continental shelf and in the exclusive economic zone; but we, the international science community, failed to convince the Group of 77, and perhaps more importantly to convince many of the major oceanographic researching States in the developed world. In fact we faced active opposition from such major research States as Canada, the United Kingdom, France, Australia, and eventually the USSR.

Although the resulting regulations on marine scientific research in the exclusive economic zone and on the continental shelf were not as restrictive as they might have been, there was widespread concern that their implementation would have a devastating effect on marine scientific research.

We have two papers to address this subject. The first by Fred Soons emphasizes the experience of the European community. The second by Dave Ross updates the experience within the United States.

Oceanography has changed dramatically in the forty-plus years I have been associated with it, but nowhere as much as in the increase in the size of the data stream. Perhaps one way to illustrate this is by personal recollection. Thirty years ago, almost to the day, I returned from a two and a half month expedition to the equatorial Pacific whose major purpose was to measure sub-surface ocean currents. With considerable help, I had designed a state-of-the-art system -- the best available at the time. During my two and a half months at sea, I was able to make about sixty sets of observations. Each set was made at about thrity-five different depths, and each observation, once all components were in place, required less than two minutes. In other words, I returned with about sixty hours of current measurements. However, to make these observations required a minimum of two people hand-recording while the instruments were in the water, and the reduction by slide rule of data from paper tapes and radar plots.

Fifteen years later, a number of my colleagues, including one on this panel, routinely measured sub-surface currents in the open ocean with moored current meters that recorded on magnetic tape, and whose data were reduced by computer. This was a major step forward, but it was only the beginning.

Having returned to oceanographic research after twenty-five years in administration, I have a graduate student who was promised to teach me how to manipulate remote sensing data from a satellite. As near as I can judge, each day's observations of the Gulf Stream area with which I will be working, encompasses more data points than all of the previous data combined that I have collected and used in an observational career that began in 1947 and ended in 1967 and covered three oceans.

Not all data are equal; and one should not confuse data with useful observations, and observational information with knowledge. A few carefully chosen observations are often more important than a large torrent of data from an ill-defined experiment. But it is important to remember that whether the data stream is a trickle or a flood, all must be treated with the same rigorous quality control and calibration procedures if it is to useful. I find the present rate of data acquisition mind boggling -- but it is little wonder that data management is high on the priority of those who contemplate the needs and possibilities of the future. Each of the members of this panel have grappled with one aspect or another of this issue.

The Developing Regime of Marine Scientific Research: Recent European Experience and State Practice

Alfred H.A. Soons
Netherlands Institute for the Law of the Sea
University of Utrecht

1. Introduction

This paper presents the first preliminary results of a study of recent experience and practice of European States (the member States of the EEC) with the developing regime of Marine Scientific Research (MSR).

The experience of the United States has been described by Wooster[1] and by Knauss and Katsouros.[2] These contributions are extremely important for assessing the impact recent State practice has on the conduct and development of MSR, and for monitoring the development of rules of customary international law on the one hand and the implementation (and interpretation) of the provisions of the LOS Convention by signatories and parties to the Convention on the other hand. For these purposes, however, not only U.S. experience should be monitored but also the experience of other States. This paper attempts to contribute to this end.

In this connection mention should be made of the important initiative of the U.N. Secretariat (Office of the Special Representative of the Secretary General for the Law of the Sea) and the Intergovernmental Oceangraphic Commission (IOC) to convene a workshop in 1989 dealing with State practice and experience concerning MSR.[3] The results of such a workshop could greatly assist both coastal and researching States in the practical implementation of the consent regime of the LOS Convention.

This study focuses on State practice with respect to the actual processing of clearance requests for MSR. Little attention is paid to analyzing the formal rules (legislation) established by coastal States. This has been done to some extent by others.[4] It has, however, proven very difficult to collect sufficiently detailed information on actual practice of so many States. The most detailed information collected concerns The Netherlands. These data still have to be expanded and checked to some extent. More information on the practice and experience of other EEC Member States is still being collected.[5] It is hoped that such information can be included in a future, expanded version of this paper.

Before discussing European experience and State practice, the LOS Convention's MSR provisions will be briefly summarized.

2. The LOS Convention Regime for Marine Scientific Research[6]

The 1982 U.N. Law of the Sea Convention provides for full coastal State control over marine scientific research in the internal waters, archipelagic waters and territorial sea (Article 245). Marine scientific research conducted in the high seas (the water area beyond the exclusive economic zone) and in the international seabed area is free (i.e., subject exclusively to the jurisdiction of the flag State) (Articles 87, 143, 256 and 257), except for marine scientific research concerning the continental shelf extending beyond 200 nautical miles from the baseline of the territorial sea. Such research is subject to coastal State jurisdiction almost to the same extent as research conducted on the

continental shelf within 200 nautical miles from the baseline, the only difference being that the absolute consent regime for marine scientific research of direct significance for the exploration and exploitation of natural resources only applies to certain designated areas of this part of the continental shelf (Article 246, paragraph 6).

All marine scientific research activities in the exclusive economic zone and on the continental shelf require coastal State consent (Article 246, paragraphs 1 and 2). This full consent regime is partly absolute, partly qualified. It is absolute to the extent that coastal States have the discretionary power to grant or withhold consent for certain categories of research, the most important of which is research of direct significance for the exploration and exploitation of the natural resources (Article 246, paragraph 5). It is qualified, to the extent that coastal States are required to grant consent, in normal circumstances, for all other marine scientific research activities (Article 246, paragraphs 3 and 4). Coastal State consent need not necessarily be given expressly. It may be implied in two situations, *viz.*, when the coastal State has not reacted within four months the communication to informing it of the intention to conduct the research (i.e., the request for consent) (Article 252), or when the research is undertaken by an international organization of which the coastal State is a member and the research project in question was approved by the coastal State when the decision was made by the organization to undertake the project (Article 247).

States intending to undertake marine scientific research in the exclusive economic zone or on the continental shelf of a coastal State should provide the coastal State with certain, specified information at least six months before the expected starting date of the research work; this is to be regarded as the request for coastal State consent (Article 248). The researching State must comply with a number of specified conditions, the most important of which are granting the coastal State an opportunity to participate or to be represented in the research, providing it with the results of the research and with access to the data and samples collected, and assisting it in assessing or interpreting the data, samples and research results (Article 249). All communications between the researching State and the coastal State should be made through appropriate official channels (Article 250). In certain, specified situations the coastal State has the right to order the suspension or cessation of research activities in progress (Article 253). Neighboring land-locked and geographically disadvantaged States should be notified of proposed research projects (except for those covered by the absolute consent regime) and are entitled to require certain, specified information and assistance from the researching State; they should be given an opportunity, whenever feasible, to participate in the research (Article 254).

Disputes concerning the exercise by the coastal State of its rights to withhold consent for marine scientific research or to order its suspension or cessation are only - and to a limited extent - subject to a conciliation procedure; all other disputes concerning marine scientific research are to be settled in accordance with procedures entailing binding decisions (Article 264 and Part XV of the Convention).

EXPERIENCE AND PRACTICE OF THE NETHERLANDS

3.1 Background Information

Geography and jurisdiction

The Kingdom of The Netherlands consists of three parts: one situated in Europe (referred to as The Netherlands), and two in the Caribbean (Aruba and the Netherlands Antilles). The European part of the kingdom borders on the North Sea, a semi-enclosed sea. The breadth of its territorial sea is twelve nautical miles. Continental shelf rights are exercised over an area enclosed by the continental shelves of Belgium, the United Kingdom and the Federal Republic of Germany. The Netherlands has also established a fishing zone, the outer limits of which coincide with the outer limits of the continental shelf. An EEZ has not been established. The total area of the territorial sea and continental shelf/fishing zone in the North Sea is approximately 60,000 square kilometers.

The Caribbean parts of the Kingdom of the Netherlands also have a territorial sea of twelve nautical miles. Both parts exercise continental shelf rights. A fishing zone or EEZ has not been declared.

The maritime areas under the jurisdiction of Aruba border on those of Venezuela, the Dominican Republic and the Netherlands Antilles. The combined area of the territorial sea and continental shelf of Aruba is approximately 30,000 square kilometers.

The Netherlands Antilles consist of two groups of islands: the Leeward Islands (Curacao and Bonaire) off the coast of South America, and the Windward Islands (Sint Maarten, Sint Eustatius, and Saba), almost 500 nautical miles northeast of the Leeward Islands. The Leeward Islands' continental shelf borders on areas under jurisdiction of Venezuela, the Dominican Republic, and Aruba. The Windward Islands' maritime areas are enclosed by those of the United States, the United Kingdom, France, St. Kitts and Nevis, and Venezuela. The total area of the Netherlands Antilles' sea area is approximately 60,000 square kilometers.

Distant-water research capability

Only institutions located in the European part of the kingdom operate research vessels capable of (and actually employed for) conducting research beyond the maritime areas under Netherlands jurisdiction. The institutions and research vessels are:

- Royal Netherlands Navy, Hydrographic Service (R/V *Tydeman*, part-time employed for oceanographic research; in addition there are two vessels employed exclusively for hydrographic surveying work)
- Netherlands Institute for Sea Research (R/V *Aurelia*)
- Netherlands Marine Research Foundation (R/V *Tyro*)
- State Institute for Fisheries Research (R/Vs *Tridens* and *Iris*; occasionally, additional vessels are chartered)
- Department of Water Management and Public Works (*Rijkswaterstaat*), North Sea Directorate, operating several research and survey vessels occasionally active in waters under foreign jurisdiction.

3.2 The Netherlands as a researching State

Procedure

Clearance requests for Netherlands research vessels to conduct research in areas under the jurisdiction of other coastal States are always made through diplomatic channels. Requests concerning fisheries research are sent directly by the Ministry of Agriculture and Fisheries to the Agricultural Attaches at the Netherlands Embassies in the capitals of the coastal States concerned. The embassy submits the request to the local Ministry of Foreign Affairs. The reply from this ministry is again sent directly to the Ministry of Agriculture and Fisheries in The Hague. For all other research projects the institutions involved send their clearance requests to the Netherlands Ministry of Foreign Affairs (Office of the Transport Adviser); the ministry forwards the request to the Netherlands Embassies in the capitals of the coastal States concerned, which submit them to the local Ministry of Foreign Affairs. The replies from the ministries are sent by the embassies to the Ministry of Foreign Affairs in the Hague.

All clearance requests are accompanied by a form containing information on the research project. For this purpose the ICES form "Notification of proposed research cruise" is used. The Netherlands Ministry of Foreign Affairs forwards to coastal States all clearance requests for research programs of Netherlands institutions, regardless of the lead time. However, it strongly advises the institutions to respect a lead time of three months for research in areas of north-western European States, four months for France and six months for all other States.

Experience

In the past several years (1980-1987) approximately 75 clearance requests per year have been submitted to coastal States by the Netherlands. About 60 of the requests (80 percent) concern fisheries research. Most of the fisheries research projects are conducted within the framework of the International Council for the Exploration of the Sea (ICES). All of this research was carried out in the waters of Ireland, United Kingdom, France, Belgium, Federal Republic of Germany, Denmark and Norway. There have been no instances of refusals by coastal States, or other cases of research which was not carried out because of (in)action by the coastal State involved (late response, unacceptable conditions), even though in most cases the lead time was less than three months. There has been one instance of an initial refusal by the coastal State (France), based on insufficient lead time, but permission was later given in time for the project to be executed in the period originally planned. In all instances the coastal State requested to receive in due course a report of the research cruise. In not one instance did the coastal State require the presence of an observer from the coastal State on board the research vessel.

The other clearance requests (approx. 15 per year) concern research not related to fisheries. About half of these requests involve coastal States not bordering the North Sea. These include Spain, Portugal, Italy, Malta, Greece, Turkey, Egypt, Libya, Tunisia, Algeria, Morocco, Mauretania, Cape Verde, Senegal and Indonesia.

In four cases the coastal State refused permission for part of the research to be carried out. In three of these cases, the refusal concerned the part of the research project to be conducted within the territorial sea: Libya; France (Mediterranean sea coast); and Norway

(Spitzbergen - the refusal in this case was due to the status of the vessel to be employed, the *R/V Tydeman*, officially classified as a warship). The fourth case concerns Greece, which refused permission to do research in the Aegean Sea because of the dispute with Turkey over the delimitation of the continental shelf.

In one instance a clearance request was withdrawn before a response from the coastal State was received (Turkey, in view of the imminent danger of armed conflict between Turkey and Greece over the Aegean continental shelf).

In another instance (Malta) a research cruise for which permission had been given was later adapted in such a way as to avoid conducting research activities in the Maltese EEZ. Malta had granted permission subject to the condition that an observer from Malta would be present on board the research vessel during its work in the Maltese EEZ for only one or two days. The Maltese condition was considered impracticable in these circumstances.

In several instances no response from the coastal State was forthcoming, although the request was made more than six months in advance. In those cases coastal State consent was presumed and the research was carried out as planned. Cruise reports were subsequently forwarded to the coastal States involved.

Except in the case of Greece referred to above and the few cases where the coastal State did not respond (which did not affect the execution of the research programs), the clearance requests for research in areas beyond the territorial sea (continental shelf, fishing zone, exclusive economic zone) have been granted, even though the lead time in several instances had been less than six months.

When granting permission, most coastal States explicitly required that reports on research results be forwarded to it. The Netherlands practice is to send a cruise report ("shipboard report") through diplomatic channels within two months of the completion of the research cruise. The coastal State is asked to get in touch directly with the scientific institution involved if it wishes to receive more information on the results of the cruise. These direct contacts have not been monitored by the Ministry of Foreign Affairs. Coastal States have contacted the scientific institution in several instances. It should be mentioned, however, that in most cases scientists from the coastal State participating in the research project have been actively engaged in the evaluation stage of the project.

In cases of research cruises outside the North Sea region the coastal States involved have generally made their consent conditional upon the presence of one or more observers or participants from the coastal State on board the research vessel. In at least two instances, coastal States which had originally indicated their intention to send observers later decided not to exercise this right.

Special mention must be made of the 15-month cruise of the Netherlands' *R/V Tyro* in the Indonesian archipelagic waters during 1984-1985. This cruise was part of the so-called "*Snellius II*-expedition", a joint Indonesian-Netherlands MSR-project conducted under a special Memorandum of Understanding between the two Governments. This joint project proved a great success in all respects.

3.3 The Netherlands as a Coastal State

A. European waters

Rules and procedures. No legislation or rules dealing specifically with the conduct of MSR in maritime areas under Netherlands jurisdiction have been adopted. MSR involving the taking of fish in the Netherlands fishing zone (including the territorial sea) is governed by legislation dealing with fishing. This legislation implements the EEC's Common Fisheries Policy. The Minister of Agriculture and Fisheries is empowered to grant exemptions from the prohibitions on fishing, for the purpose of fishing for scientific research.

As far as research on the continental shelf is concerned, Article 2, paragraph 2 of the Continental Shelf Mining Act (which also applies in the outer nine miles of the territorial sea) provides that research "which may lead to the proving of the presence of exploitable quantities of mineral resources" may only be undertaken with a prior exemption from the Ministers of Economic Affairs and of Education and Sciences. Since the entry into force of this Act in 1965 such an exemption has been granted only once. Apparently all other scientific research done on the Netherlands' continental shelf has been considered as not coming within the scope of Article 2, paragraph 2 of the Continental Shelf Mining Act.

The Netherlands requires three months advance notification of research activities to be conducted in areas under Netherlands jurisdiction. The notification should be submitted through diplomatic channels (by the Embassy of the researching State in The Hague to the Ministry of Foreign Affairs). In practice, many notifications have been processed which were received less than three months in advance. Usually it is possible to reply within four or six weeks. The replies employ the standard phrase that "there are no objections" to the proposed research cruise, instead of giving "permission" (or similar terms).

Experience

Table 1 gives the numbers of notifications of research cruises to be conducted in Netherlands' waters processed during the period 1980-1987. Of a total number of 216 notifications only one has been objected to. This case (involving a research vessel from the German Democratic Republic in 1986) was mainly due to insufficient lead time (two weeks) combined with inaccurate information supplied. The project was carried out later that year after a new notification had been received.

In 151 cases (70 percent) the project involved fisheries research. Most fisheries research is conducted within the framework of ICES. In such cases the researching State is not requested to submit a cruise report. In other cases this request is usually made. In most cases involving geological/geophysical research it is indicated that an observer/participant from the Netherlands will be present on board the research vessel.

TABLE I

Numbers of Notifications of Research Cruises in Netherlands Waters

	1980	1981	1982	1983	1984	1985	1986	1987	total
U.K.	8	12	3			7	10	7	47
Norway	6	2		5	3	5	5	3	29
Denmark					2	3	6	1	12
FRG	9	9	2			18	24	25	87
Belgium							13	7	20
France	1	1	3	1	5	2	2	2	17
GDR						1	2*	1	4
Total	24(2)	24(1)	8(1)	6(1)	10(1)	36(10)	62(29)	46(20)	216(65)

(the figures between brackets indicate the numbers of research projects *not* related to fisheries)

* One proposed research cruise was objected to.

B. Caribbean Waters

Rules and procedures

Aruba and the Netherlands Antilles have not adopted any legislation or rules dealing specifically with the conduct of MSR.

Notification should be submitted at least three (preferably six) months in advance through diplomatic channels. The Ministry of Foreign Affairs in The Hague will forward notifications to the Plenipotentiary Minister of Aruba and/or the Netherlands Antilles in The Hague, who in his turn will consult the competent authorities in Aruba and the Netherlands Antilles.

Experience

One or two notifications are received every year. The researching States involved have been the U.S. (mainly) and France and the Federal Republic of Germany. No proposed research cruises have been objected to.

EXPERIENCE AND PRACTICE OF OTHER EEC-MEMBER STATES

4.1 Belgium

As a researching State

For research by Belgian research vessels in maritime areas under jurisdiction of other States prior permission is requested through diplomatic channels, usually several months in advance. No problems in obtaining consent have been reported.

As a coastal State

Belgium regularly receives clearance requests from other States for their vessels to conduct MSR in the Belgian territorial sea, fishing zone or on its continental shelf. According to the Belgian Ministry of Foreign Affairs these requests are usually made five or six weeks in advance. No problems have been encountered so far. Belgium does not have legislation dealing specifically with MSR.

4.2 Denmark

As a researching State

Denmark has only requested permission to conduct MSR in maritime areas under jurisdiction of neigboring States, including Canada (near Greenland) and the Baltic States. No problems have been encountered, except for several instances of refusals by the Soviet Union for fisheries research in the EEZ. The Soviet Union considered such research to be fishing, for which permission would be required on the basis of bilateral fisheries agreements.

As a coastal State

Foreign research vessels may only conduct MSR in the Danish territorial sea, fishing zone and on the continental shelf with the explicit permission of the competent Danish authorities. Such permission must be requested through diplomatic channels at least one month in advance. Approximately 170 requests are received each year; permission is granted in nearly all cases. In some instances the condition is attached that a Danish observer will be on board the research vessel during the cruise.

4.3 France

As a researching State

No information available.

As a coastal State

According to Article 2 of Act No. 86-826 of July 11, 1986, any MSR in the French territorial sea, EEZ or on the continental shelf requires permission. In the absence of a Decree implementing this provision France applies the provisions of Part XIII of the LOS Convention.

4.4 Federal Republic of Germany

As a researching State

The FRG has reported several problems in recent years. In six cases research projects have not been executed because of refusals or unacceptable conditions by coastal States in Africa and Asia. In each case the clearance request was made at least six months in advance. Almost no problems have been encountered with European States. (Mangone reports that the FRG Foreign Office sends about 800 notifications or applications for MSR to other States in a year.[7] In 1979 there were two denials of fisheries research by the Soviet Union and one by Poland.)

The FRG receives approximately 30 applications per year. In all cases approval has been forthcoming.

4.5 Greece

As a researching State
No information available.

As a coastal State
Greece requires that requests for permission to conduct MSR in its territorial sea or on its continental shelf be submitted two months prior to the expected starting date of the research (Circular Note of January 31, 1978).

4.6 Ireland

As a researching State
Ireland's experience of MSR in waters under the jurisdiction of other States is limited and all such research has been limited to Europe. No difficulties in obtaining consent have been reported.[8]

As a coastal State
MSR in Ireland's territorial sea, exclusive fishery zone and on its continental shelf requires prior permission. Requests should be submitted to the Department of Foreign Affairs through diplomatic channels six months in advance. In practice, requests received not less than three months prior to the commencement of the research are normally processed

Since 1980 over 300 foreign MSR cruises have been conducted in waters under Irish jurisdiction (1980: 32; 1981: 69; 1982: 58). The States concerned included the U.K., France, FRG, Netherlands, Norway, Poland, and the U.S. In not one instance has consent been withheld. In most cases an Irish observer has been placed on board.[9]

4.7 Italy

As a researching State
No information available.

As a coastal State
Italy follows the rules and procedures set out in Part XIII of the LOS Convention in respect of all requests to carry out MSR in its territorial sea or in the area of its continental shelf.

4.8 Portugal

As a researching State
No information available.

As a coastal State
Decree No. 52/85 of March 1, 1985, lays down the provisions governing the conduct of MSR in the Portuguese territorial sea and EEZ. This Decree largely follows the provisions of Part XIII of the LOS Convention.

4.9 Spain

As a researching State
No information available.

As a coastal State

MSR in areas under Spanish jurisdiction is governed by the provisions of Royal Decree No. 793/81 of February 27, 1981, which closely follow the provisions of Part XIII of the LOS Convention. Especially noteworthy is Article 10, paragraph 2, which provides that consent for MSR in the Spanish EEZ and on the continental shelf may be presumed if the Ministry of Foreign Affairs has not reacted within four months after receipt through diplomatic channels of the request for permission.

4.10 United Kingdom

As a researching State

The U.K. has an extensive MSR program both in the waters of neighbouring States and in more distant areas. In several instances problems have been encountered with developing coastal States. In only a few cases consent has been withheld. The main problems encountered concern:

- delays caused by bureaucratic procedures;
- access to the territorial sea;
- insistence by some coastal States that publication of results is subject to their prior approval.

In 1985 one case was reported of a rejection of an U.K. request by the Soviet Union. This involved a MSR project to be carried out in the Soviet EEZ (ICES Fishing Area Barents Sea 1).[10]

As a coastal State

MSR may be conducted in the territorial sea or on the continental shelf of the U.K. only with the consent of the appropriate British authorities. For research within the British fishery zone prior notification is necessary. The application form should be submitted three months in advance through diplomatic channels; a reply is usually forthcoming within two months. In the period October 1986 - October 1987 some 90 applications were received. All were approved.

DISCUSSION OF SOME SELECTED ISSUES

5.1 Definition of MSR

From studying the files it becomes apparent that in many cases both researching and coastal States have considered certain activities to be MSR which may not qualify as such, at least not within the meaning of this term in the LOS Convention. This means that any data supplied by States with respect to their experience with the rules governing MSR should be viewed with caution.

Careless use of terms may lead to confusion about the applicable rules. MSR should be distinguished from other data-collecting activities at sea. For example, hydrographic surveying and marine archaeological research are activities with a separate legal regime.[11] These activities have been excluded from the research done for this paper. However, in some other areas the distinctions are less clear.

The term "fisheries research" is used in European State practice to denote various types of activities, most of which involve the taking of fish. Research activities, most of which involve the taking of fish,

conducted specifically for the purpose of monitoring, conservation or management of fish stocks need not be regarded as MSR. Such activities, like exploratory fishing, come within the scope of a coastal State's sovereign rights with respect to the exploration and exploitation of living resources within its territorial sea and EEZ. In practice, however, there need not be much difference between the ways a coastal State treats such activities and its treatment of (commercial) fishing activities, since such fisheries research activities, if regarded as "MSR", may be qualified as "research of direct significance for the exploration and exploitation of natural resources" which, according to Article 246, paragraph 5 of the LOS Convention, when conducted in the EEZ, is subject to a coastal State's discretionary powers to grant or withhold consent.

In a number of instances, clearance requests concerned so-called "technical fisheries research," mainly experiments with fishing gear. Those cases involved fishing. However, the fishing activity was not conducted for the purpose of catching fish to be sold commercially; the catch resulted from the testing of the gear. Even though one may call this activity "research" it would appear to me that it is not included in the concept of MSR as employed in the LOS Convention. MSR covers those scientific investigations having the marine environment as object. Since technical experiments with fishing gear do not involve the collection of information on the marine environment as such, they need not be regarded as "MSR". Rather, such activities would seem to constitute "fishing" (albeit not for commercial purpose) governed by the coastal State's fishing regulations. However, in all instances referred to above the coastal States involved have processed the clearance requests as requests to do research. They were treated in exactly the same way as MSR in the proper sense.

A similar situation involves the testing at sea of instruments for naval warfare, e.g., acoustic experiments with sonar systems. Several instances have been found where a State intending to do such research in the EEZ of another State, informed the coastal State through diplomatic channels of its intention, and requested clearance for this "research". Such activities would not seem to constitute "MSR", but were apparently treated as such by the States involved. These cases are perhaps more interesting than the fisheries research cases because in the latter cases the activity would be under coastal State control anyhow, whereas in the military "research" cases the coastal State would not have jurisdiction over such activities in its EEZ. State practice should be viewed with caution. The fact that certain clearance requests were processed (both by the researching and the coastal State) as if they concerned MSR, does not necessarily mean that the States involved have made deliberate decisions to treat them as such; rather, these could have been cases of ignorance by the bureaucrats involved of the applicable rules of international law. The impact of such State practice on the legal regime is still unclear.

5.2 Implied Consent

A number of instances have been identified where the "implied consent" rule as embodied in Article 252 of the LOS Convention has been applied. In those cases the coastal States involved did not protest after they received cruise reports indicating the conduct of the research activities.

So far, two States have in their national legislation on MSR, explicitly provided for implied consent: Spain[12] and the Soviet Union.[13]

One other State (Indonesia) explicitly recognizes implied consent according to the "Elucidation" concerning its EEZ legislation.[14] On the other hand, many States state that they follow the LOS Convention rules, but have no explicit reference to implied consent in their legislation.

In many instances, researching States have proceeded with the preparations for (and even initial execution of) research projects notwithstanding the fact that no response had been forthcoming from the coastal State within four months from the date of the clearance request. But since coastal State consent eventually was given, these cases may not formally be regarded as applications of the "implied consent" rule.

I have found no cases of coastal State refusals occurring after four months from the receipt of the clearance request without having reacted before; it would have been interesting to see how the researching State would react to such a situation.

5.3 Land-locked and Geographically Disadvantaged States

Article 254 of the LOS Convention provides that land-locked and geographically disadvantaged States (LLGDS) neighboring to the coastal State should be notified by the researching State, and should be provided with information and be given the opportunity to participate upon their request. I have not found indications that another State other than the coastal State in whose EEZ a research project was to be carried out, has been involved by virtue of the fact that that other State was a neighboring LLGDS.

Notifications or clearance requests from the researching State have only been sent to the coastal States involved.

This seems to indicate that the LLGDS-provisions of the LOS Convention are not part of emerging customary international law.

It is probable that these provisions, after the entry into force of the Convention, will not be applied and become "dead letters" in the Convention.

5.4 Official Channels

European State practice confirms that clearance requests are always made through diplomatic channels. The requirement of the LOS Convention (Article 250) to use "official channels" for all communications between researching States and coastal States thus seems firmly established in State practice.

5.5 Lead Time

The LOS Convention requires that clearance requests are made at least six months in advance. This entitles the coastal States to prohibit the conduct of MSR within six months of the receipt of the clearance requests. European State practice indicates that this period is generally considered acceptable if insisted upon by a coastal State. Several coastal States, even though they formally require six months advance notification in practice, are prepared to process clearance requests up to three or four months in advance.

Within the European context, the North Sea coastal States in particular still apply a considerably shorter period (three months) with respect to MSR to be conducted in areas under their jurisdiction. In some cases this may be done on the basis of reciprocity, in others it is applied generally. Even when officially requiring three months advance notice, the coastal States involved frequently process clearance requests made less than three months in advance.

In cases where coastal States officially require only three months advance notification it will be extremely difficult to determine if some form of modified "implied consent" rule will be established (e.g., consent may be presumed if there is no reaction within two months). Instances are known of research activities which were actually started before formal approval had been received, but in these instances approval was received during the research work (in some cases shortly after completion of the research) while it was understood from contacts with the coastal States that no objections were to be expected.

5.6 MSR By or Under Auspices of International Organizations

Article 247 of the LOS Convention provides that a coastal State shall be deemed to have authorized a MSR project to be carried out under the auspices of an international organization if the coastal State had earlier approved the project within the framework of the organization and has not objected to its execution within four months of notification of the project by the organization to the coastal State.

In recent European State practice no instances have been found of the application of such a rule. Most fisheries research is being conducted under the auspices of ICES. Still, for all such research cruises, separate clearance requests are made by the research States to the coastal States even when both States are members of ICES and the cruise is part of the research program adopted by ICES. This results in a lot of administrative work by handling hundreds of clearance requests every year by the authorities of the member States of ICES. Attempts to decrease the paperwork involved by adopting simpler procedures for such fisheries research have not been successful so far. This may be due to the fact that the membership of ICES is heterogeneous politically: it includes both NATO members and Warsaw Pact members, EEC members and non-EEC members.

Perhaps attempts to introduce simpler procedures will be much more successful if these would be restricted to, for example, the EEC Member States or the North Sea coastal States.

5.7 Scope of Coastal State Jurisdiction

It is interesting to note that EEC Member States which have not established an EEZ (United Kingdom, Belgium, The Netherlands, Federal Republic of Germany, Denmark, and Ireland) in fact claim some form of jurisdiction over MSR which goes beyond what they would be entitled to according to their sovereign rights with respect to the continental shelf and fishing zone. Those rights are limited to certain categories of MSR. However, these six countries require ("expect") to be notified also of MSR activities not concerning the continental shelf or not constituting fisheries research.[15] Although some of these States are very careful in describing their involvement with such activities (they merely "expect" or require notification, and inform the researching State of having "noted" or "making no objection to" the proposed research cruise), it could be argued that they in practice exercise some form of EEZ jurisdiction over MSR without having formally established an EEZ.[16] It would be interesting to note the reaction of these States to such MSR activities in their fishing zones which have not been notified to them.

5.8 Normal Circumstances

According to Article 246, paragraph 3, coastal States shall, *in normal circumstances*, grant consent for MSR projects to be conducted

in their EEZ. Some situations which can be regarded as non-normal circumstances seem to have emerged. In particular, situations where coastal States have overlapping claims to marine areas (delimitation disputes) appear to qualify as such. The Aegean Sea is a case in point.

NOTES

1. Wooster, W.S., "Research in troubled waters: U.S. research vessel clearance experience 1972-1978", *Ocean Development and International Law Journal 1981*, pp. 219-239.
2. Knauss, J.A. and Mary Hope Katsouros, "The Effect of the Law of the Sea on Marine Scientific Research in the United States: Recent Trends", in *The U.N. Convention on the Law of the Sea: Impact and Implementation*, E.D. Brown and R.R. Churchill eds., Law of the Sea Institute, Honolulu 1987, pp. 373-382.
   Knauss, J.A. and Mary Hope Katsouros, "Recent experience of the United States in conducting Marine Scientific Research in Coastal State Exclusive Economic Zones", in *The Law of the Sea: What Lies Ahead?*, T.A. Clingan ed., Law of the Sea Institute, Honolulu 1988, pp. 297-309.
3. Law of the Sea, report of the Secretary-General, U.N. Doc. A/42/688, 5 November 1987, pp. 22-24. See also *Oceans Policy News*, October/November 1987, p. 2.
4. Burke, W.T., "National legislation on ocean authority zones and the contemporary law of the sea", *Ocean Development and International Law Journal 1981*, pp. 289-322; Juda, L., "The Exclusive Economic Zone: Compatibility of National Claims and the U.N. Convention on the Law of the Sea", *Ocean Development and International Law Journal 1986*, pp. 1-58; Attard, D.J., *The Exclusive Economic Zone in International Law*, Oxford (Clarendon Press) 1987, pp. 119-123.
5. Some of the data on EEC Member States used in this paper are based on information collected by a Working Group on legal aspects of MSR established by the Council of the European Communities in 1987.
6. For a detailed analysis of the LOS Convention's MSR regime, see A.H.A. Soons, *Marine Scientific Research and the Law of the Sea*, Deventer (Kluwer Law and Taxation Publishers) 1982, pp. 99-260.
7. Mangone, G.J., "The Effect of Extended Coastal State Jurisdiction over the Seas and Seabed upon Marine Science Research", *Ocean Development and International Law Journal 1981*, pp. 214-215. The figure of 800 seems extremely high.
8. Symmons, C.R. and P.R.R. Gardiner, "Marine scientific research in offshore areas. Ireland and the Law of the Sea Convention", *Marine Policy 1983*, pp. 291-301.
9. *Id.*
10. *British Yearbook of International Law 1985*, pp. 500-504.
11. With respect to the regime for hydrographic surveying, see Soons, *op. cit.*, note 6, pp. 7, 46-47, 55, 125, 147, 150-153, 157, and K.W. Kieninger, D.A. Reifsnyder and W.L. Sullivan Jr., "Immunities of Hydrographic Vessels Operating in the Exclusive Economic Zones", in *Proceedings of the 2nd International Hydrographic Technical Conference*, Brighton, September 1984, Paper 11 (pp. 1-8).
12. See *supra*, section 4.9.

13. Franckx, E., "Marine Scientific Research and the New USSR Legislation on the Economic Zone", *International Journal of Estuarine and Coastal Law 1986*, pp. 367-390.
14. U.N. Law of the Sea Bulletin, No. 7, April 1986, p. 37.
15. The Caribbean parts of the kingdom of the Netherlands have not established a fishing zone. Still, in practice jurisdiction is exercised over any MSR to be conducted in waters over their continental shelf areas.
16. The other side of the coin is that these same States not only recognize EEZ jurisdiction of other States, but also act as if other States have established an EEZ even if they have not (but only established a fishing zone, or not even that).

Marine Scientific Research: U.S. Perspective on Jurisdiction and International Cooperation

David A. Ross and Judith Fenwick
Dept. of Geology and Geophysics
Woods Hole Oceanographic Institution

Introduction

Many U.S. marine scientists and administrators in the late 1970s and early 1980s were skeptical about continued research access to foreign waters. Their uncertainties were heightened with the signing of the U.N. Convention on the Law of the Sea in 1982 and with the U.S. decision not to participate in this signing. The treaty clearly defined coastal State jurisdiction over marine scientific research (MSR) in States' coastal waters. What the treaty's impact would be on marine scientific research access was not obvious. Some thought that the treaty would ease research clearance problems and promote international cooperative research; others thought that the clearance situation would be further complicated and international cooperation would diminish.[1] The answer is still not obvious.

Certainly from the mid-1970s, with the increase in national claims out to 200 nautical miles, oceanographic research projects could not be planned as easily as they previously had been and the legal consciousness of many marine scientists was involuntarily raised. *Figure 1* charts the trend of 200-n.m. zone claims and coastal State jurisdiction over MSR from 1947. By the end of 1987, 105 coastal nations (from a total of 139) have claimed jurisdiction over 200-n.m. zones and 78 have some form of jurisdiction over research in their coastal waters. Scientists and planners now must consider various national claims on maritime areas in which they wish to do research (including some areas that are disputed). This means that projects must be planned well in advance in order to be processed through the U.S. Department of State's Research Vessel Clearance Office and then passed on to coastal States for approval.

This paper assesses the impact of increased coastal State jurisdiction on the U.S. MSR effort, discusses factors that may determine geographic choices by U.S. marine scientists for their sea-going research, and offers some speculation from the U.S. perspective on the future for access and international cooperation in marine scientific research.

Coastal State Jurisdiction and the U.S. Marine Scientist

Our analysis considers only those U.S. clearance requests passed through the Department of State on to coastal States from 1979-86. This assessment expands upon earlier studies by Knauss and Katsouros,[2] and like their work, shows an increase in the number of clearance requests. This increase is occurring simply because clearance requests are now required by at least 78 countries and are highly recommended for all other maritime countries. The increase itself is not proof of more international research.

FIGURE 1

Claims of 200-n.m. Zones and
Marine Scientific Research Jurisdiction
1947-1987

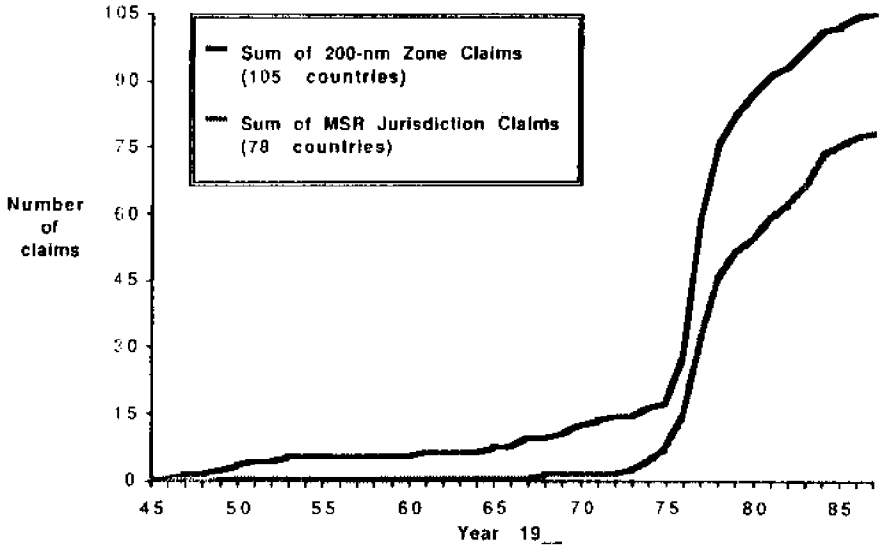


Table 1 shows all U.S. research clearance requests (passed through the U.S. Department of State) and denials by country from 1979-86. In this eight-year period there were 1,124 requests made to 76 countries. The summary of these activities (*Table 2*) also shows clearance denials and problems as a percent of the total requests. We have distinguished outright denials from clearance requests problems and segmented problems by their source. Where the coastal State was the source of problems, such problems may include late approvals resulting in delay or cancellation of research, approval withheld since the U.S. did not meet the 6-month lead time requirement, no response to the request, or conditions imposed by the coastal State (often unacceptable conditions). Where the U.S. was the source of problems, such problems may include cancellation or delay of research due to funding, equipment or scheduling problems, or where approval was granted even though the U.S. was late in submitting the request within required lead-time.

TABLE I

U.S. Department of State Clearance Request Activity 1979-1986

	1979	1980	1981	1982	1983	1984	1985	1986	Total Requests	Total Denials
ALGERIA	0	0	0	0	0	0	0	2	2	
ANTIGUA & BARBUDA	0	0	0	0	1	1	8	4	14	
ARGENTINA	1	0	3	0	0	3	1	2	10	
AUSTRALIA	2	0	0	0	0	1	2	2	7	
BAHAMAS	3	4	5	4	5	7	10	11	49	
BAHRAIN	0	0	0	0	1	0	0	0	1	
BARBADOS	1	1	3	1	5	5	8	5	29	
BELIZE	0	0	1	0	0	1	3	1	6	
BRAZIL	4	0	0	5	3	4	7	4	27	3
CANADA	14	22	14	16	27	35	36	39	203	
CAPE VERDE	0	0	0	0	0	0	1	1	2	
CHILE	4	1	2	2	5	6	1	3	24	
CHINA (PRC)	0	.	0	0	0	0	1	1	3	
COLOMBIA	0	0	0	0	1	0	2	6	9	
COSTA RICA	1	1	1	1	0	1	2	4	11	
CUBA	3	1	0	0	0	0	0	0	4	3
DENMARK	0	0	1	0	3	1	2	1	8	
DOMINICA	2	0	1	0	0	2	8	5	18	
DOMINICAN REPUBLIC	2	4	0	1	0	6	7	2	22	
ECUADOR	0	0	0	3	3	4	6	4	20	
EGYPT	0	0	0	0	1	1	0	0	2	
EL SALVADOR	0	0	0	0	0	0	0	1	1	
FIJI	0	0	0	1	0	2	2	1	6	
FRANCE	2	2	1	3	5	6	15	14	48	1
GRENADA	1	0	0	0	0	2	8	6	17	
GUATEMALA	0	0	2	0	0	1	2	1	6	
GUINEA-BISSAU	0	0	0	0	0	0	1	0	1	
GUYANA	1	0	0	0	0	1	5	0	7	
HAITI	1	3	2	2	2	5	8	4	25	
HONDURAS	0	0	1	1	1	3	6	6	18	
ICELAND	0	0	0	0	3	0	2	0	5	
INDONESIA	1	1	0	0	0	0	1	1	4	
ITALY	0	0	0	0	0	0	1	0	1	
IVORY COAST	0	0	0	0	1	0	0	0	1	
JAMAICA	1	1	1	1	3	1	3	4	15	
JAPAN	0	0	0	0	0	3	2	2	7	
KIRIBATI	0	0	0	0	0	1	4	6	11	
KOREA, S.	0	0	0	0	0	0	1	1	2	
LIBERIA	0	0	0	0	0	0	1	0	1	
MAURITANIA	0	0	0	0	0	0	1	1	2	
MEXICO	33	19	26	12	11	13	20	29	163	16
MOROCCO	1	0	1	1	2	0	3	4	12	
NAURU	0	0	0	0	0	0	0	1	1	
NETHERLANDS, THE	1	0	0	1	1	1	2	4	10	
NEW ZEALAND	1	0	0	0	1	1	3	4	10	
NICARAGUA	1	0	1	0	0	0	0	1	3	
NORWAY	0	0	0	0	5	3	0	1	9	
OMAN	0	0	0	0	0	0	3	0	3	1
PANAMA	2	0	0	0	2	3	1	5	13	
PAPUA NEW GUINEA	1	0	0	0	0	2	3	2	8	
PERU	1	1	2	4	4	3	3	5	23	
PHILIPPINES	2	2	0	0	0	0	1	0	5	
PORTUGAL	0	0	0	0	0	1	1	1	3	1
ROMANIA	0	0	0	0	0	1	0	0	1	
SAINT KITTS & NEVIS	0	0	0	0	0	0	4	4	8	
SAINT LUCIA	2	1	2	2	0	3	8	6	24	
SAINT VINCENT/GRENADINES	1	1	2	1	0	4	9	6	24	
SAUDI ARABIA	0	0	0	0	2	0	0	0	2	1
SOLOMON ISLANDS	0	0	0	2	0	1	2	2	7	

TABLE 1 (cont'd)

SOMALIA	1	0	1	0	0	1	0	1	4	
SOUTH AFRICA	0	0	0	0	1	1	0	0	2	
SOVIET UNION	2	0	0	0	0	3	0	2	7	5
SPAIN	0	0	2	2	2	2	3	8	19	2
SRI LANKA	0	0	0	0	0	0	0	1	1	
SURINAME	1	0	0	0	0	1	2	0	4	
TONGA	0	0	0	1	0	1	3	0	5	
TRINIDAD & TOBAGO	1	0	0	0	0	1	6	2	10	1
TURKEY	0	0	0	0	0	1	0	0	1	
TUVALU	0	0	0	0	0	0	1	1	2	
UNITED ARAB EMIRATES	0	0	0	0	1	0	0	0	1	
UNITED KINGDOM	3	3	2	3	5	10	18	12	56	
UNITED STATES*	0	0	0	0	0	0	2	1	3	
URUGUAY	0	0	0	0	0	2	0	0	2	
VANUATU	0	0	0	1	0	1	2	2	6	
VENEZUELA	2	1	1	1	2	2	6	4	19	4
WESTERN SAMOA	0	0	0	0	0	0	2	2	4	
No. of requests	100	68	78	72	109	165	276	256	1,124	38
No. of coastal states	34	19	24	25	30	49	58	57	76	11

* U.S. requests for 1985 and 1986 represent CRs submitted to Palau, Fed. States of Micronesia, and Marshall Islands.

Data Source: Yearly summaries of clearance requests prepared by Office of Marine Science and Polar Affairs, Bureau of Oceans and International Environmental and Scientific Affairs, U.S. Department of State.

As the totals for each year indicate, the high of 100 requests in 1979 was not reached again until 1983, reflecting the leap in the late 1970s of countries legislating jurisdiction over MSR. Of the 78 countries that have done so, 51 placed restraints on research between 1968 and 1979, with 31 of those just in the two year period of 1977-78. The balance has been evenly sprinkled from 1980-87, averaging three per year.

The following caveats on these statistics must be mentioned at this point:

Caveat 1 -- These research requests represent only those accepted and forwarded by the Department of State. Prior to 1983 the U.S. did not recognize coastal States' rights to exercise jurisdiction over research on a country's continental shelf or beyond a 3-mile territorial sea. So research requests by U.S. scientists for work off the coasts of countries with extended claims were not forwarded (unless they were amended to include some coastal research that would take the cruise inside the U.S.-recognized 3-mile territorial sea limit). Research requests are still not forwarded if the work is to take place in waters which the State Department considers a disputed area.

Caveat 2 -- These statistics reflect only those U.S. marine science projects that entailed going to sea on a U.S. vessel and should not be considered a full picture of the state of international MSR involving U.S. marine scientists. U.S. oceanographic research and many international marine cooperative programs may not entail going to sea, may involve work outside coastal State jurisdiction, or may utilize local vessels in coastal waters.

TABLE 2

Summary of U.S. Department of State Research Clearance Request Activity 1979-1986

	1979	1980	1981	1982	1983	1984	1985	1986	TOTALS	
Denials	5	1	4	2	2	8	4	12	38	11 States
% Denials of Requests	5%	1%	5%	3%	2%	5%	1%	5%	3%	
Problems										
Coastal state as source (CSP)*	15	9	5	3	9	14	34	28	117	42 States
% CSP of Requests	15%	13%	6%	4%	8%	8%	12%	11%	10%	
U.S. as source(USP)**	6	16	6	9	8	22	25	17	109	33 States
% USP of Requests	6%	24%	8%	13%	7%	13%	9%	7%	10%	
Requests	100	68	78	72	109	165	276	256	1,124	
Coastal States	34	19	24	25	30	49	58	57	76	

* Coastal State Problems (CSP) = e.g., late approvals resulting in delay or cancellation of research, approval withheld since U.S. did not meet specified lead-time requirement, no response to request, conditions or fees imposed by coastal state.

** U.S. Problems (USP) = e.g., cancellation or delay due to funding problems or equipment problems; approval received but U.S. late within required lead-time for submitting request.

Data source: Yearly summaries of clearance requests prepared by Office of Marine Science and Polar Affairs, Bureau of Oceans and International Environmental and Scientific Affairs, U.S. Department of State.

Geographic Choices for Marine Scientific Research by U.S. Scientists

What drives the choice of location by U.S. scientists for marine research? We cannot prove that increased jurisdiction over access for marine science and occasional denials by coastal States have clearly influenced geographic choices. There are a whole spectrum of factors that influence research locality. These include: 1) proximity of foreign waters to the United States; 2) history of clearance activity with particular countries and the ease or difficulty of obtaining approvals; and 3) political hot spots. In addition, there exists the unquantifiable and most elusive factor -- the substance of research itself. We hope that this is the main factor driving the choice for location, especially

as Global Change programs evolve to include so many parts of the ocean and politically fragmented waters.

The current international situation concerning research jurisdiction in foreign waters is a maze of rules and regulations. Scientists and administrators must be able to find their way in and out of this maze when planning and expediting research cruises. The U.S. Department of State's Research Vessel Clearance Officer (presently Tom Cocke) does an admirable job of keeping up with the increasing flow of requests. But U.S. scientists, like scientists elsewhere, are mainly working hard to develop and implement programs and often do not know about legal aspects concerning their research cruises. The value of easy sources of information and anecdotes on working with foreign countries is incalculable.

In considering the first factor that influences choice of research locality, research in foreign waters close to home is easily targeted. Vessel and staff logistical problems and economic issues most certainly weigh in to this factor. Seventy-four percent of all U.S. clearance activity for the eight-year period under scrutiny was for research conducted in coastal waters of the Western Hemisphere: 18 percent in Canadian waters, 15 percent in Mexican waters (despite recurring clearance request problems), 28 percent in Central American and Caribbean waters, and 13 percent in South American waters. In addition, almost all of the requests made of the United Kingdom, France, and the Netherlands were for their Western Atlantic territories or dependencies (an additional 10 percent of total clearance activity).

In order to consider the second factor on the historical ease or difficulty of obtaining clearances, we refer to *Table 1* showing those countries of which the United States has requested clearances and the total number of denials resulting from those requests. No requests have been made of Cuba since 1980, and after three successive denials (1978) and no response to one request (1980), the difficulty of obtaining Cuban approvals may have kept scientists from pursuing further clearance through official channels. The opposite picture to *Table 1* is represented in *Table 3*, which shows those 63 countries with no U.S. clearance request activity for 1979-86. The MSR jurisdiction status and date of MSR claim of these recently untapped countries is indicated in the third and fourth columns. Less than half of these countries have legislated jurisdiction over MSR in their coastal waters. We cannot assume, therefore, that these areas are being ignored because of restrictions imposed by the Law of the Sea treaty.

The third factor of political hot spots is illuminated by the experience of one of the authors. Ross recounts that prior to 1977 he entered what are now the waters of ten Middle East countries listed in *Table 3*. At that time permission was requested of three of those countries. To date only two (South Yemen and Djibouti) have legislated jurisdiction over MSR, but all ten have seen no U.S. activity in the past eight years. The lack of clearance requests for the marine areas of the Middle East may well reflect its recent spate of political and military activities.

Relative to these last two factors, most scientists think about their future work in terms of solvable problems. If an area is out of bounds and not readily available for study, one puts it out of mind in the same way that one does not spend time designing research programs where the tools are unavailable (Knauss, 1985, personal communication).

TABLE 3

No U.S. Clearance Request Activity
1979-1986

	Marine Area (000s sq nm)	MSR Jurisdiction Claimed?		EEZ Rank
		Yes/No	Date	
ALBANIA	3.6	N	-	-
ANGOLA	176.6	N	-	-
BANGLADESH	22.4	Y	1974	61
BELGIUM	.8	N	-	-
BENIN	7.9	N	-	-
BRUNEI	7.1	N	-	-
BULGARIA	9.6	Y	1987	66
BURMA	148.6	Y	1977	32
CAMBODIA	16.2	Y	1982	65
CAMEROON	4.5	N	-	-
COMOROS	72.6	Y	1976	40
CONGO	7.2	N	-	-
CYPRUS	29.0	N	-	-
DJIBOUTI	1.8	Y	1979	74
EQUATORIAL GUINEA	82.6	Y	1984	36
ETHIOPIA	22.1	N	-	-
FINLAND	28.6	N		-
GABON	62.3	Y	1984	43
GAMBIA, THE	5.7	N	-	-
GERMAN DEM. REP.	2.8	Y	1978	-
GERMANY, FED. REP. OF	11.9	N	-	-
GHANA	63.6	Y	1986	42
GREECE	147.3	N	-	-
GUINEA	20.7	N	-	63
INDIA	587.6	Y	1977	10
IRAN	45.4	N	-	-
IRAQ	0.0	N	-	-
IRELAND	110.9	N	-	-
ISRAEL	6.8	N	-	-
JORDAN	0.0	N	-	-
KENYA	34.5	Y	1979	55
KOREA, N.	37.8	Y	1977	53
KUWAIT	3.5	N	-	-
LEBANON	6.6	N	-	-
LIBYA	98.6	N	-	-
MADAGASCAR	376.8	Y	1985	16
MALAYSIA	138.7	Y	1984	-
MALDIVES	279.7	Y	1976	20
MALTA	19.3	N	-	-
MAURITIUS	344.5	Y	1977	18
MONACO	0.0	N	-	-
MOZAMBIQUE	163.9	N	-	27
NIGERIA	61.5	Y	1978/88	44
PAKISTAN	92.9	Y	1976	35
POLAND	8.3	N	-	-
QATAR	7.0	Y	1974	70
SAO TOME & PRINCIPE	37.4	Y	1978	54
SENEGAL	60.0	N	-	45
SEYCHELLES	393.4	Y	1977	15
SIERRA LEONE	45.4	N	-	-
SINGAPORE	.1	N		-
SUDAN	26.7	N	-	-
SWEDEN	45.3	N		
SYRIA	3.0	N		
TANZANIA	65.1	Y	1973?	-
THAILAND	27.6	Y	1981	60
TOGO	.6	N	-	75
TUNISIA	25.0	N	-	-
VIETNAM	210.6	Y	1977	24
YEMEN, N.	9.9	N	-	-

TABLE 3 (cont'd)

YEMEN, S.	160.5	Y	1978	29
YUGOSLAVIA	15.3	N	.	.
ZAIRE	0.0	N	.	.

63 Countries

Source for marine areas: R.W. Smith, EXCLUSIVE ECONOMIC ZONE CLAIMS. (Dordrecht, Netherlands: Martinus Nijhoff, 1986), pp. 13-16.

The Future for Access and International Cooperation in MSR

Five years ago a poll was taken of U.S. marine scientists to assess early perceptions on the impact of the Law of the Sea treaty on MSR.[3] This poll covered 266 different research efforts in foreign coastal waters during the 1970s and early 1980s by 67 scientists. Seventy-five percent of those scientists felt that the Law of the Sea treaty would affect their research operations by complicating planning and clearance requests, raising costs, and dictating the geographical location of their work. No successive studies of individual scientists have been made since 1983, but a quick survey of national and international institutional arrangements may provide a look at the future of this issue.

International organizations that deal with MSR are having financial problems. UNESCO and its core oceanographic group, the Intergovernmental Oceanographic Commission (IOC), have seen reduced commitment and funding from the United States. The U.S. Department of State office that deals with clearances has been considered in a departmental realignment that, if it occurs, would appear to reduce the importance of marine scientific research in that agency.

Fora in the United States on the issue of MSR and the Law of the Sea are dissipating. The National Academy of Sciences did have an Ocean Policy Committee and a Freedom of Ocean Science Task Group (FOSTG) which were disbanded for about five years. These fora have been replaced by one smaller group, International Ocean Science Policy Group, within the present NAS Ocean Studies Board. The University National Oceanographic Laboratory System (UNOLS) disbanded its Committee on International Restrictions to Ocean Science a few years ago. In addition, the U.S. fleet of distant-water research vessels has decreased in number and satellites are collecting more and more oceanographic data.

The International Marine Science Cooperation Program established at the Woods Hole Oceanographic Institution is attempting to fill some of this void. The office, through its publications and databases, is an information source for scientists on the issues of MSR jurisdiction and international cooperative projects. One goal of the program has been to maintain a database of MSR jurisdictional claims and to distribute the information from this database freely to the international marine science community. We have already produced a map and monograph inventorying various national maritime claims in relation to MSR.[4]

In addition to the map and monograph, we are preparing a funding guide for marine scientists interested in international work, as well as developing a clearinghouse to share information on marine research with developing countries (this is on a prototype level working initially with just one or two countries). We will soon be publishing a portion of

our database on MSR jurisdiction (see *Figure 2*) showing international treaty status, marine jurisdiction zones, formal maritime boundaries, research jurisdiction status, and U.S. research clearance history from 1972 to the present for 140 coastal states. The International Marine Science Cooperation Program is presently funded by the National Sea Grant Program.

FIGURE 2

Sample MSR Jurisdiction / Country Profile

TRINIDAD & TOBAGO

MSR Jurisdiction Claimed? Y **MSR Regs. other than Jurisdiction?** N (See below.)

TREATY STATUS

1958 GENEVA CONVENTION: party 9-10-64 (TS), 7-11-68 (CS)
1982 UNCLOS III: signed 12-10-82, ratified 4-25-86

MARINE JURISDICTIONAL ZONES

Marine area: 22.4 (000s sq. nm)

TERRITORIAL SEA:	12 nm	**Claimed:** 1969
FISHERIES ZONE:	not declared	**Claimed:**
CONTINENTAL SHELF:	200 m or to depth of exploitation	**Claimed:** 1969
EXCL. ECONOMIC ZONE:	200 nm	**Claimed:** 1983

MARITIME BOUNDARIES (Formal boundary agreements)

Venezuela

RESEARCH JURISDICTION

Statement by the Minister of External Affairs, 27 May 1983: Jurisdiction over marine scientific research in EEZ. "Guidelines for the Conduct of Marine Scientific Research in Marine Areas under the Jurisdiction of Trinidad and Tobago"-Note from Ministry of External Affairs 30 April 1985: consent necessary for scientific research in any areas under national jurisdiction. Archipelagic Waters and Exclusive Economic Zone Act, 1986: Jurisdiction over marine scientific research in EEZ.

U.S. RESEARCH CLEARANCE HISTORY

U.S. State Dept. "Notices to Research Vessel Operators" on this country:
1976 (#26-Clearance request problems)
1977 (#38-Publication restriction of research data)
1978 (#50-Embassy report)

U.S. Clearance Requests per year:

[CR=Clearance Requests; DN=Denials; CSP=Coastal State Problems; USP=U.S. Problems]

72 CR	0	73 CR	0	74 CR	1	75 CR	0	76 CR	3	77 CR	2
72 DN	0	73 DN	0	74 DN	0	75 DN	0	76 DN	*	77 DN	1
72CSP	0	73CSP	0	74CSP	0	75CSP	0	76CSP	1	77CSP	1
72USP	0	73USP	0	74USP	0	75USP	0	76USP	0	77USP	0
78 CR	1	79 CR	1	80 CR	0	81 CR	0	82 CR	0	83 CR	0
78 DN	1	79 DN	0	80 DN	0	81 DN	0	82 DN	0	83 DN	0
78CSP	0	79CSP	1	80CSP	0	81CSP	0	82CSP	0	83CSP	0
78USP	0	79USP	0	80USP	0	81USP	0	82USP	0	83USP	0
84 CR	1	85 CR	6	86 CR	2	87 CR	1			**TOTAL CR**	18
84 DN	0	85 DN	0	86 DN	1	87 DN	0			**TOTAL DN**	4
84CSP	0	85CSP	2	86CSP	1	87CSP	0			**TOTAL CSP**	6
84USP	0	85USP	0	86USP	0	87USP	0			**TOTAL USP**	0

Comments:
1979: 1 CSP=cancellation due to restrictions on publication of data results.
1984: first approval obtained since 1977 w/out publication restriction on marine science reports.
1985: 2 CSP=1 CR not approved due to pre-publication approval requirement; 1 CR with problems not specified.
1986: 1 DN=no reason given; 1 CSP=conditions for approval unacceptable.

Conclusion

Marine scientific research will continue to take place in the international arena. Access for U.S. scientists to foreign waters will become more critical as concerns for global change issues escalate and as global research programs evolve. We see little progress, however, in making access more easily obtainable from a U.S. or an international perspective. The proposed IOC and U.N. Secretariat-sponsored workshop in 1989 focussing on state practice and experience in MSR jurisdiction should be very helpful. We anticipate that scientists will be invited and involved in this effort and that its product will be widely distributed.

In addition, having data on MSR clearance experiences from other countries, such as Alfred Soons has collected (see article, this volume), is valuable and should be promulgated worldwide. But perhaps most important of all, we must remember that legal aspects and rules concerning MSR have to be translatable into scientific opportunities. If not, restraints or rules governing marine scientific research become a legal exercise with damaging effects on the international marine science community.

Acknowledgments

We gratefully wish to acknowledge the assistance of Tom Cocke (U.S. Department of State's Bureau of Oceans and International Environmental and Scientific Affairs) in providing data, and our thanks for reviews and comments to this paper by Drs. Elazar Uchupi and George Grice of the Woods Hole Oceanographic Institution. This work was supported by NOAA, National Sea Grant College Program, Department of Commerce, under grant number NA86-AA-D-SG090, WHOI Sea Grant project E/L-1. WHOI Contribution Number 6840.

NOTES

1. Ocean Policy Committee, "The marine scientific research issue in the Law of the Sea negotiations," *Science* 197 (July 1977): 230-33; W.S. Wooster, "Ocean research under foreign jurisdiction," *Science* 212 (May 1981): 754-55; D.A. Ross, "Marine science and the Law of the Sea," *EOS* 62, no. 35 (Sept. 1981): 650-52; D.A. Ross and J.A. Knauss, "How the Law of the Sea treaty will affect U.S. marine science," *Science* 217 (Sept. 1982): 1003-8; W.T. Burke, E.L. Miles, W.S. Wooster, "Ocean Research in Hot Water," *Science* 218 (Nov. 1982): 523; A.H.A. Soons, *Marine Scientific Research and the Law of the Sea* (Deventer, Netherlands: Kluwer Publishers, 1982), 383 pp.
2. J.A. Knauss and M.H. Katsouros, "The effect of the Law of the Sea on marine scientific research in the United States: Recent trends," in *The U.N. Convention on the Law of the Sea: Impact and Implementation*, Proceedings of the Nineteenth Annual Conference of the Law of the Sea Institute. (Honolulu, HI: Law of the Sea Institute, 1986), pp. 373-382; J.A. Knauss and M.H. Katsouros, "Recent experiences of the United States in conducting marine scientific research in coastal state Exclusive Economic Zones," in Proceedings of the Twentieth Annual Conference of the Law of the Sea Institute (Honolulu, HI: Law of the Sea Institute, 1987).
3. D.A. Ross, R.C. Ladner, and J.A. Early, *The Impact of the Law of the Sea Conference on U.S. Marine Scientific Research: Report on*

a Questionnaire. (Woods Hole, Mass.: Woods Hole Oceanographic Institution, Technical Report 83-15, 1983), 36 pp.

4. D.A. Ross and T.A. Landry, map, Marine scientific research boundaries. (Woods Hole, Mass: Woods Hole Oceanographic Institution, 1986); D.A. Ross and T.A. Landry, *Marine Scientific Research Boundaries and the Law of the Sea: Discussion and Inventory of National Claims*. (Woods Hole, Mass.: Woods Hole Oceanographic Institution, 1987), 173 pp.

Danny Elder: While these articles were being negotiated in the Law of the Sea Convention, there was much concern that a lot of research never actually benefitted the country in which the research was taking place. Part of the motivation was that scientists who do research should make some sort of effort to pass the information that was gathered on back to the country. I just wondered whether there's been an effort to try to do this and if a few speakers might comment on what progress has been made.

David Ross: From the United States' viewpoint we *have* to supply these reports, we have to make the data available, and we have to invite scientists to participate. As an individual scientist, speaking for myself, I did this before you had to do it, and always enjoyed having foreign scientists involved. You are indeed correct in saying that there have been examples where data has been collected from countries' waters and the information never got back to the country. I think what you've underlined is one of the very positive benefits of the articles concerning marine scientific research in the treaty. This should be done, and probably is not being done perfectly, but it is being done, at least from the United States' viewpoint.

Alfred Soons: Perhaps I could add to that. While I think the situation with respect to the EEC Member States is roughly similar to the U.S. situation, it struck me that, when you look at the history of clearance requests by studying the files, there were many cases where there was a very intensive, active cooperation, and often participation by the developing coastal States involved. Although there was a lot of paperwork, the major research projects went very well and the development cooperation character of several research projects undertaken by Western European States made it much easier to conduct them.

In this respect I think I should mention, for instance, that there has been a major cooperative project of the Netherlands and Indonesia which involved a 15-month cruise of a Dutch research vessel in Indonesian archipelagic waters. Several other States have had some difficulties with obtaining consent from Indonesia to do research in the Indonesian EEZ, but this was one major success. There was also a lot of money involved, for the purpose of training and education of Indonesian scientists.

Howard Strauss: I think that question raises one area in which perhaps scientists could go on to help themselves. I know in the Canadian context results frequently come in very slowly and too often they're very brief summaries of what was done. I think that will cause a backlash in due course. If a country, particularly a developing country, is sensitive, or does not feel that it is getting full information from the work done in its waters, then it may take full advantage of international law and even more, international practice, and start to deny research requests.

David Ross: We need a little more enlightenment in the United States' funding agencies. It's very rare that you can get any financial support to prepare the document as you suggest. You're right, it often can come

near the end of the project so that not as much attention can be put into as it deserves.

Dale Krause: These papers have been interesting and the compilations are important. Can either one of the speakers give any indication of where they think the problems tend to lie, whether they are denials, are they in the bureaucratic machinery, are they in the scientific community, is it because there hasn't been enough feedback process either in the country or between the two countries involved?

David Ross: As one gentleman said to me two days ago, to ask the question is to answer it. I think you can put your finger on many of the different reasons. Dale, you're a scientist, you've had a lot of experience, you know what scientists will do: Oh, it's his fault if it didn't work. I think scientists have been guilty, there have been bureaucratic problems, there have been honest misunderstandings, there's been mischief, I think all these things can exist. As we enter the next decade and things like global change become important, we have to keep these things at a minimum. We have to educate the scientific community, and we have to educate the bureaucrats to see the importance of this.

I think what is often the sad thing, is that the areas that are left out, for whatever reasons, are often the ones that could probably most use the information. If you look at some of the countries where research is not done by U.S. scientists, these are often areas where the research would be most beneficial.

Alfred Soons: I fully agree. David referred specifically to *denials*. I think the *conditions* imposed by coastal States are sometimes more worrisome, more important than outright denials. Outright denials are relatively few. When you regard the cases of proposed research as lost opportunities, you could divide them into outright denials and cases where the research was not carried out because the scientists found that the conditions imposed by the coastal State were unacceptable. I think that is the most important problem area. When you look at the coastal States involved in some cases it is clear that the military in that coastal State was mainly responsible for either the denial, or imposing certain conditions which were unacceptable; in other cases it was scientists working for the government.

Jack Botzum: In the remote sensing community, the parallel between open skies and freedom of marine research seems obvious to me. Does the marine community have an issue here that it should be looking at? Is there any denial of access that we know of yet to satellite data or is that denial forthcoming? I am not considering military satellites, of course.

David Ross: I'm unaware of any.

Richard McLaughlin: I was wondering if we could get Fred Soons to clarify a couple of points that he made. One is that hydrographic research activities, especially hydrographic surveys, are not governed by the LOS Treaty and are instead governed by a separate legal regime. And the second is, why you believe that acoustic military sonar activity is not considered marine scientific research.

Alfred Soons: With respect to hydrographic surveying, I deliberately used the word hydrographic *survey*, not hydrographic *research* because one should be careful what terms one uses. The term hydrographic research is sometimes used as a synonym for oceanographic research, or marine scientific research. Hydrographic surveying, however, exclusively covers the collection of data for the purpose of safety and efficiency of navigation, for making navigation charts, sailing directions and the like. When you look at the Law of the Sea Convention you see that in Articles 19, 21 and 40, dealing with the territorial sea, in particular with innocent passage and transit passage, there is a separate mention of survey activities next to marine scientific research. I think that the hydrographic surveying activities in real hydrographic surveying are one of the activities that is still governed by the freedom of navigation beyond the territorial sea. In the exclusive economic zone it can be regarded as an internationally lawful use of the sea associated with the operation of ships in accordance with Article 58 of the Convention, and can, therefore, be conducted freely.

About acoustic military research: it depends on what you are doing. If you collect data about the marine environment in a specific area, then you are doing marine scientific research; but if you are only testing instruments which you could also do somewhere else, when the particular environment where you are doing it is irrelevant, I don't think you should qualify that as marine scientific research. That, in my view at least, would be governed by the freedom of navigation when it's conducted in the EEZ of course. We're not talking about the territorial sea but about the EEZ.

John Craven: I want to remind people who participated in this process that we tried for a long period of time to define marine scientific research in the treaty in such a manner that it did not cover the activities that were not intimately tied to classic scientific research. I can recall Eliott Richardson's admonition on many occasions that "scientific research is not the mere collection of data." We therefore sought a definition that would widen the "mere collection of data" category to as wide a spectrum of ocean information collection systems as possible.

John Knauss: That's a Jesuit argument if I've ever heard one. [Laughter.]

Having made some efforts to get a clear record of what the problems have been in clearances in the United States, I very much appreciate the effort of Fred Soons to gather similar information in western Europe. It would be useful, I believe, if we could find somebody in each of the major researching nations in this world who would make some effort to gather the data that would give some kind of an historical record of the evolving marine scientific research clearance problem. Sometimes we speak in ignorance on these matters. I hope that some of you in this audience who come from countries outside the United States or the Netherlands would take that as a challenge and gather that kind of information in your own country.

Opportunities in Oceanographic Science Offered by New Advances in Data Management

Gregory W. Withee and Douglas R. Hamilton*
National Oceanographic Data Center
National Oceanic and Atmospheric Administration

Background

During the past few years a number of developments have emerged which show tremendous promise in aiding the management of ocean data. The purpose of this paper is to review some of these new developments and discuss their impacts on oceanographic science. This paper is meant to promote discussion; it is by no means a thorough review of the subject.

Introduction

Oceanographic data management has as its primary mission the task of placing ocean data, and information about data (metadata), into the hands of researchers and decision makers. In carrying out this mission, the acquiring of individual researcher data sets and the aggregating of data sets from many sources are both important tasks. This importance is evidenced by increasing attention to data management in large global programs, such as the World Ocean Circulation Experiment, as well as integrative-type coastal programs, such as those planned by the National Oceanic and Atmospheric Administration (NOAA).

Ocean science's potential gains through data management opportunities are abundant. Technological advances are giving us the tools needed to grasp those opportunities. In the following sections those advances are outlined briefly, and the resulting impacts and opportunities are discussed.

Discussion

A complete review of advances in data management is not possible here; however, through the following anecdotes, several advances are illustrated. They range from progress in computer hardware technology to new concepts for managing and distributing data.

1. Observations

Nothing substitutes for actual data. Recent technological advances are providing digital data at an unprecedented rate. The National Oceanographic Data Center (NODC) is expanding its *in situ* databases alone by over 20 percent per year.

Sensors

The ocean may be viewed in new ways because of new sensors and improvements in existing sensors, both *in situ* and remote. The trend is toward remote, unmanned sensing of the ocean and marine atmosphere, making data available from data-sparse regions. Satellites, of course, have provided immense opportunity along with perplexing data management problems. Global satellite measurements of sea surface temperature, sea ice extent, waves, and sea level are now routinely available; further operational measurements, such as wind stress and ocean chlorophyll,

from satellites are planned. Continuing improvements in instrument sensitivity and resolution are increasing the volumes of data flowing to earth. Despite such challenges, these data make possible both a global perspective, and more detailed studies of local conditions (Sherman, 1985).

In situ sensors have become more reliable, accurate, and less costly. Since the mid-1960s, an expendable instrument (Expendable Bathythermograph - XBT) has provided an effective, low cost way to sample upper ocean temperature conditions. Continuing progress in sensors is making it possible to measure other parameters with expendable instruments. Soon, an expendable conductivity, temperature, depth (XCTD) probe will be available to support studies of ocean dynamics, fisheries, and other areas.

It is noted that ocean-based remote sensing techniques are advancing rapidly. One technique, acoustic tomography, measures ocean properties over thousands of square kilometers through acoustic arrays. Early results are promising (Munk, 1988).

Another recent innovation in remote sensors for *in situ* application is the use of acoustic doppler techniques to monitor ocean currents remotely at various depths. Tests of these systems show that it is possible to mount these devices to ship hulls, allowing for routine, unmanned measurements of ocean currents on global, long-term scales (Cutchin, 1985). Acoustic Doppler Current Profilers (ADCP) are already providing real-time data on currents in estuaries and shipping channels (Wilmot, 1987).

Data Gathering Systems

Ocean measurements are now being obtained from ships, moored buoys, drifting surface buoys, subsurface buoys, satellites, and occasionally from aircraft. The Shipboard Environmental data Acquisition System (SEAS), which was designed around inexpensive components, has greatly improved subsurface thermal data transmission from ship to shore in real time. As upper ocean temperature-depth measurements are made, the SEAS unit processes data to check for quality, compresses the record to inflection points in the temperature-depth curve, formats the data according to international standards, and transmits the record via satellite to shore stations. These units operate with little human interaction, making it possible to place them on merchant vessels as well as research ships. As a result, more ocean thermal data are being collected, more ocean areas are being sampled, and more data are available in real-time for analysis and forecasting. Incorporation of salinity and current measurements are planned (Roman, 1986).

Recent improved technologies have made surface drifting buoys an economical way to gather ocean circulation and marine weather data from remote ocean areas. Drifting buoys have created hundreds of observations daily, which are relayed in real-time and used in prediction models and analyses (Patterson, 1985). Subsurface, neutrally buoyant floats are being designed for long-term measurements of deep ocean currents. Drifters of one type will pop to the surface periodically to report via satellite their position and data collected while under water (U.S. Science Steering Committee for WOCE, 1988).

Finally, satellites are serving as data relay platforms, as well as sensor platforms. Polar and geostationary satellites gather and relay data from ocean buoys and ships.

2. Small, Inexpensive Processing Systems

Back on the beach, data managers have benefitted from industry standards resulting from large computer hardware and software markets. Technical progress by the commercial world in producing small, inexpensive systems with considerable power has greatly improved environmental data management. For example, a system called CLICOM has been instrumental in gathering climatic data from developing countries around the globe. The microcomputer-based system assists users in entering meteorological data, producing disks in a standard format. These disks allow easy merging of the data into global historical data banks. The systems also give developing countries experience in automated data management and a direct connection to global climate projects.

A system such as CLICOM could be used in oceanographic science, allowing developing countries to capture and merge their data into larger data bases. Just as important, a CLICOM-like system would enable developing countries to capture data and information by electronic networks from larger science programs. Such systems even allow some degree of information processing so that shared information can be used for the country's particular interest.

3. Intelligent Software

Advances in software techniques that increase data management capability are numerous. Two such techniques, artificial intelligence and geographical information systems, are briefly presented.

Data management includes the process of extracting knowledge from large and diverse data sources. That process can be burdensome, even impossible, in some particularly challenging projects. Expert systems, which take advantage of advances in artificial intelligence, make that task more feasible. For example, Atlantic Ocean warm and cold core ring position and size are being predicted by a Navy experimental system (Lybanon, 1988).

In meteorological data management, the National Oceanic and Atmospheric Administration's (NOAA) Program for Regional Observing and Forecasting Services (PROFS) has developed an expert system, called HAIL, which has skill in predicting thunderstorm severity. Furthermore, it shows marked skill in distinguishing between significant and severe hail in its predictions (Merrem, 1987). Possible application in oceanography can be found in quality control. It may be possible, for example, using artificial intelligence, to simulate fairly accurately the intricate and personal quality control procedures of a particular scientist who has become the acknowledged quality control expert in one type of data.

Another exciting technique, called geographic information systems (GIS), is under intense development, particularly in the geographic community. By providing techniques to make data bases available in a uniform, geo-referenced, intercomparable format, GIS provides the means for comparing and/or integrating vastly different data types. This technique shows promise in helping researchers deal with perplexing multidisciplinary problems, and also makes possible the overlay of dissimilar data sets, such as satellite and *in situ* data. For example, a program for Chesapeake Bay in Maryland is developing GIS capabilities to track changes in characteristics, such as subaquatic vegetation, and proposes to match those changes to variations in water properties. Both satellite and *in situ* data are involved (Johnson, 1986).

4. Standards

Data management standards in several areas have improved efficiency and data quality. International standards in data formats, for example, have been developed for international oceanographic data exchange (Intergovernmental Oceanographic Commission, 1987), and electronic transmission of ocean and meteorological data (World Meteorological Organization, 1987). Standards have also been developed within an organization to efficiently use data across many data management functions (Treinish, 1987). So far, however, there has not been a system that is standard for all data management functions. The "Standard Format Data Unit" concept (Consultative Committee for Space Data Systems, 1987) may provide such a standard for all data management functions in the future.

Government agencies involved in earth sciences have realized that because we are all studying one earth system, sharing information is essential (des Jardins, 1987). The goal of sharing information highlights the need for standards in data management. Two consequences have come from that realization. First, within the United States interagency data management working groups have been created and are now working on a number of standards. Second, it is being discerned that data management must be given high priority in research and observational programs (Earth Systems Science Committee, 1988).

5. Data Base Technology

In the past few years advances in the information resource management arena have been investigated for use in earth sciences data management. Relational data base technology, entity-relationship data modeling, and data architecture design (Martin, 1983; Appleton, 1983) are being seen as helpful in earth sciences data management.

Another consideration when constructing data bases, is the growing concerns for metadata or information about data. Metadata, for example, are now accepted as vital to understanding and using environmental data (National Research Council, 1982). Instrument calibrations, processing methods, and supporting documentation can provide key information about a data set. The National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, National Science Foundation, and the U.S. Geological Survey are working together to agree on metadata needs for proper data interpretation. This information about data will be recorded in online data directories and catalogs, and will include descriptions of the ocean data themselves.

6. Data Storage

Oceanographers are benefitting from the fact that data storage technology is becoming widespread and standardized throughout the community. As a result, scientists can have quick access to massive data files for use in ocean models and for hypothesis testing. Also, because of widespread standardization, costs are lower and data are more secure.

Two new storage technologies are notable. The first, Write Once, Read Many times, so-called WORM technology is not yet standardized but offers storage of up to 2 billion characters of data per 12-inch disk. The technology is improving continuously. The second storage technology is video tape digital data recording. This inexpensive technology allows for some 2 billion characters of data to be stored on standard, easily available Video Cassette Recorder tape.

7. Media

One of the most exciting developments in the area of data exchange media is on compact disk read only memory, or CD-ROM, technology. The capacity of CD-ROM disks is around 600 million data characters and is equivalent to the capacity of many computer compatible magnetic tapes. In oceanographic data terms, for example, it is possible to record all historical global thermal profile data, over 1.5 million profiles, on one CD-ROM disk.

With CD-ROM technology it will be possible in the near future for oceanographic centers to have "hands-on" access to large ocean data bases. These disks will be useful for quick reference, for comparing new data to historical observations, and for research. There is an obvious impact here on the way data will be distributed in the future, compared to present day methods. Creation of a Global Oceanographic Data Library, which consists of some 20 disks containing all ocean data held by NODC, is being discussed.

8. Networks

It was not too long ago that the primary data communication tool in oceanography was restricted to the mail. Oceanographic research plans, ship schedules, lists of collected data, and actual data became available to the ocean community in time periods of months to years. Today, there are networks for electronic mail and for data transmission that can shorten that time-period to minutes.

The Global Telecommunications System, one of the first global data networks, is used for transmitting meteorological and oceanographic data around the globe. This network, although invaluable in real-time data gathering, is available only to major meteorological centers of the world.

More recently, several other networks have been developed, and are being used by the ocean community. For example, NASA's Space Physics Analysis Network (SPAN) has been made available to the oceanographic community for both electronic mail and for data transfer (*Figure 1*). This network is available to university scientists and Federal agencies alike 24 hours a day.

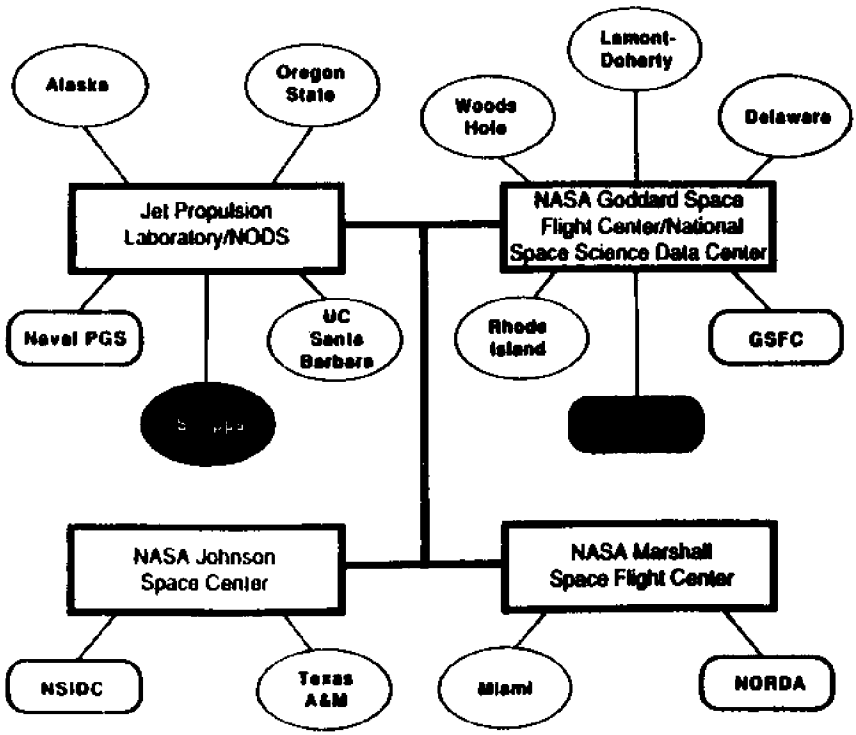
During the past two or three years, the ocean community has been learning how to take advantage of this new technology. As a result, a number of data management functions, exemplified in the following, have been improved:

a. Active data acquisition - NODC routinely acquires thermal profile data over SPAN from a NOAA group in California. Data which in the past took months to years to obtain now are available within a few days after data collection.

b. Active ROSCOPs - The Report of Observations/Samples Collected on Oceanographic Programs (ROSCOP) is a means for principal investigators to notify others of the existence of data collected within the previous month or two. ROSCOP forms have traditionally been mailed to NODC, which uses them to answer questions about data availability. In part, because of the difficulty of the process of submitting the forms, this process has not worked. Now plans are underway to use networks to make that information more accessible to requestors, first by having an electronic form for principal investigators to complete and send electronically, and second by making them available via SPAN for browsing and searching.

FIGURE 1

Ocean Data Communication Network
(based on NASA's SPAN)



c. Active data access - Observed data and data products (such as model outputs) are being transmitted over networks providing opportunities for rapid data and information exchange. Already in the U.S. many access systems are available to the ocean community through electronic means (see *Figure 2* for some examples). Within NOAA several systems (for example, Soreide, 1986; and Hewitt, 1988) have materialized over the last year or two. Global ocean data inventories are now accessible online in a prototype system being developed by NODC (Hamilton, 1988). Each access system has its own characteristics, and each points to local data sets and information. Oceanographers are finding more data and metadata (information about data) available for their use.

d. Scientific projects - The use of networks in a joint project called the Joint Environmental Data Analysis Center (JEDA) between the Scripps Institution of Oceanography and the National Oceanographic Data Center illustrates how networks can have a dramatic effect on data management. Data flows for the JEDA project are shown in *Figure 3*. Each arrow depicts data transfers as part of the Pacific Tropical Ocean

Global Atmosphere Thermal Project. The goal of this project is to monitor Pacific Ocean tropical thermal conditions in an effort to predict El Nino events. Data for that purpose are needed within 30 days of collection. The use of SPAN to transfer data to and within JEDA has made it possible to meet stringent time requirements for data and data products (White, 1988).

FIGURE 2

NOAA Ocean Data and Information Access Systems

NOAA OCEAN DATA AND INFORMATION ACCESS SYSTEMS

DATA BASE	ACCESS SYSTEM	NOAA ORGANIZATION
Real-Time Ocean Data & Products	NNODDS	NOS/Navy
AVHRR Archives		NESDIS/SDSD
NODC Data Archives	NOSIE	NESDIS/NODC
U.S. WOCE Information	SONIC	NESDIS/NODC/U. Delaware
EPOCS Data	EPIC	OAR/PMEL
Station Data	Hydrosearch	SIO with NODC*
Estuarine/Coastal Information	Proposed	NOS/OHA*
CalCOFI Data	CCFIHYDRO	NMFS/SWFC

*Planned

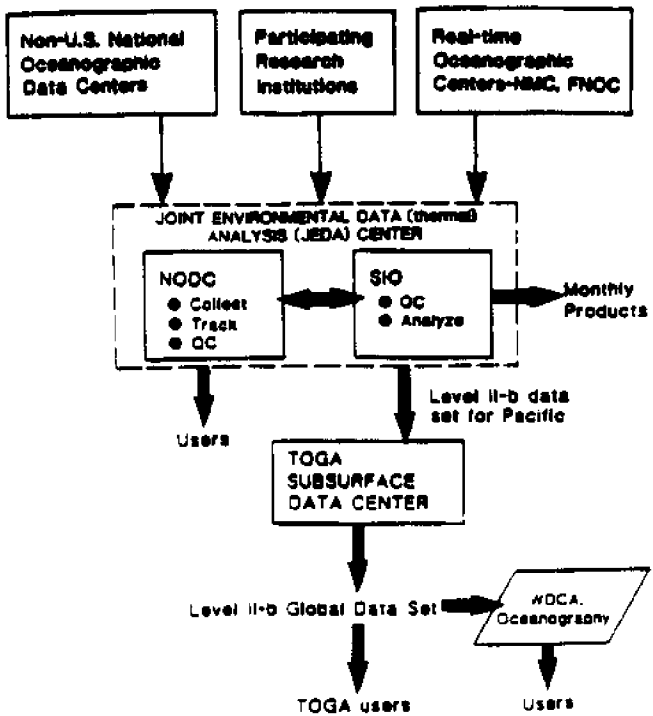
9. Joint Ventures

Other projects have been started which have technological, data management, and ocean science ingredients.

The University of Delaware and NOAA have created a Joint Center for Research in the Management of Ocean Data (*Figure 4*). Already, this joint center, in support of the World Ocean Circulation Experiment (WOCE), has developed on-line information resources which are available via SPAN. Further developments in the area of on-line graphics software, CD-ROM software, and a data set browse capability are being considered.

FIGURE 3

Data Flows Associated with the Joint
Environmental Data Analysis Center (JEDA)



NODC - National Oceanographic Data Center
SIO - Scripps Institution of Oceanography
FNOC - Fleet Numerical Oceanography Center (Navy)
NMC - National Meteorological Center (NOAA)
WDCA - World Data Center A. Oceanography

Another venture, between the University of Hawaii and NODC, is exploring opportunities of making data, from a scientist's active archive, available through a national data management center. Through the Joint Archive for Sea Level, personnel at the University of Hawaii, under the scientific guidance of Dr. Klaus Wyrtki, nurture a global sea level archive. At the same time, data from that archive are made available to users as a service of the National Oceanographic Data Center.

FIGURE 4

JCRMOD

Joint Center for Research in the Management of Ocean Data
(NODC/University of Delaware)

AREAS OF INTEREST

Research Applications of Large Data Bases

- Improve quality of historical data
- Merge satellite and conventional data

Management of Oceanographic Data

- Develop online catalogs, directories, and inventories
- Develop distributed systems
- Explore new graphical display techniques

Technology

- Experiment with effective use of computer networks
- Establish standards for formats and documentation
- Test feasability of "standard" software for common algoritms

(Example of a joint academic-government center for data management).

Summary

Increasing opportunities in oceanography are possible through new technological and data management developments. For example, more ocean measurements are available from an increasingly complex set of sensors, both *in situ* and satellite. Many of these observations are available for use a few days after observation.

Continued advances in media, such as CD-ROM, will soon make it possible for ocean centers around the world to have large collections of historical data sets available locally. Increased communications among scientists, planners, and decision makers through electronic mail and bulletin boards is stimulating open discussion about projects and data management problems. Ocean scientists and planners have access to much larger data sets for models and hypothesis testing because of lower cost computer storage.

New technology is clearly affecting the way oceanographers gather, relay, and use ocean data. Systems for integrating and assisting in data interpretation will enable us to solve many oceanographic problems, including those in coastal regions and the Exclusive Economic Zone.

BIBLIOGRAPHY

Appleton, D. S. (1983) "Data-Driven Prototyping." Datamation, November, 1983: 259-268.

Consultative Committee for Space Data Systems. Space Data Systems Operations with Standard Formatted Data Units: System and Implementation Aspects. Washington, D.C.: National Aeronautics and Space Administration, 1987.

Cutchin, David L. (1985). "Performance of a doppler-acoustic ocean current profiler installed onboard the tanker Exxon Jamestown." SIO Reference No. 85-17. Scripps Institution of Oceanography, La Jolla, CA.

des Jardins, R. and C. Mazza. (1987) "Data Management Standards for Space Information Systems." AIAA/NASA International Symposium on Space Information Systems in the Space Station ERA. American Institute of Aeronautics and Astronautics.

Earth System Sciences Committee. Earth System Science, A Closer View. Washington, D.C.: National Aeronautics and Space Administration, 1988.

Hamilton, D. and J. Ward, "Online Access to NODC Information Services," to be published in OCEANS 88, 1988.

Hewitt, Roger, S. Jacobson and C. Meyer. CalCOFI ON-LINE DATA SYSTEM PROGRAMMER'S MANUAL. Administrative Report LJ-88-03. La Jolla, CA: National Marine Fisheries Service, 1988.

Intergovernmental Oceanographic Commission. A General Formatting System for Geo-referenced Data. Paris: Unesco, 1987.

Johnson, D.F., K. Hess and P. Pytlowany, eds. "Interdisciplinary Synoptic Assessment of Chesapeake Bay and the Adjacent Shelf." NOAA Technical Memorandum NESDIS AISC 5. Washington, D.C., 1986.

Lybanon, Matthew. (1988) "Oceanographic Expert System Functional Description." NORDA Technical Note 368. NSTL, Mississippi: Naval Ocean Research and Development Activity.

Martin, James. Managing the Data-Base Environment. New Jersey: Prentice-Hall, Inc., 1983.

Merrem, Frank H., Jr. and Raymond H. Brady. (1987) "Evaluation of a Meteorological Expert System." PROFS Report 1, no. 4: 9-11.

Munk, Walter H. and P.F. Worcester. (1988) "Ocean Acoustic Tomography." Oceanography Magazine 1, no. 1. The Oceanography Society.

National Research Council. Data Management and Computation. Washington, D.C.: National Academy Press. 1982, pp. 9-11.

Patterson, Steven L. (1985) "Surface circulation and kinetic energy distributions in the Southern Hemisphere oceans from FGGE drifting buoys." Journal of Physical Oceanography, 14(7).

Roman, C.M., M. Szabados, R. Taylor. (1988) "Transmission of Real-Time Oceanographic and Meteorologic Data from Ships." Horizon, 11(1). Marion, MA: Sippican Ocean Systems, Inc.

Sherman, John W. III and J. McElroy (1985). "The Oceanic Satellite Data Challenge." Sea Technology, April, 1985.

Soreide, N. and S. P. Hayes. (1986) "EPIC: An Oceanographic Data Archival and Retrieval System." Proceedings of the Fourth Working Symposium on Oceanographic Data Systems. Washington, D.C.: IEEE Computer Society, pp. 174-177.

Treinish, L. and M. Gough. (1987) "A Software Package for the Data-Independent Management of Multidimensional Data." EOS Transactions, American Geophysical Union 68: 633-635.

U.S. Science Steering Committee for WOCE. U.S. WOCE Implementation Plan. College Station, TX: U.S. Planning Office for WOCE, 1988.

White, W. B., S. E. Pazan, G. W. Withee, and C. Noe. (1988), "Joint Environmental Data Analysis (JEDA) Center for the Scientific Quality Control of Upper Thermal Data in Support of TOGA and WOCE." EOS Transactions, American Geophysical Union 69, no. 9.

Wilmot, Wayne, and Robert G. Williams. Charleston Harbor Oceanography Project, Phase 1: Quality Assurance of NOS Tide and Tidal Current Predictions. Rockville, MD: National Oceanic & Atmospheric Administration, 1987.

World Meteorological Organization. FM 94-1X BUFR Binary Universal Form for Data Representation. Commission for Basic Systems, Draft Recommendation 6.4/9 (CAS-1X). Geneva: 1987.

Maximizing the Benefits from the New Technologies of Oceanographic Data Gathering and Management

The ICSU Perspective

S.I. Rasool
NASA Headquarters
Washington, D.C.

Introduction

I work for NASA and am a member of the Special Committee on the International Geosphere/Biosphere Program of ICSU (International Council of Scientific Unions). You have been hearing for some time now about the issue of Global Climate Change. I am going to address the issue from the ICSU perspective and describe some of the international activities that are taking place and that have been made possible by major advances in both science and technology.

One might ask why, despite rapid advances in space and computer technologies in the last 20 years, important questions in Earth sciences, with direct bearing on our future livelihood, remain totally unanswerable, and why we are unable to predict the behavior of the atmosphere with any confidence. We can reply that observing Earth with better resolution and doing model calculations at higher and higher speed is not enough to solve these problems. A good example is the question of how the buildup of greenhouse gases in the atmosphere will alter the direction of global change, and how that change will in turn affect global productivity and ocean circulation and eventually feed back into the state of the climate as well. Is the buildup a runaway process, or has Earth some thermostat that will keep it from running away?

Whether we can answer these questions depends entirely on our ability to probe simultaneously into three completely different areas of research in the Earth sciences: How are vegetation cover and soils around the globe changing with time, and how exactly do these changes influence the buildup of CO_2, CH_4, N_2O, and O_3 in the atmosphere? How does the deep ocean circulation regulate the exchange of gases at the ocean/atmosphere surface? And what are the processes of chemical exchanges in the atmosphere and how are they being perturbed by human interactions?

Space technology and computer speeds will, of course, help in resolving each of these questions, but our predictions for the future state of Planet Earth will get better only when progress is achieved in all three fields of research concurrently.

How to Proceed

One way to assure that in the future we follow a "correct" strategy of research to address these problems is first to examine why answers to these important questions in Earth sciences have to far remained elusive. Several impediments to progress emerge:

a) We lack consistent, validated, and continuous sets of data over the globe to provide a precise account of how Earth as a whole is changing over the time scale of decades.

b) The models used to study complex processes are extremely simple. Our inability to represent in climate models the processes of exchange of gases and energy between atmosphere and oceans and between atmosphere and land surface severely restricts the ability of all current models to predict the future state of Earth.

c) Only a few research groups studying continental-scale phenomena, such as the Sahelian droughts, Indian monsoons, and dynamics of sea ice, use real data as inputs to or checks on model studies.

d) Lack of coordination of the many scattered efforts, both national and international, of excellent scientists slows the pace of progress.

e) Finally, there is no long-term commitment to a global Earth sciences program.

The best way to proceed, then, is to rectify the current situation and begin a program that will probe into the ways Earth functions as a system and address the changes in atmosphere, oceans, and biosphere simultaneously.

The International Council of Scientific Unions (ICSU) has begun. Last year, ICSU decided to launch an ambitious program of planetary dimensions. The International Geosphere-Biosphere Program is a scientific effort directed at providing the information we need to assess the future of Earth in the next 100 years. It stresses understanding the processes that govern the evolution of Planet Earth in the time scales of years to decades. It is an immensely interactive program, focusing on the processes through which the land, ocean, and atmosphere are connected. It crosses traditional boundaries of geophysics, geochemistry, and biology, and above all, promotes the exchange of scientists and data across national frontiers. The program will last for at least a decade and will involve the interplay between modeling and measurements, field projects and process studies, theory and experiment.

Initial Priorities

In a program of global scope, which embraces numerous disciplines of science and is of major economical and ecological importance, it is difficult to give priority to the areas of research that need to be tackled. However, logically speaking, the tasks to be accomplished first are either areas that fill gaps in current programs or new directions of research that can expedite achieving our objective. Many scientific groups around the world, working with the ICSU planning group, have discussed these issues during the past several years. What is coming out in reports of those deliberations is a common theme. We have to work towards two goals at once:

1. Document precisely the nature of global change that is occurring now and has taken place in the recent past.
2. Improve our ability to represent the processes of global change as realistically as possible for use in predictive models.

To achieve the first goal, we will have to:

a) Expand and improve the current satellite observation system for Earth. Develop new instrumentation and new methodologies that will provide precise information on changes in, for example, global precipitation patterns and rates, productivity of ecosystems,

distribution and type of vegetation cover, soil moisture content and evaporation rates, ice sheet thickness, and tropospheric chemistry.

b) Supplement space observations with a network of ground measurements that will help validate the satellite data and describe characteristics unobservable from satellites.

c) Assure continuity of current observing systems and programs, which allow preparation of global data sets of key parameters such as cloud cover, land and ocean surface temperature, ocean currents, levels of ozone and stratospheric aerosols, solar input, surface energy balance, extent of sea ice, and global snow cover.

d) Strengthen research efforts in reconstructing past changes in Earth environments from decades to thousands of years by using new technologies in analyzing ice cores, sediments, and tree rings.

e) Study new ways that data from space, ground, sea and from past records can be merged to produce unique information on rate and direction of changes in the geosphere-biosphere. A new challenge is to disseminate this information rapidly to interested research groups across national boundaries.

To achieve the second goal, we need to:

a) Develop new global biospheric models that take account of boundary conditions and interactions at the interfaces of land, ocean, and atmosphere, including chemical exchange between biosphere and atmosphere, marine biosphere/atmosphere interactions, effects of changing vegetation on the water cycle, and effects of climate on ecosystem change.

b) Use actual data on rates and directions of global change both as inputs to the models and tests of model prediction.

c) Promote interaction of scientists involved in developing these models as the very first step in building the program.

How to Succeed

With more than a dozen nations now active in developing and flying space missions, with as many as 35 countries involved in research on the ground and in the atmosphere on various aspects of a global change program, and with the entire world as a beneficiary of the results that we will obtain, it is neither desirable nor feasible for one nation to implement the necessary program and analyze the results alone. Thanks to the efforts of the U.S. National Academy of Sciences (NAS) and ICSU, we now have all the ingredients in place to embark on such a program with contributions from all. It is important to note that ICSU, formed in 1931, is a nongovernmental, nonprofit organization representing the science academies of 74 nations and involving more than 100,000 scientists of all countries.

For the Global Change Program, an international structure has now been set in place. An ICSU Committee on Geosphere/Biosphere has been named and will meet in July, 1988. More than 25 countries have already decided to form their own national groups on global change research programs. The types of programs that will be discussed include activities in tropospheric chemistry research in the Federal Republic of Germany, studies of the marine biosphere in the United Kingdom and France, research on the global water cycle in Australia, analysis of ice cores for past climate studies in Switzerland and France, studies of changing surface cover in Venezuela, Senegal, and India, and a proposal from France to launch a satellite to measure the energetics of the tropics,

which appear to be the primary source of all major perturbations in global climate. The Soviet Union has also announced a broad program of research ranging from studies of solar activity and its impact on the atmosphere to dynamics of the ocean and the effect of the study of changes in climate and the biosphere caused by human activity.

At the same time, the unions of ICSU are enthusiastically putting together international efforts that will directly respond to our needs. Projects like the International Tropospheric Chemistry Program, Joint Global Ocean Flux Study, World Climate Research Program, International Satellite Land-Surface Climatology Project, and Man and the Biosphere Program, all testify to the will of the world to get together and get along.

To carry out the program, the technology is available, and the computer power and software are state of the art. The public is aware of the importance of such a program and is probably getting impatient because of the many contradictory forecasts of the future that keep appearing in the press. Last and perhaps most important, talented scientists from around the world in different disciplines are ready to jump aboard as soon as the train gets a signal to move.

Developing Technologies Within the Oceanographic Component of the World Climate Research Program

Raymond H. Godin
SCOR-IOC Committee on Climatic Changes and the Ocean
Paris, France

The role of the ocean in climatic change was recognized in the late seventies by Roger Revelle and others to be a global issue, requiring the Scientific Committee on Oceanic Research and the International Oceanographic Commission Committee on Climatic Changes and the Ocean (CCCO) to initiate oceanographic planning for the World Climate Research Global Programme (WCRP), which has resulted in the planning of the Tropical Oceans and Global Atmosphere Program (TOGA) and the World Ocean Circulation Experiment (WOCE).

Both TOGA and WOCE have been jointly developed through their sponsoring bodies, i.e., the CCCO (which is co-sponsored by SCOR and IOC) and the Joint Scientific Committee (JSC) for the WCRP (which is co-sponsored by ICSU (International Council of Scientific Unions) and WMO (World Meterological Organization)). Both the scientific and implementation plans for these programs have been developed through the efforts of scientists from the international community, and the leadership of the TOGA and WOCE Scientific Steering Groups (SSG).

Within the WCRP, WOCE is a principal component of Stream 3, which is concerned with the prediction of decadal climate change. The basic goal of WOCE is to develop models for the prediction of decadal climate change and to collect the data to test them. This goal has led to the formulation of four objectives which are to determine (1) the large-scale fluxes of heat and fresh water, their divergences, and annual and interannual variability; (2) the dynamic balance of the global ocean and its response to forcing; (3) the components of ocean variability on longer space and time scales and its statistics on smaller scales; and (4) the rates and nature of water mass formation, ventilation and circulation. In order to meet these objectives, priority has been given in the WOCE field program to three projects: Core Project 1 involves the Global Description; Core Project 2, the Southern Ocean; and Core Project 3, the Gyre Dynamics Experiment.

Core Project 1 focusses on obtaining a relatively uniform global description of the ocean circulation with enough detail to resolve all major features of the dynamic topography and all boundary currents. Elements of the field program, which can be related to WOCE objectives, include satellite measurements of surface winds and sea-surface elevation and data for the calculation of the fluxes of heat and momentum; a global system of hydrographic measurements, including geochemical tracers and some repeat sections; direct measurements of the velocity at one deep level using floats and at the sea-surface using drifters; and the transport in boundary currents and overflows.

Core Project 2, for the Southern Ocean, includes all the elements of Core Project 1 with additional emphasis on the dynamics of the Antarctic Circumpolar Current and its interactions with the oceans to the north,

as well as on the formation of water masses in the regions to the south, a special problem being the role of sea-ice.

Core Project 3 is directed at examining those processes that will need to be parameterized in models of the circulation. It will be primarily carried out in the Atlantic, as far south as the Brazil Basin. A basic premise of Core Project 3 is that by studying one ocean basin in more detail than is possible for the Global Ocean, it will be possible to develop models for that basin which can be extended to the global ocean. Thus, within the Atlantic the intensity of deep float and surfacer drifter observations being sought is roughly four times that of the general Core Project 1 coverage, and intense coordinated studies will be carried out in four or five locations called "control volumes" as well as in the abyssal regions of the Brazil Basin. In addition, more traditional process-oriented experiments examining, for example, subduction, ventilation, and cross-isopycnal diffusion, using purposeful tracers, will be carried out, where possible, within the control volumes of the deep Brazil Basin. Other process-oriented studies may, for logistic and/or scientific reasons, be carried out in other regions of the global ocean.

The Implementation Plan for WOCE will be published in July, 1988. It will include both the scientific rationale for the development of the Core Projects as well as details of the field programs necessary to meet WOCE objectives. Although the basis of WOCE as reflected in the first WOCE Implementation Plan can be expected to remain relatively fixed, details of the experimental program will continue to evolve as the result of changing scientific understanding of the problem, and because of the need to adjust the program to the resources supplied by nations.

Hydrography in Core Projects 1 and 2 consists of a global survey of the highest quality to be carried out once during the WOCE period and of repeat surveys and ocean stations, a portion of which will form a monitoring network extending beyond the WOCE Intensive Observation Period. The global survey in conjunction with direct velocity and altimeter measurements is to provide estimates of ocean transports of heat and fresh water. One zonal transect in each ocean (at 24 degrees North and 28 degrees South or 32 degrees South) is measured with boundary current observations in order to obtain the best estimate of oceanic tranports, especially of heat. Equally intensive measurements are designated in three places across the Antarctic Circumpolar Current, in Drake Passage, south of Africa and south of Tasmania or New Zealand.

Time series from research vessels and ships-of-opportunity will provide information on monthly, seasonal and interannual scales. The extent of research vessel operations of greater capability will be limited by availability and will have to be coordinated with available ship-of-opportunity observation. Both programs are vital for the needs of WOCE.

The WOCE ship-of-opportunity network is designed to give sparse coverage of the global upper ocean. Its purpose is to quantify variations in circulation and transport. One may consider these measurements as an adjunct to high quality hydrographic sections, thus requiring close spacing along the sections and attention to data quality. The WOCE network incorporates a portion of the existing planned TOGA network and extends it to higher latitude.

Quantitative geophysical parameters derived from satellites will be used as inputs of constraints on models of the ocean circulation. The two main parameters are wind stress and sea-surface topography. Wind stress will be measured by scatterometers from ERS-1 (approved to be

launched in the autumn of 1990) and NSCAT which is proposed to be launched during the WOCE time-frame on a Japanese satellite. Sea-surface topography will be measured by altimetry. In the pre-WOCE period, this will be available from GEOSAT, now in orbit, and during WOCE by ERS-1 and a fully-optimized joint U.S./French project mission, TOPEX/POSEIDON, to be launched in the fall of 1991.

To obtain the mean circulation, the absolute velocity, it is also necessary to determine an accurate global geoid. This may be obtained through one or more proposed satellites dedicated to gravity measurements. In this regard GRM (Geopotential Research Mission) and the GRADIO (Gradiometry Report) projects are under study respectively by NASA and the European Space Agency (ESA). Currently the time period for such a mission is around 1993-1994, although continuation of the two missions is possible.

Satellites can also be used for data collection and determining the local position of buoys and other platforms. The ARGOS system will be continued on NOAA satellites at least until 1995 and will be improved for this purpose.

Direct velocity measurements will be derived from moored current meters, surface drifters, deep floats, shipboard doppler acoustic current profilers, and specialized systems such as submarine cables and expendable electromagnetic current profilers. The goals of the direct measurements are to provide information on the "mean" and variable circulation and on the statistics and geographic description of eddies. These data are needed as an input to heat flux calculations, for comparison with existing circulation models, and for calibration of indirect velocity estimates which might suggest monitoring schemes.

Moored current meters are especially good when flows are constrained, for example, in passages and near boundaries. Moorings can also give the vertical profile of eddy fields, but are poor for mapping horizontal structures. Principal boundary current measurements are planned to be made at each end of the given heat flux sections at 24 degrees North and 30-32 degrees South. Also suggested priority boundary current measurements are east of the Kuril Islands, northeast of Chatham Rise, off the Lesser Antilles and at three sites near 15 degrees South in the Indian Ocean. Sites with lesser priority include the Brazil Current, south of the Aleutian Island Chain, south of India, west of Borneo and off Somalia, and in the Gulf Stream region (the latter being given lesser priority because comparatively much is already known). Principal passages are the Timor Strait, the Samoan Passage, the Denmark Strait, the Romance Gap, the Vema Channel and Drake Passage. Monitoring the sea level and dynamic height on either side of the Atlantic Circumpolar Current between South Africa and Antarctica, between Tasmania or New Zealand and Antarctica, and between the seamounts along the Greenwich meridian has also been recommended. Moorings for eddy statistics have not been much discussed, but suggestions exist for sites near the Kuroshio, in the South Pacific, South of Iceland and in the Gulf Stream region, the less Antilles, the Argentine Basin, the Agulhas retroflexion region, meridionally in the Indian Ocean, in the region of the west wind drift off Chile, and spaced around the globe every 30-40 degrees just north of the Antarctic Circumpolar Current.

Finally, long-term moorings have been suggested at numerous sites. Although primarily for a time-series of hydrography, perhaps using moored temperature and salinity sensors or a moored profiler, these moorings may also carry current sensors. The sites are principally off Hawaii and Mexico to monitor dynamic height across the gyre, in the Sea

of Okhotsk, the Bering Sea and the Labrador Sea to monitor water mass formation, in the Coral and Tasman Seas and near the Chatham Rise, in the West Wind Drift off Chile, and near Iceland and the Azores in cooperation with the Joint Global Ocean Flux Studies (JGOFS). Hawaii would also be joined with JGOFS, as would be an expansion of the Panulirus site near Bermuda. Other sites and motivations may be suggested and the discussions are still to be held to decide on trade-offs and priorities.

Floats and drifters (by convention, "floats" are subsurface, "drifters" are at the surface) are good for broad-scale, low frequency flows and are especially good for mapping fields of flow and variability. Previous work in the western North Atlantic has shown that even eddy energy statistics may be obtained if the floats or drifters are sufficiently numerous. Surface drifters that carry meteorological or subsurface sensors that may compromise the water-following characteristics of the drifter (meteorological sensors cause more problems than subsurface sensors). Deployments are suggested in all the oceans at about 500 km. average separation to give a global view of the surface velocity field that would complement that obtained from a century of ship-drift observations. South of 30 degrees South meteorological drifters at 1,000 km. average separation would provide surface meteorological measurements that are lacking in the Southern Ocean. Additional regional arrays of drifters with thermistor chains to give heat content are suggested for the regions east and west of southern South America, south of South Africa, south of New Zealand, and in the Weddell Sea.

Deep float arrays are also of two kinds: acoustically tracked regional arrays using SOFAR (fixed receiver) or RAFOS (fixed sources) floats, and global arrays using pop-up floats that rise to the surface briefly each month to reveal their position. Deep floats are more useful for giving a mid-depth reference level for use with the hydrographic surveys. Pop-up floats may be used primarily in the Southern Ocean. Pop-up regional arrays, probably acoustically tracked, might be placed just north of the equator in the Atlantic, the Tasman Sea, southeast of New Zealand, and in the Kuroshio region.

Shipboard measurements of velocity are possible in the upper 150-300 m. using an acoustic doppler current profiler (ADCP) and good ship navigation, preferably the Global Positioning System (GPS). Installations will be on many WOCE research ships and possibly on some volunteer observing ships/ship-of-opportunity programs. The ADCP data would be made more useful if complemented by surface meteorological measurements and XBTs. On the Voluntary Observing Ships (VOS) this can be done using an automated unit like the SEAS provided by NOAA (U.S.) that can telemeter the meteorological and XBT data and provide it over the Global Telecommunciations System (GTS).

To help with the planning of WOCE, an International WOCE Scientific Conference, jointly sponsored by SCOR, WMO and ICSU, was held under the aegis of the JSC and the CCCO; it was hosted by IOC (at UNESCO Headquarters, Paris, 28 November - 2 December 1988) and organized by a Committee chaired by Professor C. Wunsch.

The Objectives of the Conference were to:

1. Review and explain the scientific purposes of WOCE.
2. Outline the plan for the implementation of WOCE.
3. Identify means by which countries can contribute to WOCE.

4. Identify major resource commitments, as well as gaps and how the latter can be overcome.

5. Review additional requirements for WOCE, including data submission and distribution, access to ports and scientific data from Exclusive Economic Zones.

6. Examine institutional arrangements for WOCE.

REFERENCES

WOCE Scientific Plan, WCRP Publication Series, No. 6, 1986.

WOCE-IPO Report of the WOCE Sao Paulo, Brazil Workshop, July 20-22, 1987.

WOCE-IPO Report of the WOCE Chinese Workshop, April 6-7, 1988.

Management of Oceanographic Data and International Cooperation in China

Dai Ruguang
State Oceanic Administration
Beijing, China

With the development of modern science and technology, exploitation of marine resources has been receiving more and more attention, and marine survey and research have been developed in an unprecedented fashion. Consequently, a great quantity of oceanographic data and information has been obtained. It is an important task confronting the oceanographic community around the world to properly manage and rationally utilize these valuable data and information in order to give full benefit to human and social development. Now, let me briefly introduce the management of oceanographic data, and the status of international cooperation, in China.

I. Collection of Oceanographic Data

Marine environmental data are the direct product of oceanographic survey and observation, and also provide the basis for marine research and exploitation. Therefore, the collection of oceanographic data and information occupies a very important position in marine affairs in China. There are many units or departments engaged in the collection of oceanographic data, such as the State Oceanic Administration (SOA), Academia Sinica, some universities, some fishery departments, marine petroleum departments, some environmental departments, and so on. The most important is SOA. Data are acquired mainly by marine research vessels or other kinds of ships, and marine observatory stations, and partly by offshore buoy, aerial remote-sensors and satellites. At present, China has more than 160 research vessels which belong to different departments, 300 coastal marine observatory stations mainly used for the observation of nearshore waves, tidal level, meteorology, temperature, salinity and so on, and about 250 merchant and fishing ships for auxiliary observation. Since the late 1970s, buoys, aerial remote-sensors and satellites have been increasingly applied to the collection of oceanographic data. For example, Expendable Bathythermograph (XBT), Salinity-Temperature-Depth recorder (STD) and Conductivity-Temperature-Depth detector (CTD) have been used in marine environmental investigation and monitoring; some kinds of aerial remote-sensors and discriminating techniques of satellite images have been employed in the monitoring of silt dynamics, sea ice, sea surface temperature, color of sea water, marine pollution and so on. By using these instruments and techniques, quality and quantity of the obtained data have been greatly increased.

The oceanographic data collected in China may fall into nine categories:

1. Multi-disciplinary oceanographic data from comprehensive marine investigations;
2. nearshore hydrological, geomorphological, and shallow stratigraphic data from coastal zone and harbor surveys;

3. data on temperature, salinity, nutrients, water chemistry, biology, sediments and so on from the survey of fishery resources;
4. hydrological, geological and geophysical data of continental shelf areas from the exploration of marine oil resources;
5. data on hydrology, aquatic chemistry, biology, sediments and pollution (heavy metal and organic pollutants) from marine environmental investigation and monitoring;
6. data from cooperative investigations between China and foreign countries;
7. data from marine surveys;
8. data from marine observatory stations and profile surveys; and
9. data from open sea surveys and Antarctic exploration.

Of the above-mentioned data about half are stored in the National Oceanographic Data Center, and the rest are separately collected by all departments involved in marine affairs.

II. Treatment of the Oceanographic Data

At present, we deal with the oceanographic data usually in the following ways:

First, according to the source of the data and user's requirements, the data are standarized with the international coding system in order to meet the needs of computer recognition for coding some features of the data, such as country, survey department, research vessel, station, geographic area, cruise, processing number, type of station, weather and so on.

Second, standard formats and application formats of the data are designed, and pre-processing is conducted for the purpose of data standardization.

Finally, all data are stored in the computer system, then various data documents and data bases may be established. The data or information may be automatically requested and retrieved, and various data products may be provided for users.

III. Management of the Oceanographic Data

The oceanographic data, which can be used repeatedly, are one of the important environmental information resources in the country. Just like any other natural resource they should belong to the State, benefit mankind, and be managed and preserved by the State.

The National Oceanographic Data Center of China, which was founded in 1978, is a service organization which is in charge of the management of oceanographic data in China. Its main tasks are:

1. to establish, develop and preserve the national oceanographic data base;
2. to exploit data sources both at home and abroad, and to increasingly extend storage of the data; and
3. to develop various kinds of data products by managing and processing the information, in order to meet different needs of the users.

The center operates a Model IBM-4341 electronic computer which has 4 megabytes and an operating speed of 8 MH_Z. The marine environmental and resource information service has been preliminarily established. At present, the center has completed ten data documents: Nansen Station data, current data, wave data of marine stations, temperature-salinity

data of marine stations, tidal data, harmonic constants of tide, marine geophysical data, grain-size data of sediments, data of oceanic manganese nodules, and marine geochemical data. The total data stored in the center is 54,000 mega words.

In terms of the international exchange of data, the center has established contacts with five international organizations, such as IODE, and 172 organizations in about 35 countries since 1978. In 1984, the center officially acceded to the Aquatic Sciences and Fisheries Information System (ASFIS) co-sponsored by FAO and IOC. Therefore, the center has entered into an international network of data exchange.

However, due to the fact that a part of the data is separately stored in, and belongs to, several departments, it is very difficult to manage data in a unified way, and even difficult to exchange and fully utilize these data. Therefore, from now on, China will intensify the legislation of data management, establish some necessary regulation of the collection, management and utilization of data, and try to change the status of data-ownership by the separate departments in order to realize our tentative plan for separate storage, but unified management and State-wide exchange. I think this tentative plan is realistic due to the extensive improvement targeted for the different departments in China in the coming years.

IV. International Cooperation

China consistently holds that, based on the principle of equality and mutual benefit, extensive cooperative investigations of a scientific nature may be carried out. We appreciate the principles on marine scientific research contained in UNCLOS III. We also hold that coastal countries have the right to exercise jurisdiction over research conditions in their territorial sea, EEZ, and continental shelf.

Since the middle 1970s, China has pursued a number of cooperative scientific investigations. They include: the Global Atmospheric Experiment co-sponsored by WMO and ICSU, Sino-American Cooperative Research of Air-Sea Interaction, Sino-Japanese Cooperative Investigation of Kuroshio, and Sino-French Cooperative Research of Changjuang and Huanghe Estuaries.

The guiding principle is that foreign parties may conduct marine investigation for peaceful purposes in areas under China's jurisdiction only after submitting written applications and relevant explanatory documents which have been approved. Such parties must abide by Chinese regulations and accept supervision and examination by Chinese authorities. China may send her scientists on board to work with foreign colleagues. China also has the right to use and collect all the data, samples and specimens obtained in areas under Chinese jurisdiction. Foreign research vessels in these areas may not conduct offshore drilling, use explosives, introduce harmful substances into the marine environment or hinder China's normal activities at sea.

Technology and Data Management
U.S. Science Community Views

Ferris Webster
College of Marine Studies
University of Delaware

As oceanographers and others in the earth sciences community begin planning for a major study of global change, it is timely to consider establishing and implementing a data policy that will provide for effective collection, distribution, use, and preservation of data sets.

The National Research Council's Committee on Geophysical Data will shortly be issuing a report entitled "Geophysical Data: Policy Issues". The report is a synthesis of academic community concerns about policies relating to geophysical data, including oceanographic data.

The Committee on Geophysical Data (CGD) consists of a group of geophysicists from half a dozen disciplines, from space science to meterology and oceanography. The committee is concerned about common problems related to the national and international handling of geophysical data. As the current CGD chairman, I would like to take this opportunity to spread the word on the geophysical data policy document prepared by the committee. I believe that it addresses some critical data issues.

This paper will summarize the findings of the policy report and look at how implementation of the policy will affect the U.S. and the international oceanographic research community. Most of my words are taken directly or paraphrased from the report. In some cases, I have sometimes altered the words of the report to emphasize the oceanographic aspects of data problems. I take responsibility for any misstatements in paraphrasing the report, and the conclusions of this paper are my personal views.

Geophysical Data Issues

Because of the global nature of geophysics (including the field of oceanography), international exchange of data has been critical to the field. From the mid-19th century onward, the oceanographic community has made arrangements for the interchange of oceanic data on national and international bases. These arrangements evolved in a pattern which was driven by the needs of the user community.

In recent years, the interchange of oceanic data has been greatly altered by technology. Sophisticated instrumentation is producing an explosive increase in the quantity of data being recorded. Substantial concomitant problems concern data reliability, credibility, accessibility, the question of what is to be archived, and defining the responsibilities of the scientists who collect the data.

Collected often at enormous expense, data represent a resource that must be managed carefully to ensure that they are preserved and available when needed. Oceanographic data are useful not only in research but in a wide range of societal applications. The fact that a data set may have been assembled for a particular study and that it has already served the purposes of that study by no means signifies that the usefulness of the data set has been exhausted. It is in the interest of

the marine community and other users of ocean data that data sets be properly archived and made accessible.

Thus the oceanographic community needs to adopt a set of data guidelines or principles that will define the responsibilties of the working scientist as he or she plans, budgets, and executes a project that results in the generation of oceanographic data.

An effective data management system must have the support of the federal agencies that fund most data collection and research. Federal agencies that fund research or other projects resulting in the collection of oceanographic data need to coordinate their activities to ensure that data collected with federal funds are made accessible to the widest possible number of users and are properly managed -- not only in the short term but also for the use of future generations. Lack of effective coordination within and among these agencies, and the lack of overall guidance to either the federal agencies or the scientific community in data matters, are the source of most of our current problems with the collection, storage, and retrieval of oceanographic data.

The working marine scientist should assume responsibility for the data he or she collects; the funding agencies should assume responsibility for the national management of these data in an efficient and effective way. The distribution of costs among data providers, data centers, and data users must be addressed.

These factors led the CGD to come up with two recommendations. The first deals with the rights and responsibilities of geophysicists, and the second with the federal agencies engaged in geophysical activities. (I have not modified the text of the recommendations, which are here reproduced in their entirety.)

Recommendation 1

The following data principles should be adopted as guidelines regarding the rights and responsibilities of geophysicists for data that they collect and their access to data collected by others:

1. Geophysical data are a national resource, and should be treated as such.
2. Geophysical data collected using federal funds are the property of the general public, and special efforts must be made to ensure their accessibility to users in all cases not in conflict with the interest of national security.
3. As an integral part of the planning of an experiment or project that will result in the generation of data, the geophysicist is responsible for making adequate provisions for both the short-term and long-term disposition of the data.
4. The geophysicist who collects data using federal funds normally has a right to exclusive access to these data for an appropriate period of time. This period of exclusive use should be as short as is reasonable under the circumstances. Upon completion of the initial data analysis period, the geophysicist should initiate arrangements whereby the data become generally available to others.
5. The geophysicist who collects data is responsible for the documentation and quality control needed to assure that the data will be useful to others.
6. The geophysical community should monitor the holdings and performance of the geophysical archives and data facilities, and should advise in regard to data acquisition, retention, and purging to ensure that the most valuable data are accessible to users.

7. An adequate portion of funds allocated to research should be set aside for the management of the resultant geophysical data, to ensure their accessibility.

Recommendation 2

Each federal agency engaged in geophysical activities, taking into account the geophysical data principles in Recommendation 1, should formulate its own data policies and procedures. The federal agencies should coordinate their procedures to facilitate interagency data uses and consistent national implementation.

The following are recommended as guidelines for the formulation of agency policies and procedures:

1. Scientific data collected using federal funds lie within the public domain, and should be made available to the general public, except where this conflicts with the needs of national security.

2. Every project that involves the generation of scientific data and is funded by any agency of the federal government, whether in-house or by contract or grant, should include (in the project plan or proposal) a plan and associated budget for the management of the data to be generated, including the long-term disposition and accessibility of the data to the public.

3. The federal government operates a number of data archiving and dissemination facilities, designated as national data centers. Geophysical data collected using federal funds should, in general, be made accessible through these centers.

4. The functions of the national data centers should include the following:

(a) Provide long-term storage of scientific data collected using federal funds.

(b) Promote the adoption of good data management policies and procedures, including the development of a uniform data interchange model and quality assurance.

(c) Integrate data sets from various sources and, where necessary, develop new data products, so as to make the data as useful as possible to government, academia, and the general public.

(d) Develop comprehensive referral systems and catalogues of data holdings and make these available to potential users.

(e) Make full use of state-of-the-art technology so as to make the data center operations as efficient and economical as possible.

(f) Provide prompt and responsive data services to the entire user community.

(g) Provide geophysicists with the necessary background information needed for the submission of data to the center.

(h) Serve as information centers regarding the availability of relevant data that are not held in the center.

Conclusions

The principles recommended by the data policy report have been generally accepted when reviewed by groups of geophysicists. To date, however, few of these principles are being observed. The oceanographers (I am pleased to say) are generally ahead of most of their geophysical colleagues when it comes to enlightened data management policies. Led by the Division of Ocean Sciences of the National Science Foundation, a group of federal agencies have prepared a new federal policy for *in situ*

ocean data (addendum A). Nevertheless, a strong peer-pressure or community will is needed if we are to put these principles into practice. It will take time, money, and an attitude of unselfishness motivated by the common goal of scientific understanding.

It is essential that we begin to establish national procedures to implement these data policies. We are about to enter a period when effective handling of ocean data sets will be crucial. Many agencies of the federal government are enthusiastic about a concerted program to study long-term global change. In the words of NASA's Earth System Science Committee: "Of paramount importance to the success of Earth System science is an advanced information system that will promote productive use of global data. The worldwide space and *in situ* observations required for a deeper understanding of the Earth System can be utilized only if the research community has effective access to them." (Earth System Science Committee, 1988).

The practices for the sharing and preservation of data sets that have been built up over the last century will surely need to be updated if we oceanographers are to play the critical role demanded of us studying our planet. Indeed, studying the Earth System will demand an interdisciplinary approach to data management. I am hoping that oceanographers will show the way in implementing new data policies.

REFERENCES

Earth System Science Committee, *Earth System Science, A Program for Global Change*, National Aeronautics and Space Administration, Washington, D.C., 1988.

National Research Council, Committee on Geophysical Data. *Geophysical Data: Policy Issues*. National Academy Press, Washington, D.C., 1988.

ACKNOWLEDGEMENT

Preparation of the CGD report on geophysical data policy issues took place over a substantial period of time and involved many individuals, - including members of the Geophysical Data Committee, diverse (National Research Council) boards and committees concerned with geophysical programs and research, and a large number of outside reviewers. Special credit is due to Dr. Michael Chinnery, first at Lincoln Laboratory, MIT, and now at the National Geophysical Data Center, for his work in preparing the policy report.

ADDENDUM A

Proposed Federal Policy for *In Situ* Ocean Data

Purpose

This statement establishes a policy and guidelines to assure timely submission of appropriate real-time and archival quality *in situ* oceanographic data to national centers, while recognizing needs of principal investigators to protect their intellectual investment and encouraging their continued efforts to collect useful oceanographic data.

Policy

Much *in situ* ocean data collected under Federal sponsorship is needed for purposes other than those for which they were originally collected. Such data are to be made available for these secondary purposes in a reasonable time as described below.

Data needed for forecasting are to be submitted in real time through the WMO/IOC Integrated Global Ocean Services System (IGOSS).

Data sets likely to be of high utility for other purposes are to be submitted to and archived by designated national centers. These data sets should be accompanied by a brief description of the methods and techniques used for their collection and processing.

The national centers receiving such data sets will assure that: inventories of data received are distributed to funding agencies; archived data and related information are accessible and available to secondary users in a timely and efficient manner, either on the basis of exchange or in accordance with applicable cost recovery policies; and these data are preserved and properly managed to assure their quality.

Funding agencies are responsible for assuring that data and related information likely to be of high utility for secondary use are archived in designated national centers. These agencies, with assistance from NOAA's National Environmental Satellite, Data, and Information Service (NESDIS), will identify such data and related information and will require their principal investigators to submit these data and related information to the designated center. Funding agencies will also work with their principal investigators to assure that other appropriate data are achived within a reasonable period of time at the principal investigator's or an associate institution in order that these data will be available for secondary use upon request.

NOAA/NESDIS centers will work with principal investigators to assure that data submitted to these centers are in mutually agreed-upon formats. Data are to be submitted via computer-compatible digital media, when possible, rather than as printed reports.

Principal investigators and ship operating institutions are responsible for meeting all legal requirements for submission of data and other research results which are imposed on them by a foreign government and which they accept as a condition of that government's granting of a research clearance. It is the responsibility of each principal investigator in this respect, with the assistance of the Department of State and sponsoring Federal agencies, as necessary.

Funding agencies will apply this policy to their internal ocean data collection and research programs and to those of their contractors and grantees and will establish procedures to enforce this policy.

Guidelines

Ocean Data which are needed for real-time and/or archival purposes are to be submitted in accordance with the guidelines listed below.

Real-time and Delayed Real-time Data

Surface and mixed-layer temperature and salinity data are to be submitted in real-time along with standard surface meteorological observations. These data should be transmitted at regular intervals in accordance with procedures specified by IGOSS. Marine weather observations are requested in the SHIP code within one hour of the observation as prescribed by the WMO, whereas BATHY and TESAC messages may be accumulated up to 48 hours after the time of observation before transmission to national centers. NOAA will make all relevant instructions and forms available to research vessel operators and will provide updates and changes as they are promulgated by the responsible international bodies.

Submission of data through IGOSS does not substitute for later submission of archival-quality data.

Navigational and related information, such as soundings of previously uncharted shoals, are to be reported in accordance with the "Guide to Marine Observing and Reporting, Publication 606 of the Defense Mapping Agency Hydrographic/Topographic Center", a copy of which should be available aboard every research vessel.

Archival Data

The following centers have been designated to receive data for archival: the National Oceanographic Data Center (NODC); the National Climate Data Center (NCDC); the National Geophysical Data Center (NGDC); and the National Snow & Ice Data Center (NSIDC).

Types of data which are to be archived are:

Ocean physical data - temperature, salinity, light transmission or attenuation, ocean currents, waves, pressure, sea level, sound speed (NODC);

Ocean chemistry data - nutrients such as phosphates, nitrates, nitrites and silicates; chemical tracers such as helium, tritium, freon and argon; pollutants such as petroleum hydrocarbons, organochloride and organophosphorous pesticides, polychlorinated biphenyls (PCBs) and heavy metals and particulates. Data may represent chemicals in water samples (NODC), marine sediments (NGDC) or biota (NODC);

Ocean biology data - primary productivity; concentrations of pigments in phytoplankton, such as chlorophyll a; biomass of phytoplankton, zooplankton, benthos and nekton; bioluminescence (NODC);

Surface meteorological data - air temperature, sea-surface temperature, dew-point temperature, pressure, wind speed and direction, weather, short- and long-term radiation, visibility, cloud cover and type, and ice accretion (NCDC);

Geophysical and geological data - bathymetry, magnetics, gravity, seismic and other quantitative geophysical data; geological data including station locations, collection/storage locations, and preliminary descriptions of seafloor samples recovered (NGDC); and

Sea ice and other glaciological data - sea ice, icebergs, ice shelves and associated physical oceanographic and meteorological data (NSDIC).

Inventories of all such data collected are to be submitted to the designated center within sixty (60) days of the end of the observational period/cruise or periodically for continuing observations if there is a

significant change in location, type or frequency of such observations. Inventory forms, such as the Report of Observations and Samples Collected on Oceanographic Programs (ROSCOP), and instructions will be supplied by NOAA/NESDIS, based on lists of investigators provided to NOAA/NESDIS by funding agencies.

Principal investigators will assure that data sets identified for submission to national centers are submitted to the designated center within two years of the observational period/cruise. This period may be extended under exceptional circumstances by agreement between the principal investigator and the funding agency. Data produced by long-term (multi-year) projects are to be submitted on a yearly schedule. Principal investigators working together on coordinated programs may, in consultation with their funding agencies, establish more stringent data submission procedures to meet specialized needs of such programs.

Federal agencies which engage in and/or fund data collection will promote quality control of ocean data which they and their contractors and grantees collect.

Each national center will:

- upon archival of a submitted data set, send to the principal investigator a copy of the data set as archived;
- monitor submitted data to assure that they are submitted in accordance with these guidelines and in appropriate formats; and
- report regularly to principal investigators and Federal agencies on the rates of data submission, archiving and usage.

Daniel Cheever: I would like to ask Dr. Webster, apologetically, if he has already answered my question in his last remarks, can these principles, rights and responsibilities of the agencies as well as the scientists actually be reconciled so as to be operationally feasible, or are some of them internally inconsistent so that it will be difficult to implement them? I am thinking, particularly, of national security considerations and that sort of thing.

Ferris Webster: I think it's essential that we put these policies into effect if we are going to develop the data system to meet our needs. For example, looking at the Global Change Program, the Committee on Geophysical Data will propose a strategy for data management on global change. We have been asked to do this by the Interagency Working Group on Global Change. A data system is going to be expensive. It will take money that otherwise would go for research. A lot of scientists say, "I don't want them to take my research dollars and put it into data management."

Secondly, there is a social problem: "This is my data, I went to sea, I collected it, it's mine." I think we must change some of that attitude. It *is* changing, by the way. The fact that an oceanographer can get data from a satellite from a national oceanographic data center on a regular monthly basis begins to change his perception on how valuable his own data set is. He realizes that it has to be merged with other data sets to be effective. This is changing perceptions. I think the answer to your question is it's going to be difficult to implement this policy, but I think it's technically feasible and I'm hoping we can actually do it.

John Craven: Please identify, if possible, where the locus of responsibility in the federal government for this national policy is, and for its time-binding history, past and future.

Ferris Webster: I don't believe there is an identified focus. The National Oceanic and Atmospheric Administration has the charge for handling oceanographic data; it is written into the law that they shall collect all the data sets. If you look at the satellite data, much of it is handled by NASA. NASA tends to set up its own system, sometimes in parallel with or sometimes complementary to NOAA. I think the hopeful fact is that Thomas Pike, the assistant administrator of NOAA for satellites, and Shelby Tilford, I've forgotten his title, but he's responsible for earth science systems at NASA, Ray Watts from the U.S. Geological Survey, and Bob Corell from NSF, and a couple of other people at that level have been getting together regularly and talking about closing the circle and coming up with a uniform agency policy. I'm very optimistic about that.

John Craven: So, following up, shouldn't your first recognition be the generation and identification of a locus of responsibility in the federal government for this problem?

Ferris Webster: In hindsight, yes. Perhaps the Committee on Geophysical Data can clarify this in its Global Change report which it hopes to get out by Christmas 1988.

Edward Miles: Ferris, I've listened now for several days to plans of global exchange research and this morning is especially graphic because of Dr. Rasool's presentation followed by several others on the data management issue. If you look at the research plans and the data management plans, and you look at the length of time for which this is necessary, and the clean-up that must be done, what assurance is there that governments are going to be committed to this over the length of time that is necessary to do the work you guys have been planning?

Ferris Webster: You can't ask an oceanographer questions like that. I don't know where the governments are going to get the commitment, but they must have it. I think the only way we can do it is to have the money in the budget, so we've got to convince not only Congress but the population of this country and other countries. It is important to begin to describe the nature of the changes in the environment of our planet more carefully than we've been able to do so far. We just must do that.

S.I. Rasool: It is a bit a problem but I think it can be done because there have been two examples recently.

One is the ozone hole problem. Fortunately it happened all the way in the Antarctic, though there was nobody there but the resources that NASA, NSF and NOAA put together jointly to get this program going. The response with the aircraft measurements, ground measurements, satellite measurements, all the satellite data for the last 12 years was analyzed and calibrated in one year. It was a beautiful example that money was found to do it.

The second thing that is happening now is the whole problem of the greenhouse effect. I mentioned this CO_2 problem has been dwarfed, so to say, by the discovery that methane is increasing also and freon and N_20 and so on. I think the awareness is becoming pretty important in Congress. I have testified that people are pretty concerned.

The bigger problem is the agencies don't like to get orders from the top. You know, a letter from Fletcher doesn't do anything -- I can say that, but it's formed in the agencies inside at the working level, and I can mention a few names. These people get motivated to get the program going and they have in their pockets several hundred million dollars. We are not talking about a new space mission which is much more expensive. They from their own funding can put aside some money just like they did for ozone, and get it done at a low level. It's not a new start which you're looking for which is always a big problem but it's a progam which can extract some funds from here and there and get going. The last thing is that everybody is looking at what the United States will do for the global change program before they get going. I know that Sweden and France have already starting to get going without waiting for us, actually, so I think that will help greatly. I have just come from Japan where there is a lot of activity right now on global change. There is a major program in space. They have done something which we didn't do, that is to set aside, from the beginning, money for data. I think these three things will help the management in our agencies and the medium-level management to get together and get it going. There is hope. There's light at the end of the tunnel, I think.

John Knauss: Ed, if I could also add a point. You, as a student of the social sciences and governmental operations, must recognize that if you have a large enough inertia which has been building behind this program, it may not come out the way these people have been talking about it today, but I think you can be pretty certain that we're going to have *some* kind of a global change program on an international level, because of the effort that has been building over the years. It may take longer. It may be a bit different, but it will exist at some level in some way.

Edward Miles: But John, it is precisely because I've studied a lot of these things before that I'm worried about two problems. One is magnitude and the other is continuity.

S.I. Rasool: Yes, but it has to come. See, NASA goes from mission to mission, you know they have to have a $2 billion project to get a new start, like in astrophysics, or space telescope, and so on, and we are trying for this to go, not as a new start but a collective program which is bits here, and bits there, the UARS, the earth systems science program and so on, put it all together to get it going. It may take longer than we think, but I think the momentum is there to get it started. The ozone hole is a great example that we have a new program with the Soviets now flying over the northern hemisphere in the Arctic this winter to see if the ozone hole is starting in the north. That is the major new addition with the Soviets, which came out after the Gorbachev meeting.

John Knauss: I think the major concern is the continuity. This is both a very large program and a long-term program and this combination is something that the international ocean science community has never had to deal with before, a program of this length and of this magnitude. I think that program length is probably of greater concern. I suspect that for this program to continue, there will have to be some rather interesting results along the way to maintain that interest; but given what's been happening to the global environment in the last five or ten years I would be very surprised if those results would not be forthcoming. I'm not all that enthusiastic about the ozone hole, even if it does bring money into the sciences, but I am afraid we're going to have a few more "ozone holes" of one kind or another over the next ten years.

Dale Krause: For the benefit of the lawyers in the room I'd like to ask about the problem of trans-national, trans-border data flow. Is this going to be a problem for the kind of data that we're talking about?

S.I. Rasool: We are discussing precisely that at a meeting in a few months. There has not been any problem in the areas like astronomy, planetary sciences, and terrestrial physics. The world data centers that exist after the IGY are pretty active in exchanging data. The problem comes when you talk about high-resolution data from the ground, i.e., the national security problem. But most of the data we are talking about is low-resolution data on the ground.

It's the volume of data that has become important and the transmission and so on, so what we are looking at is some mechanism like a world data center where these data can be put but what first brought up in question was how good is the data? Can we use the data collected 25 years ago in the same fashion as the data we collected today? Is the change we are seeing because of the sensor or because of the real change

of the earth? That's the basic problem, so validating some other country's data as the same as our own is the big problem. I don't think there will be a problem in getting data through the system.

Greg Withee: There is a problem which is starting to occur beyond the legal considerations and that's one of cost. Many of the satellite data outputs are not exchanged freely between nations. Hence, these environmental data are not available to scientific investigators at free or minimum cost as is the case for meteorological satellite data, as agreed to by members of the World Meteorological Organization many years ago. In fact, some satellite data now cost for a single tape, for example, over U.S.$3,000. That is not a trivial cost when your project requires a thousand of these tapes. I think that cost or "pricing policy" is something that we should be looking into in global change programs even when considering low bit rate data. Some of the international organizations like the Intergovernmental Oceanographic Commission, WMO, UNEP, and ICSU may help here. There's a real role to keep access to data easy and inexpensive for scientific research.

PART VI A

OCEAN MANAGEMENT CONCERNS OF SPECIAL INTEREST

PANEL 6A

INTRODUCTION

Lee Kimball: Last year at the annual meeting of the Law of the Sea Institute when I was asked to organize a panel on the regional interests of the Southeastern Pacific in the Law of the Sea, I tried to use it as a vehicle to address, not just the traditional LOS issues, such as national resource claims and boundary delimitation, but also emerging issues in ocean law and policy: issues that derive from the expanded obligations of States under the 1982 Convention, in particular in offshore areas under national jurisdiction; to protect and preserve the marine environment and to conserve living marine species. Topics considered included States' obligations to conduct environmental assessment and monitoring (Articles 204-206) and to further elaborate global and regional rules for marine environmental protection. We also discussed designation of marine protected areas (Article 211(6) and 234), and received a preview of Marty Belsky's evolving ideas on ecosystem management further elaborated here earlier this week.

The LOS Convention not only requires States to protect the marine environment from the six sources of marine pollution. It also obligates them:

1. to take measures to protect and preserve rare or fragile ecosystems and the habitats of depleted, threatened or endangered species and other forms of marine life;
2. to ensure that activities under their jurisdiction or control do not cause damage by pollution to other States and their environment, nor spread beyond areas where they exercise sovereign rights under the LOS Convention;
3. to take measures to maintain or restore populations of harvested living species within national jurisdiction and on the high seas, on the basis of "the best scientific evidence available" and taking into account effects on associated or dependent species. The latter provision was further developed as the 'ecosystem' standard for conservation of marine living species in the 1980 Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), referred to in earlier panels; and
4. it even obligates States to cooperate in establishing appropriate scientific criteria for the formulation and elaboration of rules, standards and recommended practices and procedures for marine environmental protection.

Whether or not viewed as an enforceable legal rule, as Marty advocates for ecosystem management, these obligations constitute the foundation for States to regulate and manage activities in offshore zones of jurisdiction in an integrated and environmentally sound manner.

The theme of this meeting -- "The Implications of Developments in Science and Technology for the Ocean Law Regime" -- is integrally linked to expanded States' obligations under the LOS Convention. As has been pointed out in earlier sessions, however, implementing these obligations requires data and information on the marine conditions and species and relationships between marine, atmospheric and terrestrial environments that either we do not yet have or are not yet able to organize and systematize in a manner that is useful for policymakers or those

responsible for ocean management. It has also been mentioned that data management should be part and parcel of data collection in order to ensure its accessibility for the scientific community at large and for those responsible for the management and regulation of ocean activities. Finally, it has been pointed out that if we in the United States have not yet achieved these objectives, other countries are well behind us.

This panel on 'Ocean Management Concerns of Special Interest' will look at three aspects of implementation of the State obligations noted above:

What are we doing to collect and analyze data and information on marine species and conditions?

Alasdair McIntyre will summarize the findings of the United Nations Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) working group, which is preparing a revised assessment of the state of the oceans, and explore some of its implications for the further development of law and policy.

What are we doing to help other nations, particularly the developing nations, to better address their offshore management responsibilities and interests?

Stella Vallejo will discuss trends in coastal and ocean management and describe the work of the United Nations Secretariat in this regard. Having known Stella for over ten years I have no hesitation in saying that her efforts and those of her colleagues in a relatively small office have been instrumental in helping many developing nations around the world focus on how to implement expanded offshore rights and responsibilities in a sound, rational manner. The recent merger of the legal/policy expertise of Under Secretary-General Nandan's office with the ocean management experience of the Ocean Economics and Technology Office should prove a valuable resource for many countries worldwide.

Steve Olsen, who directs the Coastal Resources Center at URI and is in charge of implementing the U.S. AID coastal resources management program in Ecuador, Thailand and Sri Lanka, will share some of his insights of the difficulties and rewards involved.

What are some of the emerging tools available to those responsible for offshore management that will order and facilitate this task in the future?

Eric Carlson, of James Dobbins Associates, will present an overview of advanced means to integrate large volumes of information collected through assessment and monitoring programs. His company has developed computer mapping techniques targeted to coastal areas and resources as tools for resource managers and policy makers.

The State of the Marine Environment

Alasdair D. McIntyre
University of Aberdeen
Aberdeen, Scotland

Introduction

The proceedings of this 22nd Annual Conference address a number of interesting questions about what Marine Science and Technology might have to offer towards the end of the century. But while looking ahead in this way at the positive developments that may be expected to benefit society, it is important at the same time to take into account any adverse circumstances that could detract from the smooth course of progress. It is, therefore, entirely appropriate that the Conference should also consider the extent of man's detrimental effects on the oceans, and how these may alter the environment within which other activities are conducted. This paper briefly reviews the present state of the oceans, and then looks ahead to the issues that may be relevant during the next decade.

Anthropogenic Impacts on the Oceans

In discussing the impacts of man on the oceans, it may be useful to begin by identifying the various categories of human activities with which adverse effects are associated. I would like to consider eight categories all of which are currently being discussed by the United Nations Joint Group of Experts on the Scientific Aspects of Marine Pollution (GESAMP) in the context of their second review of the Health of the Oceans.

Disposal of Urban and Industrial Waste Waters

This constitutes the most ubiquitous of all marine contaminating situations. Waste water from human communities, large and small, reaches the sea directly or indirectly via rivers from all countries throughout the world, often without any form of treatment. When stormwater or industrial wastes are channelled through sewerage systems the resulting effluent is a highly diverse mixture containing oil, metals, and synthetic chemicals as well as a variety of solid materials, but two components of major concern are pathogenic organisms and nutrients.

Dumping of Wastes

Although there is opposition in some countries to the use of the sea for waste disposal, this is widely practiced throughout the world. The bulk of the dumped material consists of sediments, particularly dredge spoil, and the major proportion is relatively inert, but chemical wastes and sewage sludges add both toxic substances and nutrients.

Marine Transportation

On regional scales as well as in global terms it is estimated that almost half the input of oil to the sea is due to shipping (NAS, 1985). Much of this input comes from the normal operations of vessels, although in some years accidents can make a significant contribution, and of course accidents may release other hazardous cargos, apart from oil, into the sea.

Disposal of Solid Matter

The main concern in this category is with plastic litter and the problems are that this is non-biodegradable and therefore persistent; it is buoyant and therefore floats; it is often disposable by design and therefore readily discarded into the environment. There are three main groups: fishing gear which, in the past, was made of natural fiber, is now largely composed of synthetic materials. This means that nets and warps which are lost or discarded will remain in the sea for a long time. If partially weighted and drifting, or anchored on the bottom, such gear can continue to trap and kill marine organisms by 'ghost' fishing, while it presents a danger to shipping when floating on or just below the surface, entangling propellers and choking water intakes.

A second problem arises from the plastic materials used externally in packaging. These range from large straps round bulky cargo items to the small yokes securing packs of beverage cans. When floating free in the sea they can encircle marine animals, fish and birds, tightening round their bodies as the animals grow and, eventually, causing death. Plastic sheeting, especially when covered by encrusting organisms, is often swallowed by marine animals, interfering with their digestive processes.

Thirdly, there are 'industrial' plastics - small granules usually less than 4 mm in diameter which constitute the bulk material in which plastics are produced and transported before being formed into the products for everyday use. These granules enter the environment during either manufacture or transport (Gregory, 1978), are ingested by marine organisms (Van Franeker, 1985) and cause adverse effects.

Finally, plastic materials of all kinds are washed up on beaches causing significant amenity deterioration in resort areas. It has been estimated, for example, that nearly four million objects constituting man-made litter are afloat each day in the Mediterranean Sea (McCoy, 1988).

Exploitation of Non-living Resources

The most obvious item in this category is oil exploitation at sea which in recent years has been pushed out from the shallow inshore areas to exposed regions in, for example, the North Sea, and exploration is proceeding or pending in such places as Georges Bank, the Grand Banks, and even in the particularly hostile waters of the Beaufort Sea. However, experience in the North Sea (McIntyre, 1988) suggested that although there are always potential dangers in extracting and transporting oil it has been possible for operations to proceed without major environmental input.

Other non-living resources taken from the sea include a number of minerals which are actively exploited in the form of unconsolidated deposits collected directly by dredging, such as construction materials (sand, gravel, and shells) or heavy mineral placers containing titanium, tin, gold, metalliferous muds or nodules. There are also consolidated deposits which must be fragmented before collection - coal, iron ore and other minerals occuring in mounds, stacks, veins or channels in solid host rocks. These minerals are recovered by a variety of methods - scraping, excavating, drilling, or tunneling which cause physical disturbance on the sea floor and produce turbidity plumes in the water column (Cruickshank, 1973). The main effects, however, are limited to the period of actual recovery and are restricted to the vicinity of the mine site. Possible far-field effects in deep oceanic water are less

well known, but are likely to be associated with resedimentation of the plume and to affect organisms living on the sea floor.

Exploitation of Living Resources

In harvesting marine species of commercial importance man now has, at his disposal, a range of highly sophisticated techniques for finding, catching and processing the resource. The world catch at present exceeds 80 million metric tons annually, and most of the major familiar stocks are either fully fished or at risk from overfishing. There is no doubt that indiscriminate and uncontrolled exploitation of these resources by man has done more damage to natural populations than can be attributed to known examples of chemical pollution.

The yield from wild species is now significantly augmented from mariculture activities. Although this still represents less than 10 percent of the total it is rapidly increasing and in some countries contributes an indispensable proportion of the total production; in others it adds significantly to revenue by producing high quality exports. Mariculture is at present largely confined to the shallow coastal zones where it requires clean water of high quality, yet the processes involved in feeding and growing in intensive farms are themselves generators of pollution.

Development of Coastal Areas

This is a convenient heading under which to bring together a wide range of activities, - harbor constructions; shoreline embankments; canalization; wetlands reclamation; industrial, residential and recreational building and, indeed, all the structural developments associated with coastal urbanization. Although each individual case is associated with a specific site the overall problem is of global extent given the widescale influx of population to coastal areas.

Activities in Hinterland Areas

This heading also is convenient for listing together many diverse operations but here associated not with the coastline directly, although ultimately impinging on it. The most obvious activities are dam building for energy generation and diversion of water for irrigation, but a wide range of land use practices is also relevant, including both deforestation and afforestation as well as the general application of chemical fertilizers to agricultural land.

Adverse Effects

The activities listed above can result in a wide range of adverse effects on the marine environment, but the more significant of these may be grouped under three headings - public health effects, eutrophication and habitat damage.

Public Health Effects

For obvious reasons we may consider this first, and of the eight activities listed, the first two are of major relevance in this context. There are two sorts of public health effects - those arising from toxic chemicals and those related to pathogenic organisms.

Toxic effects to human consumers of residues in commercially harvested aquatic organisms are of particular concern in some freshwater situations but in the sea the problem is much less significant. Metals or synthetic organic compounds do inhibit harvesting of resources because of high levels of residues in edible tissues, but for the most

part such problems are restricted in space to the close vicinity of an effluent pipe or in time to the immediate aftermath of a chemical spill and are not of general concern in the sea.

Pathogenic organisms, on the other hand, present a significant global problem. These comprise of bacteria, viruses, the cysts of protozoan parasites and the eggs of metazoan parasites including tapeworms and roundworms, and can have two sorts of public health impact. First they affect swimmers and other users of beaches by direct contact, causing ear, nose and throat infections as well as gastro-enteric diseases. Second, if filter-feeding shellfish are harvested from contaminated waters more serious illnesses such as cholera and hepatitis can result from their consumption, especially if they are eaten raw. For example, recent epidemiological studies in several countries suggest that a major proportion of the cases of infectious hepatitis is associated with the consumption of contaminated shellfish.

Eutrophication

This refers simply to the excessive stimulation of plant growth by the addition of nutrients, mainly compounds of nitrogen and phosphorus. The process has long been known in freshwater lakes where it can cause substantial damage. In the sea eutrophication can arise from natural causes such as upwelling of deepwater near the coast or high seasonal run-off from the land, resulting in increased primary production usually in a beneficial way. There are many well documented examples of hot spots associated with specific inputs of nutrients but it has been generally thought that the vast extent of the sea would enable it to absorb all nutrient inputs from man. However, accumulating evidence from many parts of the world makes it clear that this is not so and that the problem is not confined to isolated hot spots. The most obvious initial sign of trouble is an exceptional algal bloom whose decay and decomposition by bacteria increases the oxygen demand on the system thereafter producing conditions unsuitable for aerobic life, often resulting in mass mortalities of fish and invertebrates. One problem is that such events can occur naturally and even after the massive bloom off the east coast of the U.S. in 1976 (Swanson and Sinderman, 1979) a credible natural explanation could be offered (Falkowski, *et al*, 1980). As a result we have, perhaps, been slow to accept that eutrophication in the sea might constitute a major threat, but recent observations must lead to a revision of thinking. To the high inputs of nutrients from urban waste waters both directly to the coast and from rivers, there has in recent years been major additional contributions in the form of chemical fertilizer run-off from agricultural land and animal wastes from intensive farming. It is not suggested that the open ocean is likely to be widely affected, but there is now no doubt of a risk to inshore zones fed by large rivers and coastal run-off adjacent to urbanization and intensive agriculture, in areas where water circulation is slow. This has been well demonstrated in the Baltic Sea, the southern North Sea, the Adriatic, in the coastal regions of Japan and along the eastern seaboard of the U.S. In May-June, 1988, massive blooms of the alga *Chrysochromulina polylepsis* have spread along the shallow waters of southern Scandinavia, causing a loss of over $200 million to the fishing industry mainly through the death of Norwegian salmon in sea cages. It must now be recognized that eutrophication of coastal waters is a major problem throughout the world.

Damage to Habitats

While eutrophication alters and eventually damages habitats, there is a third category of effect which emphasizes other types of habitat damage resulting from a range of human activities, largely those covered by the last two items on the list of human activities, - development of coastal areas, and activities in the hinterland.

In the development of coastal areas the most direct impact is from the clearing of sites and the laying down of concrete and asphalt, which eliminates natural wetlands and other habitats for wildlife, and breeding grounds or nursery areas for resource species. But even when some coastal areas are apparently preserved for the tourist industry, their value as natural habitats is impaired by the presence of buildings, lights and general activity so that beaches which were, for example, egg-laying sites for turtles are no longer suitable. In addition to industrial and tourist development, the rise in aquaculture is putting a steadily increasing demand on, for example, reclamation of mangrove regions. In Panama it is estimated that the rate of depletion of mangrove forests is about 1 percent per year, while in Ecuador, by 1990 almost one-third of the mangroves which existed at the beginning of the decade may be gone.

While these activities on the shoreline are of concern, developments in the hinterland also raise major problems along the coast. The most obvious is the building of dams for a variety of purposes such as power generation, irrigation and flood control. Petts (1984), estimated that about 20 percent of the stable run-off in Africa and North America is contributed by impoundments, and the corresponding figure for Europe and Asia is around 15 percent. It is suggested that by the year 2000 about 66 percent of the world's total stream flow will be controlled by dams. This results in a major change in the hydrological regime at the coast and adverse changes in habitats and natural communities are being documented. In East Africa the sediment load of the Zambezi river has dropped to less than half as a result of dams, while sediment discharge of the Nile into the Mediterranean, once about 150 million tons per year is now about zero, with damaging effects on fisheries, and the sediment contribution of the Colorado river to the Gulf of California is greatly reduced.

While it is obvious that major water management schemes will have repercussions on the coast, it is perhaps not so obvious that a variety of land use practices conducted in the hinterland can also have significant implications for shorelines. Deforestation, for example, can activate soil erosion and the effects are opposite to that of damming - increased run-off and enhanced sediment loads, with different but equally serious repercussions on coastal ecology, particularly on coral reefs which are highly sensitive to increased sedimentation.

The Present State of the Marine Environment

From the above discussion it will be clear that for the most part, the impact of man on the oceans appears at present to be confined mainly to the margins. Some contamination, particularly of oil, can be recognized from marine transportation along the main shipping routes, but apart from this, inputs to the open ocean are chiefly from the atmosphere. In the period of nuclear weapon testing in the 1960s, enhanced levels of radionuclides were found off the continental shelves but following the Partial Test Ban Treaty these levels have been declining (GESAMP, 1982), and unless there are other Chernobyl-like accidents this decline should continue. Among synthetic organic compounds and the heavy metals, those

attributable to man's activities, which are transported via the atmosphere from the major land masses are found at higher concentrations in the open sea. However, the concentrations are well below those at which any significant damage might be expected, and some improvement has been detected. Thus, for lead there are recent decreases in some open ocean concentrations explained in terms of the reduction of lead in gasoline. In general, then, the open ocean is relatively little influenced by inputs from man.

Coastal zones, on the other hand, are clearly at risk. Throughout the world the shift of population to the coast and the increasing demands of development and tourism are placing substantial pressures on the narrow interface between land and sea, while operations in the hinterland are adding to the problems.

The Future

Looking ahead towards the end of the century, what can we say about the state of the marine environment? A number of suggestions can be made.

1. The build-up of pressure on inshore areas will certainly continue, and site-specific problems, which are currently becoming of regional concern, could develop into major global issues.

2. There may well be an increasing demand for offshore dump sites, particularly as land disposal options with the associated possibility of ground water contamination are adequately evaluated in comparison with sea disposal. In preparation for this, further investigations towards a better understanding of deep sea ecology are required.

3. A feature will be the expansion of mariculture which will be pushed out into deeper water as appropriate technology develops and as more inshore space becomes crowded or damaged by pollution.

4. In regions where oil fields on the continental shelf are reaching the ends of their useful lives, the decommissioning of offshore installations will be a major issue, and if this is not resolved to the satisfaction of other users of the sea, there could be stronger opposition to the development of new fields.

5. The utilization of ocean energy may further develop, and the environmental implications will need to be reassessed.

6. If the greenhouse effect and the ozone depletion do indeed represent the threat to which current thinking seems to be pointing, the signs should be stronger by the end of the century. Fortunately, some of the larger scale oceanic and atmospheric studies now being planned on a global basis will by then be producing results which should make the analysis of these phenomena more adequate.

REFERENCES

Cruickshank, N.J. 1973. Mining and mineral recovery. Chapter 3 in Undersea Technology Handbook Directory, 1973. Compass Pub. pp. A15-A26.

Falkowski, P.G., Hopkins, T.S., and Walsh, J.J. 1980. An analysis of factors affecting oxygen depletion in the New York Bight. Journal of Marine Research 38, pp. 479-506.

GESAMP, 1982. The Review of the Health of the Oceans. Reports and Studies 15. UNESCO, Paris. 108 pp.

Gregory, M.R. 1978. Accumulation and distribution of virgin plastic granules on New Zealand beaches. New Zealand Journal of Marine and Freshwater Research *12*, pp. 399-414.
McCoy, F.W. 1988. Floating megalitter in the eastern Mediterranean. Marine Pollution Bulletin, *19*, pp. 25-28.
McIntyre, A.D. 1988. Pollution in the North Sea from oil-related industry: An overview. In: Proceedings of International Conference on the Environmental Protection of the North Sea, 24/27 March, 1987, IMO London.
NAS, 1985. Oil in the sea: Inputs, fates and effects. Washington, D.C. National Academy of Sciences. 601 pp.
Petts, G.E. 1984. Impounded rivers. Perspectives for Ecological Management. John Wiley and Sons. 326 pp.
Swanson, R.L., and Sinderman, C.J., 1970. Oxygen depletion and associated benthic mortalities in New York Bight, 1976. NOAA Professional Paper 11. Washington 345 pp.
Van Franeker, J.A. 1985. Plastic ingestion in the North Sea fulmar. Marine Pollution Bulletin *16*, pp. 367-369.

New Challenges for Coastal Area Management and Ocean Management in the 1990s

Stella Maris A. Vallejo*
Ocean Affairs
United Nations, New York

I. The First Two Decades in the Evolution of Coastal and Ocean Management: The 70s and the 80s

The record of coastal and ocean management experiences at the world level (*Table 1*) indicates that although the concepts of coastal area management (CAM) and of ocean management (OM) originated about the same time, the early 1970s, they have evolved separately and at a much different pace.

Conceptually, they have emerged with two distinctive geographical components: the coastal area, and the ocean area. This dichotomy is reflected in their practical applications since projects and programs are designed and implemented independently. Thus, national efforts are either coastal-oriented or ocean-oriented. As yet, the only initiative which encompasses both the coastal and ocean areas under one single plan is being undertaken by the State of Oregon (USA).[1]

It appears that CAM has evolved much more rapidly than OM both in terms of conceptual development and practice. From the 1980s onwards, CAM gained momentum and took off from the stage of institutional development to the stage of formulation and implementation of programs. Currently, eleven developing countries are in the process of formulating programs and/or projects. It is expected that other countries will join in the near future.

On the other hand, the practical application of OM concepts has not followed the same course. The take-off from theory to practice has not occurred as yet. From the early European efforts for the development of a conceptual basis to their translation into the operational context, the process has been extremely slow.[2,3,4,5,6,7,8] Only three countries have formulated OM programs, although there are indications that at least a couple of new programs may emerge before the end of the decade.

The above trends indicate that despite the current dynamism of CAM efforts, these two decades of experience encompass a very slow and hard process. It took almost ten years until CAM was replicated outside the developed world. The descriptions of the genesis of some of the ongoing programs indicate that recognition by a nation of the need for an integrated coastal and/or ocean management program usually has required:

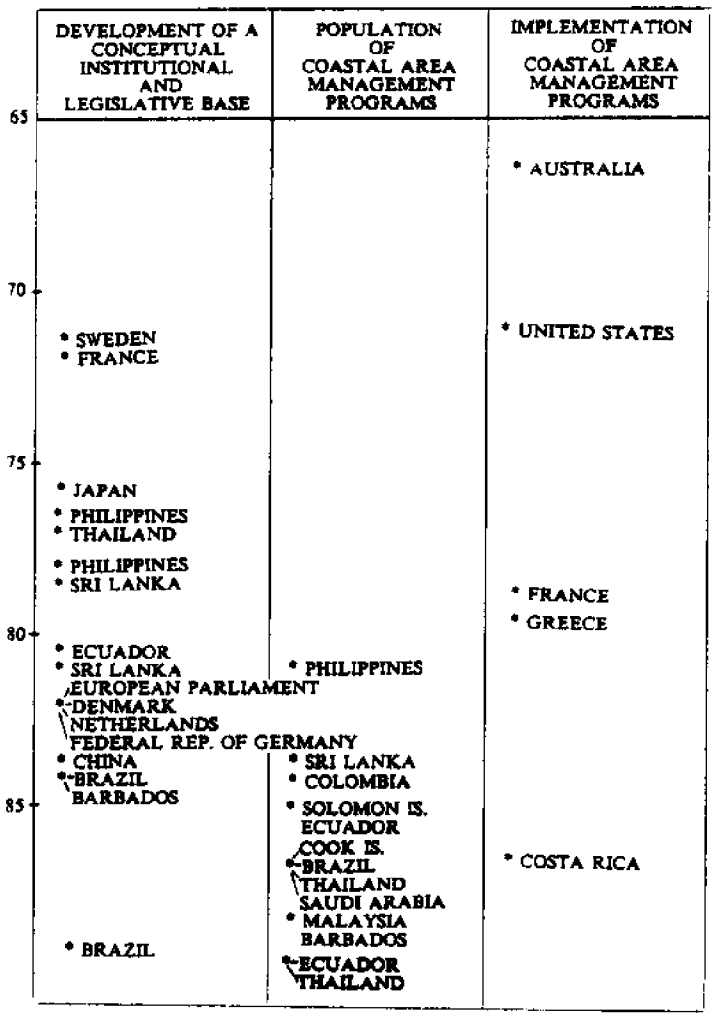
a) evidence of resource degradation (e.g., overexploitation, misuse); environmental problems (e.g., pollution, modification of the structure and processes of critical coastal ecosystems), and/or intense conflicts among different resource use activities and their associated groups (e.g., fisheries vs. oil and gas activities);[9]

b) international assistance missions that are requested by countries in an advisory capacity, or for the organization of conferences and seminars, in the field of coastal and/or ocean management; and/or

c) training of governmental officials, planners and other professionals in the concept and prerequisites for the formulation of coastal and ocean management programs.

TABLE 1

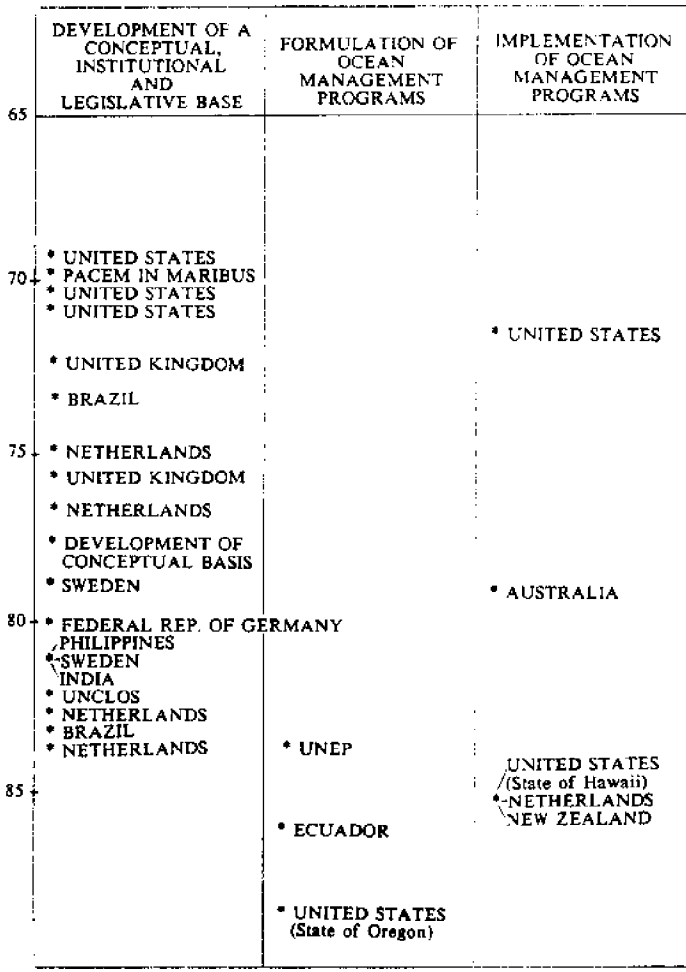
Coastal Area Management Initiatives
(1966-1988)



Source: Updated from Vallejo (1987b)

TABLE I (cont'd)

Coastal Management Initiatives
(1969-1988)



Source: Updated from Vallejo (1987b)

However, even in the presence of a crisis involving resources and the environment, countries appear to be somewhat reluctant to embark on a new type of integrated planning undertaking. This being the case, questions can be raised about the processes, dilemmas and impediments that countries face in meeting the challenge of integrating their "marine dimension" into the entire political, economic and social fabric of their countries, in fact, into the complex processes and apparatus of national development planning, and especially, in dealing with inter-ministerial problems and with the difficult issues that arise from interactions between interest groups having a wide range of perspectives, sometimes in open opposition.

At the moment, the majority of countries face limitations in their ability to formulate and implement integrated coastal and/or ocean management programs. These limitations seem to have stemmed, by and large, from five factors:

First, at the national level the existing institutional frameworks, planning approaches and legislative instruments have not provided an adequate foundation for integrated coastal and ocean management. Existing administrative structures do not make allowances for new and differing marine issues and are thereby comparatively rigid, causing difficulties in both the utilization of the marine potential and the implementation of suitable measures with regard to problems never addressed before, e.g., marine pollution control, access to coastal and nearshore areas.[10]

Second, when problems arise, the responses are carried out on an *ad hoc* basis, instead of contributing planned, anticipatory integrated strategies.

Third, in almost every country the planning and management of marine areas are designed to focus on single marine functions which are often thought of as an extension of land-based activities, e.g., fisheries is placed under the jurisdiction of the Ministry of Agriculture. This narrowly focused sectoral planning and management perspective does not take account of interactions between sectors. The problems of fisheries, energy, shipping, and other coastal and ocean interests have been addressed at length, but only as single-factor issues, without benefitting from cross-sectoral analysis that highlights relationships between resource users and that reconciles the forces and processes acting upon natural, socio-economic and political problems.

Fourth, there is a lack of experience in marine and coastal planning as well as in the establishment of new procedures to ensure intersectoral and intrasectoral coordination within existing sectoral plans relevant to marine and coastal development, and the introduction of the "marine dimension" within development planning.[11] National planning authorities have concentrated their efforts on land planning, while the planning of the open sea areas is still in a developmental stage. There are considerable differences between planning at sea and planning on land. Those differences stem from the following facts:[12]

a) in the open sea, the number of activities and conflicts is smaller and of a different nature than on land;

b) the geographical nature of the ocean system with its distinct physical characteristics, processes, and dynamic systems imposes different planning requirements since the physical limits of functions and activities at sea are not established in the same manner as on land;

c) at sea, the planning of activities is more uncertain. This is due to more limited information and knowledge about the marine environment, about the various activities and their effects on other interests, and about the capacity of the marine environment to respond to a diversity of impacts, and

d) sea planning faces greater jurisdictional problems.

Fifth, multiple jurisdictions and laws apply to various geographic limits within the land-sea interface which creates difficulties in decision-making and overlapping and confusion in applying regulations. Moreover, there is a lack of adjustment in the regulatory framework and an absence of coordination in the application of the fragmentary norms and rules that regulate resources and uses.

II. United Nations Activities in the Field of Coastal Area Managment and Ocean Management[a]

The United Nations, through its Ocean Affairs and the Law of the Sea Office of the Secretariat at United Nations Headquarters as well as through some of the United Nations agencies, has played a fundamental role in the process of promoting coastal area planning and management and in enhancing the capacity of countries to deal with the variety of technical problems and policy issues involved in the design and implementation of a national program (see *Table 2*). These efforts have been complemented by other initiatives organized by national institutions (universities and private organizations).

TABLE 2

United Nations Activities in the Field of Coastal Area Management

Activities / U.N. system	Creation of Awareness and familiarization with the Concept and pre-requisites involved in CAP & M	Training of Specialists in the Scientific Disciplines that nourish CAP & M	Study and Training on Specific Coastal Problems in Selected Areas	Preparation of Region wide or County Diagnosis of Environmental conditions and Economic activities along Coastal Areas	Training of Trainers
OALOS	X			X	
ECLAC	X				
UNU		X	X		
UNESCO		X	X		X
UNEP				X	
CCOP/SOPAC			X		

KEY:

CAP & M: Coastal area planning and management
OALOS: United Nations Office for Ocean Affairs and The Law of the Sea
ECLAC: United Nations Economic Commission for Latin America and the Caribbean
UNU: United Nations University
UNESCO: United Nations Educational, Scientific and Cultural Organization
CCOP/SOPAC: Committee for Coordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas

Source: Vallejo (1987a).

Five specific goals underlie the efforts at the international level:[13]

1. Creating awareness and familiarizing government officials with the concept and pre-requisites involved in CAM and OM;
2. Training specialists in the scientific disciplines that nourish CAM;
3. Studying and undertaking training courses on specific coastal problems in selected areas;
4. Preparing region-wide or country diagnoses of the environmental conditions and the economic activities taken place along the coastal areas as working documentation for the training activities or as background information on specific regions and areas; and
5. Training of trainers.

The *Office for Ocean Affairs and the Law of the Sea* (OALOS) played a leading role in the first type of activities.[b] From its inception in 1973, the United Nations Coastal Area Development Program, and the various activities which comprise it, has included a number of training elements, including the preparation of a world register of courses.[14] A series of seminars and workshops were implemented at the inter-regional, regional, sub-regional and national levels. They were designed to familiarize participants with the broad range of environmental, social-economic, technical and institutional/legal issues encountered in the process of planning and management and to acquaint them with the basic elements and prerequisites of an integrated approach within the context of national development planning. These efforts were complemented by research projects encompassing the preparation of technical reports and guideline documents on coastal area management as well as support for projects of national interest, such as the technical assistance provided for the creation of the Institute of Marine Affairs in Trinidad and Tobago. The former Ocean Economics and Technology Branch also participated in the Regional Seas Program of UNEP with regard to the impact of coastal and marine resources development on the marine and coastal environment. In this endeavor, various studies were prepared on the environmental problems of particular regions, e.g., the Persian Gulf, West and Central Africa, and East Africa.

As regards ocean management, the former OETB prepared, in close co-operation with the specialized agencies and organizations concerned with marine affairs, on a regular basis since 1973, studies on "Uses of the Sea" submitted to the United Nations Economic and Social Council. The objective of these studies has been to provide the international community, particularly the developing countries, with updated information and data on economic and technical trends and developments in marine affairs.

This research effort was complemented by reports on particular sectoral or issue areas, e.g., marine minerals, ocean energy, institutional arrangements and marine technology. The training component for ocean management was implemented through special training sessions at the request of individual countries or organizations, e.g., Brazil, where a course was given on Planning and Management of the Coastal Area and the Exclusive Economic Zone, at the university level. Likewise, OALOS has assisted the International Center for Ocean Development of Canada, in the design and implementation of a new training module in Sea Use Planning and Management delivered at the World Maritime University in November, 1987. Other activities include advisory missions, e.g., the

multi-agency mission at the request of the Government of Sri Lanka to advise on the structure and re-organization of the National Aquatic Resources Agency (NARA).

The need to create awareness with regard to ocean management issues was also undertaken, later in 1983, under the *Joint Program of the United Nations Economic Commission for Latin America and the Caribbean* (ECLAC) and the *United Nations Development Program* (UNDP) *on the Resources of the Sea and the Development of Latin America.* One of the major action areas of the program is the preparation of human resources through the implementation of courses or seminars on topics of relevance to ocean policy, with the assistance of major academic institutions in the region.

The second type of activities - training of specialists in the scientific disciplines that support coastal area planning and management - has been the overriding thrust of *UNESCO* and the *United Nations University* (UNU). For these organizations training and research go hand in hand with emphasis on the intensive study of local problems, comparable case studies and field work.

During the last few years, UNESCO has given emphasis to the development of coastal programs with the general objective of acquiring better scientific understanding of the functioning of coastal ecosystems and of the consequences of man's modification of these systems as a basis for sound managerial policies. While a heavy accent has been given to the study of various ecosystems of the coastal areas (such as mangrove swamps, coastal lagoons, estuaries and coral reefs), the interaction between these critical coastal systems has also been studied. UNESCO's program aims at the establishment of regional networks of advanced training and research programs and the setting up of a few projects operating in each major region of the world. A basic strategy for implementing regional activities consists of the integration of research and training as well as the establishment of guidelines for management. Basic tools for the implementation of this strategy include research working groups, workshops, symposia, and the work of teams of specialists. The results and findings of these activities are issued in a number of reports, proceedings, handbooks and guideline documents.

The third type of activities - undertaking training courses on specific coastal problems in selected areas - is conceptually based on problem-oriented training, participation strategies and the development of technical skills. The *CCOP/SOPAC*[c] *inshore coastal resource program* exemplified this type of activity at the international level. This program was initiated in 1979 within the larger framework of the ESCAP/UNDP offshore mineral prospecting project. The inclusion of additional inshore "coastal" activities and marine studies responded to increased requests from member countries for inshore environmental baseline data. A second objective was to encourage the development of a small group of trained nationals capable of carrying out investigations, conducting baseline measurements and similar activities in the inshore marine environment with minimal outside assistance.

The fourth type of activities - the preparation of region-wide or country diagnoses of the environmemtal conditions and the economic activities taking place along the coastal areas - has been undertaken by several organizations. Within the United Nations System a large number of publications are prepared jointly by one or two organizations (e.g., several of the UNEP's Regional Seas Reports and Studies). Other reports are prepared as working documentation for specific training activities, e.g., the working paper prepared by U.N./OETB for a seminar on coastal

management in Ecuador.[15] A third component consists of manuals and handbooks.

Finally, training of trainers is a new endeavor that has been undertaken by UNESCO and non-U.N. organizations. The first of these activities was an In-Service Training Course in Coastal Development Planning and Management held at the Thailand Institute of Technological Research, Bangkok, in 1985. As a result of this course, a "Manual of Coastal Development Planning and Management for Thailand" has been issued,[16] for the use of those agencies directly concerned with the development and management of coastal resources, as well as for research institutes, university departments and private consulting firms interested in the subject.

III. Lessons Learned from Two Decades of CAM and OM Experience

Despite the limited number of ongoing programs, the past and present experience is extremely valuable. New perspectives are brought into the field as each country enters into the process of selection and orientation for their programs, and of choosing planning and management approaches, as well as implementation strategies.

Ongoing programs encompass a diversity of geographic settings: island countries (large and small); archipelagic countries, and continental countries. To this should be added their different levels of development, and thus, of alternatives for growth; their different resource endowments, and thus, of choices for maximizing the effective use of limited resources. In sum, each country provides a wealth of experience and valuable lessons for other countries.

The main issues under discussion are:

a) transferability of experience (CAM);
b) program orientation (CAM);
c) differences between CAM and OM;
d) program orientation (OM), and
e) integration of CAM and OM.

i) *Transferability of experiences (CAM)*

The review of national experiences has taught us that the transferability of concepts and practice from developed to developing countries is not an easy process. The direct transplant of ideas and methodologies designed for countries having different environmental conditions, development needs and institutional structures than those of the recipient countries does not appear to be the most effective solution. In response to that, countries as well as assistance organizations tend to adopt the experiences of other countries to the particular circumstances at stake, and if necessary, to create new approaches and tools more suitable to the particular needs of the recipient country.

ii) *Program orientation (CAM)*

From the early experiences of the Philippines to the most recent ones of Costa Rica and Barbados, the national programs offer a wide range of perspectives. Three trends are emerging:

First are those countries that have opted for the development and implementation of a full-fledged (CAM) program, generally at the State level. Examples are the cases of Brazil and Malaysia. Brazil has recently enacted legislation[17] to establish the National Coastal Management Plan which is an integral part of the National Policy for Ocean Resources and of the National Environmental Policy (Art. 1). The

plan will be elaborated by a Coordination Group under the direction of the Secretariat of the "Comissao Interministerial para os recursos do Mar" - SECIRM - and will be implemented with the participation of the Federal Administration, the States, the Territories and the Municipalities through the organisms and entities of the National Environmental System - SISNAMA.

In anticipation of the Coastal Management Plan, there have been some initiatives at the State level. The Conselho Estadual do Meio-Ambiente (COSEMA) of the State of Sao Paulo, designated in 1985 in the Iguape/Paranagua region, a 2,000 km^2 area - including a 180 km stretch of coastline - for a special coastal area management and planning program. This region was selected because of increasing resource user conflicts that can best be resolved in a broad planning context. In consideration of the special beauty of the region and the vulnerability of its fragile landforms and ecosystems, high priority is given to designing a comprehensive multisectoral CAM and planning approach to economic development and environmental conservation.[18]

Malaysia has chosen South Johore as the pilot site for a coastal resources management project funded by the United States Government under the aegis of an ASEAN-U.S. Cooperative Program in Marine Science. Comprehensive resource assessments are conducted to obtain the necessary information for the formulation of management strategies for coastal development. The results of the project will be presented to the State Government of Johore and the Economic Planning Unit of the Prime Minister's Department for consideration. If accepted at the federal and state levels, it will be proposed that plan implementation be on a regional basis with relevant agencies bidding for funds under the Sixth Malaysian Plan.[19]

Second are those countries that have opted for the development and implementation of a full-fledged problem-oriented program. This is the case of Sri Lanka whose program is designed to address the critical problems first (erosion, loss and degradation of natural coastal habitats, loss and degradation of archaeological, historic and cultural monuments and sites, and recreational and scenic areas) since those problems have resulted in significant economic and social losses and are most amenable to management within anticipated budgetary and personnel constraints. Subsequent plans will address additional problems.[20]

Third are those countries that have opted to focus on a specific priority problem as the basis upon which a full-fledged program is developed. This is the case of Barbados, which through the Coastal Conservation Project Unit established in 1984, is initiating a coastal management program that has arisen from early efforts centered on erosion control.[21]

iii) *Differences between CAM and OM*

The disparities in the evolution of coastal and ocean management efforts might offer some advantages. The incipient development of the conceptual base for OM and the limited number of experiences puts all countries on almost an equal footing. This can have an enormous bearing on prospective management approaches which will reflect interests, problems and needs of all countries. On the other hand, the regional and international dimensions of OM will always carry weight in the outcome of all and each of the individual programs. This will be conducive to a further exchange of ideas and probably the emergence of a commonality of approaches, particularly in the case of countries bordering common water bodies, e.g., semi-enclosed seas.

iv) *The program orientation (OM)*

Integrated management plans for the areas beyond the coastal zone have been developed by a few countries. Their experience provides valuable information as to the possible trends that may emerge in the near future. The Netherlands[22] and the State of Hawaii (U.S.)[23] have formulated integrated ocean management plans, which in fact have a certain resemblance since they are basically programs aimed at harmonization of ocean related policies. Other efforts comprise:

a) the marine planning schemes of New Zealand[24] which extend from the mean high water to the limit of the territorial sea (12 miles). In this case, authority for maritime planning comes under the Harbor Boards. Currently three harbors have been appointed for four areas: Wellington for Wellington Harbor, Marlborough for Marlborough Harbor, and Auckland for the Waitemata and Manukau Harbors. Local variations in resources and uses are reflected in each maritime planning scheme. Planning is incremental and aims at the regulation and influence of ongoing processes of conservation and development of the maritime planning areas;

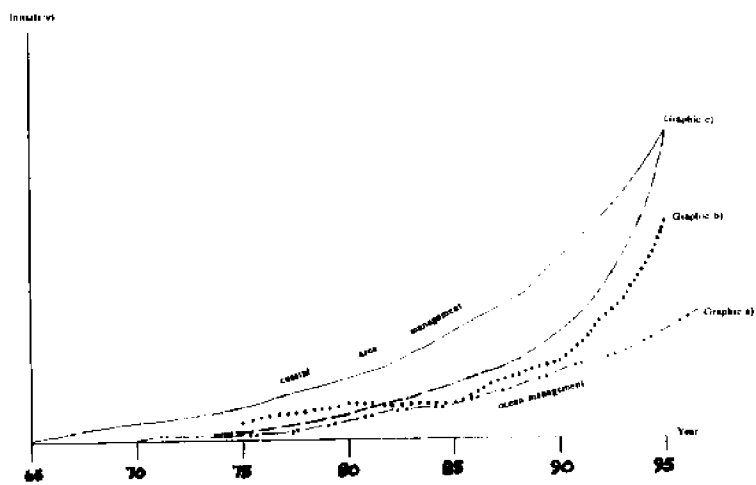
b) management and zoning plans for the establishment of "marine sanctuaries" or "marine parks" in the United States,[25] Ecuador,[26] and Australia.[27] These programs aim at encouraging multiple use consistent with the protection of natural resources and the conservation of natural qualities.

v) *Integration between CAM and OM*

Ocean Management has evolved independently from CAM (*Graphic 1*).

GRAPHIC 1

Hypothetical trends in coastal area management and ocean management



Source: Vallejo (1987).

Despite the scientific as well as managerial drawbacks of this approach, present trends (curve b) indicate that in the next years it appears that the majority of countries will choose a path of increasing activity in coastal and ocean management, but independently from each other. Ideal conditions are represented by curve c, where OM initiatives are integrated with CAM efforts. This is the case of the State of Oregon (U.S.) which is pioneering the integration of coastal and ocean management efforts. Senate Bill 630 sets out ocean policy and establishes a procedure for implementation. It establishes a state-level program to plan for coordinated, comprehensive ocean management both within State waters (3 miles) and beyond. Applicable elements of Oregon's existing coastal zone management program are in integral part of the ocean resources management plan.[28] An interim plan has been completed[29] while the final plan, "Oregon Ocean Resources Management Plan", is scheduled for completion by July 1990.

Whatever path is chosen by countries, coastal or ocean management, both can be an avenue for promoting an integrated development approach. For example, in those countries which have established some form of CAM programs, the extension further offshore would involve an expansion of their programs and the application of new planning strategies, management techniques, and administrative mechanisms for dealing with problems that are distinct to the open ocean areas. In turn, those countries initiating OM programs may promote CAM as one of the key inputs into the ocean development process.

V. New Challenges - New Perspectives

There is no doubt that the decade of the 1990s entails a great challenge to both the countries that have to respond to new responsibilities and opportunities, as well as to the international organizations that should assist them in the process of development and management of their EEZs.

If we look in retrospect at the major inputs that were made during the 1970s and 1980s to EEZ planning and management, for both coastal and ocean components (see *Table 3*), the above summary of activities indicates that up to the early 1980s the majority of effort was devoted to the creation of awareness and the initiation of programs dealing with the scientific aspects of CAM. Countries responded positively and the impact of these efforts is being demonstrated in the decade of the 80s through the initiation of the current CAM programs. Another outcome of this period is the preparation of a considerable number of studies, manuals, guideline documents and case studies. After 1985, there was a new wave of initiatives at both the training and operational levels through the design of new courses - e.g., core course on CAM, training of trainers - and through the formulation of CAM programs in a number of developing countries.

The concept of CAM is undergoing numerous reviews as it applies to the developing world. New efforts in CAM, particularly for small island countries, e.g., Solomon Islands and Cook Islands,[30] may stimulate new approaches to CAM encompassing social and legal aspects that are indigenous to the South Pacific Islands. On the other hand, institution building is probably one of the weakest components in this process, and trends are difficult to establish, because the countries that are actually formulating programs are also in the process of designing their institutional components.

The concept of OM is evolving. Current experiences differ in approach, geographic extent of the management area and objectives. For

example, the experience of New Zealand involved the adoption of the territorial sea as a management unit while Hawaii's plan covers ocean waters around Hawaii's jurisdiction over the three-mile territorial waters, but extends its scope beyond these responsibilities. On the other hand, plans for the establishment of marine sanctuaries or marine parks cannot be considered ocean management plans *per se*, but they may be important concepts and tools of great value for OM, and they can provide incentives for the expansion of the plans into full ocean management programs.

TABLE 3

Major Inputs into Coastal Area and Ocean Planning and Management 1970s - 1980s

	INFORMATION	TRAINING	BASIS FOR MANAGEMENT	INSTITUTIONAL
CAM 1970s	· Scientific information · Sectoral information	· New training programs by international organizations (creation of awareness)	· Development of a conceptual basis	Early formulation of institutional strategies for CAM
CAM 1980s	· Scientific information · Sectoral information · Development of coastal-oriented literature · Region-wide or country diagnosis · Case studies	· Training programs (creation of awareness) · Training of specialities · Training on specific coastal problems · Core course on CAM · Training of trainers	Review of conceptual basis Development of technical guidelines and manuals Formulation and implementation of CAM programs · Newly oriented efforts on CAM (small island countries; archipelagic countries)	· Formulation of institutional strategies for CAM
OM 1970s	· Scientific information · Sectoral information · UN/OALOS Uses of the Sea Report	· Course on marine resources management and conservation (EEZ oriented)	· Early efforts for the development of a conceptual basis	Institutional building (on a sectoral and cross sectoral basis)
	· A few studies on integrated sea-use planning for particular areas · UNEP's Regional Seas studies UN/OALOS Special Studies	· Course on marine resources management and conservation (EEZ oriented) · New course on Sea-Use Planning and Management	· Further development of the conceptual basis · Formulation of two integrated ocean manage ment plans Formulation of one integrated ocean manage-ment plan (coastal and ocean related)	Early formulation of institutional strategies for OM

With regard to the 1990s (see *Table 4*), it appears that the major CAM issues will focus, among others, on:

a) the *consolidation* of CAM as a discipline;
b) the *integration* of CAM within the framework of national development planning;
c) the *expansion* of the data available on the coastal areas; and
d) the *establishment* of integrated systems for the exchange of management and technical information.

It is still questionable how much integration will occur with OM efforts. Nevertheless, an expanded conceptual basis encompassing comprehensive planning of maritime regions (land-sea) might be fully developed, along with coastal-ocean oriented programs.

With regard to OM, the new legal regime established by the 1982 United Nations Convention on the Law of the Sea marks a turning point, since by according the coastal States sovereign rights of exploitation of resources and other powers of exclusive jurisdiction in the Exclusive Economic Zone (EEZ) it has greatly affected the requirements, methods and scope of policy-making and planning in these countries.

As a direct consequence of the above, there is a radical increase in the need for advice and assistance with respect both to the rights that would accrue to countries and to the consequent obligations that would be assumed. To fulfill this task and to take advantage of the benefits and opportunities of the new legal regime, the countries will need a wide array of information on resources, uses, and environment conditions, as well as methodologies and guidelines for planning and management of the EEZs, and their effective incorporation within their national development planning frameworks.

The responses of countries to the challenge of marine resource development began well before the adoption of the Convention, and were accelerated by it. A large number of countries, including many developing countries, have taken measures to strengthen their capabilities in the marine field, giving greater attention to policy-making, management, and resource development in the widest sense.

Thus, there is enough evidence to suggest that the interest of the international community in marine affairs has gained substantial momentum. As a result, there will be no need to develop programs for the creation of awareness as it was the case of CAM at its initial stages. It appears that a more effective approach at this stage would be to impart a problem-oriented technical, and practical skill perspective to the programs of assistance.

TABLE 4

1990's Major Issues

COASTAL AREA MANAGEMENT (CAM)	OCEAN MANAGEMENT (OM)
Consolidation of CAM as a discipline	Strengthening of the conceptual base of OM through the process of formulation of new OM programs
Integration of CAM within the framework of national development planning	Development of Methodologies, guidelines and planning tools for the effective incorporation of the EEZ into national development planning
New institutional structures for CAM	Formulation of institutional strategies

TABLE 4 (cont'd)

Specialized courses of CAM	Training in the conceptual, analytical methods and operational requirements involved in the formulation and implementation of OM programs
Training of trainers	Specialized courses on OM and related disciplines
Further development of CAM literature	Development of OM literature (country diagnosis; comparative studies)
Expansion of data bases (national, international)	Development of a broad information base to support the process of planning and management, and of institution building
Establishment of integrated systems for the exchange of management and technical information	
Integration of CAM and OM (formulation of coastal-ocean oriented programs)	Integration of OM and CAM (formulation of ocean-coastal oriented programs)

The major OM issues would focus, among others, on:

a) the *strengthening* of the conceptual base for OM through the process of formulation of new OM programs;
b) the *development* of methodologies, guidelines and planning tools for the effective incorporation of EEZs into national development planning;
c) the *development* of a broad information base to support the process of planning and management, and of institution building.

The tasks ahead are enormous, challenging and fascinating, both for the countries and the international organizations. Up to now the level and diversity of assistance provided by the United Nations system in the field of marine affairs has been high. A large majority of these activities support national endeavors in EEZ management and resource development. However, the range of economic and technical subject-matter that comprehensive planning must take into account is extremely broad, and the issues and problems that it must address are highly diverse. Thus, as more initiatives in OM arise and the needs of the Member States grow, commensurately higher levels of support and assistance will be required from the organization of the United Nations system.

In response to the above, most aspects of the work carried out by the United Nations Secretariat in the field of marine affairs have been consolidated into the Office for Ocean Affairs and the Law of the Sea (U.N./OALOS). This new office implements a program that combines the ongoing Secretary-General for the Law of the Sea with most of those previously carried out by the former Ocean Economics and Technology

Branch (OETB) of the Department of International Economic and Social Affairs.

The implications of these reform measures are that the work previously carried out by the former OETB in the areas of marine minerals (seabed and nearshore), coastal area and exclusive economic zone policy-making, planning and management, information and data dissemination, and substantive support for technical cooperation will be carried out by the Office for Ocean Affairs and the Law of the Sea. This consolidation will strengthen the capacity of the Secretariat to provide assistance to Member States in the marine field, and, to the same end, to cooperate more actively and effectively with other United Nations organizations in areas of common interest requiring a coordinated or joint effort.

ANNEX I

Explanatory Note to *Table 1*
Central Area Management Initiatives (1966-1988)

1966	Australia:	Port Philip Authority
1972	Sweden:	Guidelines on management of land and water resources
	France:	Conservatoire de l'Espace Littoral
	United States:	Coastal Zone Management Act
1976	Japan:	Approaches to coastal area planning
1977	Philippines:	Coastal Zone Management Committee
	Thailand:	Office of Coastal Land Development
1978	Philippines:	Coastal Zone Management Task Force
	Sri Lanka:	Coast Conservation Division
1979	France:	Decree (National Planning Directive for Protection and Management of the Coastal Areas)
1980	Greece:	National Coastal Management Program
1981	Ecuador:	Seminar on Coastal Area Management
	Sri Lanka:	Coast Conservation Act
	Philippines:	Issuing a Master Plan for Coastal Zone Management
1982	European Parliament:	European Coastal Charter
	Denmark, Netherlands, Fed. Rep. of Germany:	Joint Declaration on the Protection of the Wadden Sea
1983	China:	Working Group to prepare a Draft of Coastal Zone Management Law

1983-86	Sri Lanka:	Formulation of a Coastal Zone Management Plan
1984	Brazil:	Drafting of a Coastal Zone Management Bill
	Barbados:	Establishment of the Coastal Conservation Project Unit
	Colombia:	Formulation of a Coastal Zone Management Program
1985	Solomon Islands:	Coastal Area Management Program (SOPACOAST)
	Ecuador:	Formulation of a Coastal Zone Management Program
1986	Cook Islands:	Coastal Area Management Program (SOPACOAST)
	Brazil:	Formulation of A Coastal Area Management and Planning Program (State of Sao Paulo and Parana)
	Thailand:	Formulation of a Coastal Area Management Program
	Saudi Arabia:	Coastal Area Management Program (Red Sea Coast)
	Costa Rica:	Implementation of a Coastal Zone Management Program
1987	Malaysia:	Formulation of a Coastal Zone Management Plan (South Johore)
	Barbados:	Implementation of a Coastal Zone Management Policy
1988	Brazil:	Enactment of legislation to establish the National Coastal Management Plan
	Thailand:	Formulation of plans at the local level
	Ecuador:	Formulation of plans at the local level

Ocean Management Initiatives (1969-1988)

1966	United States:	Stratton Commission Report
1970		*Pacem in Maribus*
1970	United States:	National Oceanic and Atmospheric Administration (NOAA)
1971	United States:	National Advisory Committee on Oceans and Atmosphere (NACOA)

1972	United States	National Marine Sanctuary Program
1973	United Kingdom:	Fabian Pamphlet
1974	Brazil:	Interministerial Commission for the Resources of the Seas
1975-1976-1979	Netherlands:	Dutch Parliament Notions
1976	United Kingdom:	House of Lords Debate
1976-1979		Development of a conceptual basis
1977	Netherlands:	Interdepartmental Co-ordinating Commission
1979	Sweden:	Swedish Marine Resources Commission (DHS)
	Australia:	Marine and Estuarine Protected Areas
1980	Fed. Rep. of Germany:	Comprehensive Report on North Sea Activities
1981	Philippines:	Cabinet Committee on the Law of the Sea
	Sweden:	DHS carries out studies on use and protection of four marine areas
	India:	Department of Ocean Development
1982	UNITED NATIONS CONVENTION ON THE LAW OF THE SEA	
	Netherlands:	Harmonization Report
1983	Brazil:	National Maritime Commission
1984	Netherlands:	Government policy toward North Sea
1984-87	UNEP:	Blue Plan
1985	United States:	State of Hawaii Ocean Management Plan
	Netherlands:	Action Program Implementation
	New Zealand:	Maritime Planning Schemes
1986	Ecuador:	Management Plan for the Marine Reserve of the Galapagos Archipelago
1988	United States:	State of Oregon Ocean Management Plan

The author regrets that some initiatives in both coastal and ocean management might have been omitted because the information was not available at the time of publication.

NOTES

* Ocean Affairs and Law of the Sea Officer at the Ocean Affairs and the Law of the Sea Office of the United Nations. The views expressed in this paper are those of the author and do not necessarily represent those of the United Nations.

a. Material for this section is extracted from: S.M.A. Vallejo, 1987a.

b. Carried out by the former Ocean Economics and Technology Branch (OETB) of the Department of International Economic and Social Affairs before its merger with the Office of the Special Representative of the Secretary-General for the Law of the Sea in 1987.

c. CCOP/SOPAC: Committee for Co-ordination of Joint Prospecting for Mineral Resources in South Pacific Offshore Areas.

1. 64th Oregon Legislative Assembly - 1987 Regular Session. Senate Bill 630. The Oregon Ocean Resources Management Act of 1987.
2. Young, E. (1985), review of "The North Sea: Sea Use Management and Planning," by H.D. Smith and C.S. Lalwani, *Marine Policy* 9: 346-348.
3. Young, E. and Johnston, B. (1973), "Law of the Sea," *Fabian Research Series* 313, p. 42.
4. United Kingdom (1976), *Hansard Parliamentary Debates*, House of Lords, Vol. 368, cols. 517-564.
5. Wiggerts, E. (1976), *Naar een planologie van (wit) de Noordzee: Blue Heart Megalopolis (Towards a Special Planning from the North Sea: Blue Heart Megalopolis)*. Plan 3.
6. Van Hoorn, H. and De Jong, A. (1977), *Naar een Planning van de Noordzee (Towards North Sea Planning)*, Delft, the Netherlands: Research Center for Physical Planning TNO (in Dutch).
7. Brown, E.D. (1978), "Sea Use Planning in the North Sea: the legal framework". Paper presented at the Twelfth Annual Law of the Sea Institute Conference, the Hague, October 23-26, 1978, pp. 48-49; Brown, E.D., "Sea Use Planning in the North Sea: the legal framework", in *Law of the Sea: Neglected Issues*, ed. John K. Gamble Jr. (Honolulu: The Law of the Sea Institute, University of Hawaii 1978), pp. 437-480.
8. North Sea Working Group (Conference on North Sea Issues, 1979).
9. Sorensen, J., McCreary S. and Hershman, M. (1984), *Institutional Arrangements for Management of Coastal Resources*. (Renewable Resources Information Series. Coastal Publications No. 1). "Prepared by Research Planning Institute, Inc., Columbia, South Carolina, for National Park Service, U.S. Department of the Interior, Washington, D.C." pp. 27-29.
10. Hultmark, E. (1983), Effective Coordination of Marine Resource Development within New Areas. In: *Institutional Arrangements for Marine Resource Development*. Report of the expert group meeting on institutional arrangements for marine resource development, United Nations Headquarters, January 10-14, 1983. United Nations, New York. ST/ESA/144.
11. Vallejo, S.M.A. (1987), The institutional framework for ocean management. In: *Sea Use Planning and Management*. International Center for Ocean Development, Sea-Use Planning and Management Course, World Maritime University, Malmo, Sweden, November 4-13, 1987, p. 2.

12. Council of Europe, Development and Physical Planning in the Coastal Regions of the Netherlands (1983). Document prepared by the Netherlands Delegation to the Sixth Session of the European Conference of Ministries Responsible for Regional Planning. Torremolinos, Spain, MAT-6-HF 73, pp. 49-50.
13. Vallejo, S.M.A. (1987a), *International coastal zone management training programmes and resources*. International Coastal Resources Management Project. The University of Rhode Island, Narragansett, Rhode Island, p. 49.
14. United Nations (1976), *Register of Courses and Training Programmes* (New York, 1976, ST/ESA/54).
15. Vallejo, S.M.A. and Capurro, L. (1980), Preliminary information on the resources, uses and problems of the Ecuadorian coastal zone. Working paper No. 1. United Nations, Department of International Economic and Social Affairs, Ocean Economics and Technology Branch. (Original in Spanish) (Internal Report), p. 81.
16. Thailand Institute of Scientific and Technological Research (1986), *Manual of Coastal Development Planning and Management for Thailand*. (Ed. by I. Baker and P. Kaeoniam), p. 179.
17. Lei No. 7.661, May 16, 1988.
18. D'Almeida Pires-Filho, I. and Cycon, D.E. (1987). Planning and Management of Brazil's Coastal Resources. In: Coastal Management, ed. J. Sorensen (Taylor and Francis: London, England). Vol. 15, 1:61-74.
19. Ch'ng Kim Looi (1987), Coastal zone management plan development in Malaysia: issues and possible solutions. In: *Coastal Zone '87*. Proceedings of the Fifth Symposium on Coastal and Ocean Management. (Ed. by O.T. Magoon, *et al*). Vol. 4 (American Society of Civil Engineers, New York), pp. 4601-4615.
20. Sri Lanka (1986), Sri Lanka Coastal Zone Management Plan (Draft).
21. Cambers, G. (1987). Coastal zone management programs in Barbados and Grenada. In: *Coastal Zone '87*. Proceedings of the Fifth Symposium on Coastal and Ocean Management. (Ed. by O.T. Magoon, *et al*). Vol. 2 (American Society of Civil Engineers, New York), pp. 1384-1394.
22. Peet, G. (1986), Techniques and methods for sea use planning and management in selected areas. (Sea Foundation), p. 175.
23. State of Hawaii, Department of Planning and Economic Development, State of Hawaii Ocean Management Plan, Honolulu, 1985, p. 38.
24. Hall, D.R. (1987), Maritime planning in New Zealand. In: *Coastal Zone '87*. Proceedings of the Fifth Symposium on Coastal and Ocean Management. (Ed. O.T. Magoon, *et al*). Vol. 1 (American Society of Civil Engineers, New York). pp. 30-44.
25. National Oceanic and Atmospheric Administration, Office of Coastal Zone Management (1982), National Marine Sanctuary Program, Program Development Plan. U.S. Department of Commerce (Washington, D.C.).
26. Broadus, James and Gaines, A.G. (1987), "Coastal and Marine Management in the Galapagos Islands," in *Coastal Management*, ed. J. Sorensen (London: Taylor Francis), Vol. 15, 1:75-88.
27. Ivanovici, A.M., Inventory of declared marine and estuarine protected areas in Australia. Vol. 1 and Vol. 2. Australian National Parks and Wildlife Service (Special Publication 12).
28. 64th Oregon Legislative Assembly - 1987 Regular Session. Senate Bill 630. The Oregon Ocean Resources Management Act of 1987.
29. Telephone conversation between Ms. Stella Maris A. Vallejo and Mr. Jeff Weber, Ocean Resources Program, Land Conservation and Development, State of Oregon, July 29, 1988.

30. Baines, G.B.K. (1987), Coastal area management in the South Pacific Islands. In: *Coastal Zone '87*. Proceedings of the Fifth Symposium on Coastal and Ocean Management (Ed. O.T. Magoon, *et al*). Vol. 2 (American Society of Civil Engineers, New York), pp. 1682-1695.
31. Vallejo, S.M.A. (1987b), Development and Management of Coastal and Marine Regions: An International Perspective. Paper presented at the IGU International Geographic Union, Study Group in Marine Geography, Cardiff, United Kingdom, July 3-6, 1987. University of Wales Institute of Science and Technology, Department of Maritime Studies. Pre-print of Conference papers, pp. 17.1-17.18. [Final version of the paper to be published in *Ocean Yearbook* 7, Fall/Winter 1988].

Coastal and Ocean Planning

Eric Carlson
James Dobbin Associates
Alexandria, Virginia

Planning is an essential component of an integrated coastal and ocean management program. As consultants, we at James Dobbin Associates, specialize in coastal and ocean planning assignments, employing and adapting techniques developed in the field of regional planning to the unique requirements of coastal and marine resource systems.

Oftentimes, traditional approaches to coastal and ocean planning issues have been fragmented. A variety of disciplines have approached myriad resource issues and users on a piecemeal basis. We try, in our work, to integrate disciplines and involve the full range of users in the planning process.

Mapping and the use of geographically-referenced information are essential to our planning approach. Computerized Geographic Information Systems (GIS) now allow us to display and manipulate geographic information electronically permitting more detailed and extensive analysis than previously possible with manual techniques.

Attention in both spatial and policy dimensions in the terrestrial natural resource planning process is generally taken for granted. However, in the coastal and marine planning realm this has not always been the case, since many of the resources are not normally visible. In our projects, we try to bring the spatial dimension to those oftentimes invisible or ephemeral resources, through the creation of marine resource atlases and geographic databases.

In a typical coastal or marine planning project we will compile a geographic database in the form of maps depicting the natural resources, human activities and impacts within a region. Using an overlay process that combines these maps in different ways, we can identify concentrations of resources, uses, and threats, creating a synoptic view of key resource/use conflicts. We can then identify specific sectoral issues and develop action-plan policies and implementation recommendations.

We have used this planning process in a continuing project for the Saudi Arabian government, undertaken in conjunction with the International Union for the Conservation of Nature (IUCN). Employing the inventory and analysis approach, we arrived at recommendations for a coastal zone management program which included a marine protected area system.

In a project aimed at achieving more immediate coastal management objectives we have again collaborated with IUCN and the government of Oman, developing a coastal zone action-plan for a 200 km. portion of coastline in the capital region of Muscat. There, our recommendations regarding the damaging nature of coastal sand-mining, construction infringing on mangroves and coastal process zones, and the need to set aside offshore island bird nesting habitats have resulted in the Omani government taking specific and positive management actions.

Using a Geographic Information System in a current project for the World Bank, we are compiling an electronic data atlas of the Mediterranean Basin as a tool for the Bank's Environment Program for the Mediterranean. The more than 100 map themes in the geographic database

will be combined and used to illustrate the most pressing natural resource and environmental issues in the region and help guide strategic investment decisions.

Geographic Information Systems will become increasingly prevalent in coastal and ocean planning, but they are not prerequisites for good coastal and ocean planning programs. Well thought-out methodologies and creative approaches are still the keys to successful projects.

Integrated Coastal Resources Management Programs for Developing Countries

Stephen Olsen
Coastal Resources Center
University of Rhode Island

Introduction

The need for new approaches for managing the natural resources and human conflicts in coastal areas of developing tropical countries is emerging as a priority among the governments of many developing coastal nations and donor agencies. The urgency of the situation is encapsulated in the fact that an estimated 75 percent of the planet's population already lives in coastal areas and that the majority of a doubled human population that is predicted by the year 2020 will be concentrated along the shorelines of developing tropical countries, primarily in huge sprawling coastal cities. This is a bleak prospect.

Already, the degradation of the resource base, mounting user conflicts, and in some cases political instability are the result of this concentration of people in the complex and often physically unstable zones where terrestrial and marine ecosystems meet. These problems assume even greater complexity when one considers the impacts of a likely rise in global sea level during the next century.

Integrated coastal resource management programs are an attractive option where the traditional sectoral management of human activities and resources is proving to be inadequate, and an approach that stresses a focus on the interplay among sectors and the response of ecosystems to a number of simultaneously acting human impacts is required.

The experience that I am going to share with you is drawn from the international coastal resources management project being implemented by the Coastal Resources Center here at the University of Rhode Island with funding from the U.S. Agency for International Development (AID) Bureau of Science and Technology. This is a five-year effort that commenced in 1985 and whose primary objective is to work with three countries, Ecuador, Sri Lanka, and Thailand, to establish up and running national coastal resources management (CRM) programs that can serve as pilots for other developing nations. This project is about to enter its fourth year and will probably be continued an additional two years with an ending date of May 1992. We have been operating in Ecuador and Sri Lanka for nearly three years and in Thailand for one year.

The underlying hypothesis being tested in this project is that aspects of the U.S. experience from some 38 state CRM Programs is indeed relevant to addressing the problems and creating the institutions required to implement workable programs in developing tropical nations. It is my feeling that this hypothesis is correct if one accepts that the U.S. experience provides as rich a body of failures as well as notable successes. I say this in full recognition that the context within which CRM programs are played out in the U.S. is profoundly different from the context in developing tropical nations. It strikes me that the most important difference is that the U.S. programs were initiated as an expression of the environmental movement of the 1960s and early '70s. The majority of the U.S. state coastal zone management (CZM) programs were at least initiated as expressions of an antidevelopment sentiment

and an attempt to redress and reverse development trends that were believed to be needlessly destructive, counterproductive, or otherwise undesirable. This contrasts sharply with developing countries where the overwhelming priority is to utilize available resources as efficiently and often as rapidly possible. In my view CRM Programs for developing nations must be integrated with development needs.

Are the Issues, their Causes and their Consequences Similar?

Our experience in the three pilot countries, and a more superficial exposure to coastal problems elsewhere in the developing world, has impressed us with both the similarity of the problems and the approaches that are being considered in order to address them. In essence the priority CRM issues are:

1. Degradation of important coastal habitats including estuaries, coral reefs and mangroves.
2. Loss of important nearshore fisheries resources.
3. Degraded water quality which brings major impacts on human health, activities such as mariculture, and in many cases also damages habitats and fisheries.
4. Mounting conflicts among user groups in all three pilot countries; conflicts between traditional fisheries and tourism development is a significant problem.
5. Problems caused by the inappropriate siting of coastal structures; these include interference with natural shoreline processes and loss of access to the water.

All these specific issues are overshadowed by institutional conflicts and problems. The dominance of institutional issues also characterized the initial phases of establishing a state program in CRM in the United States.

A major difference between working in the U.S. and in developing countries is that the rate at which changes are taking place in the condition of the resource base and in the intensity of human activities is being telescoped from a century or more to two or three decades. Let me illustrate this with an overview of some of the major events that have happened in the condition and use of coastal resources in Rhode Island.

In its early colonial history, Rhode Island was known as the "garden of New England" that was blessed not only with extraordinary physical beauty, but with a wealth of natural resources, particularly fisheries. The once extraordinarily rich finfish fisheries of Narragansett Bay collapsed in 1864 (Goode, 1887). This was attributed to the uncontrolled and irresponsible proliferation of trap nets that were placed up and down the length of Narragansett Bay and along the ocean shores that intercepted entire schools of migrating fish of several species. Despite a variety of management initiatives the fisheries never recovered to anything approaching their pre-1864 abundance. The collapse of several shellfisheries in Narragansett Bay, most notably scallops in the 1940s and wild oyster populations sometime before, (Olsen, 1975) are still remembered by some of our old timers. Rhode Island once had a very profitable mariculture industry centered in Narragansett Bay that provided employment for up to 1,500 people. This industry peaked in 1910 but had collapsed and disappeared by 1957 (Olsen and Stevenson, 1975).

The reasons for the demise of the oyster industry are attributed to a combination of declining water quality, destruction of the spawning habitats and user conflicts. Narragansett Bay has also seen the rise and fall of an important tourism industry centered in the upper and mid-bay that features establishments that fed vast amounts of fish and shellfish in the form of shore dinners to people who went from one little resort to another on numerous ferries and in an armada of pleasure craft. Here again, a combination of declining water quality and competing activities that together produced what was perceived as a decline in the quality of the upper bay, contributed to the demise of this industry before World War II. For Rhode Island, much of the energy expended in framing and implementing this state's CRM Program is an attempt to prevent similar mistakes and patterns in the decline and degradation being repeated in the less sparsely developed lower bay and south shore regions.

I reviewed these events because they are so reminiscent of the problems that I suspect may be repeated in the countries in which I am now working, albeit at a much more rapid rate. If anything, however, in developing countries the stakes are higher. If the cycle of profligate misuse, degradation of the resource base and collapse of important industries that provide both food and income continues, the results will be untold human suffering and sometimes political instability that affects us all as we become more closely interdependent on a rapidly shrinking planet.

Do the Principals for CRM That Have Emerged in the U.S. Apply?

I believe that a number of lessons may be drawn from the U.S. experience in CRM over the past 20 years. The first of these is that major difficulties are encountered when the transition is made between planning a strategy and implementing it. Invariably a new cast of characters and therefore a new set of problems emerges when this takes place. It is the practice, therefore, in the URI/AID International CRM Project to complete the loop through planning, implementation, evaluation and readjustment as often and as early as possible. We also believe that since the process of formulating workable integrated management strategies is a difficult and uncertain one, programs should be designed in an incremental manner. In our judgment it is simply not possible to plan out in detail a three to five-year CRM program for a country in the first year of the program's operation. We therefore go through an exhausting, but very productive process of carefully assessing in each country the successes and failures of each year's experience, and using this as the basis for designing the subsequent year's activities. A second lesson that we draw from the U.S. experience is that a program of public involvement, closely tied to a range of public education initiatives, is crucial to the success of any program. Simply stated, CRM programs will not succeed if they have no constituency amongst those who will be or are affected by the program's plans and policies. In some countries public participation in the policy process is not possible, or is considered somewhat radical. Our initial experience, however, at least in Sri Lanka and Ecuador, reaffirms that it is crucially important to involve the major stakeholders, most of whom are in the private sector, in how CRM issues are resolved in the definition of problems and the formulation of management strategies.

An underlying concept embodied in the United States Coastal Zone Management Act of 1972 is that the problems and solutions to coastal problems will differ from one region to another. Thus the individual states had considerable freedom in defining the issues and the ways in

which they chose to address them. The decentralization philosophy has been borne out to be a good one within states, even states as small as Rhode Island, where special area management plans for small geographic areas have emerged as the only effective way to deal with some of the more complex coastal management issues. Our approach in developing countries has similarly focused on attempting to develop strategies for defined regions. It must be noted, however, that such efforts cannot be carried out in isolation. Particularly in countries with planned central economies, it is crucially important that central government approach and encourage such local level initiatives.

In essence, the United States Coastal Zone Management Act offers states a variety of incentives to examine their CRM issues, articulate policies that define what they are going to do about them, and then demonstrate that they have the authorities and mechanisms in place to implement those policies effectively. In my judgment these principals can be applied to developing tropical nations. The major stumbling block, however, lies in the CZMA's requirement that adequate authorities and mechanisms are available and will be brought to bear on implementing the program.

In developing nations implementation is the all-important issue. Most developing nations are awash in unimplemented policies, programs and regulations. Many are carefully thought through and sound documents. Many, however, are simply unimplementable. It is our experience in developing countries that too often preparing and adopting a plan or program is an end in itself. Expectations for effective implementation are often very low. Herein lies the number one challenge to the International CRM Project. Can we assist countries in developing programs that will prove to be effectively implementable? We believe that a strong program of public involvement and a strong focus on selected geographic areas will lead to framing strategy that maximizes the chances for an implementable program.

Conclusions

The theme of this conference is to examine how technological advances are affecting the legal, political and economic aspects of our international experience. It is my belief that U.S. experience in coastal management offers us a body of experience from which we can extract a philosophy and an approach to problem solving rather than a set of technologies. It is also my belief that the application of this experience to the problems in developing countries will be both an exciting and important activity for the next several decades.

I would like to share with you a comment made by Dr. Ariel Lugo in this same room a month ago. Dr. Lugo is the Director of the Institute of Tropical Forestry in Puerto Rico. His topic was on the relationship between tropical forests and global atmospheric changes. He concluded by saying that as he looks ahead he concludes that the two top priorities are for more quantitative research on the ecological processes and gaining experience in the implementation of integrated natural resource management strategies. In my view, and I believe in Dr. Lugo's, the two are equally important and must proceed hand in hand.

I would also like to suggest that in the field of coastal resources management one of the priorities for the future is to document and better understand the economic relationships among priority CRM issues and the economic consequences of various trends in the condition and use of coastal resources. In the United States at least the economic aspects of CRM issues and policies have received very little, and in many cases,

no attention. In the developing world the economic aspects of CRM issues are of the utmost importance. Unfortunately, we at present lack the tools and the experience to address the economic implications of these issues effectively.

Finally, as I attempt to look into the future I believe that it is of the utmost importance that mechanisms be put in place that will allow those struggling to formulate and implement resource management strategies in developing countries to share their experiences with one another. I find it disturbing that most of the exchange that goes on at present is for "experts" from developed countries, primarily Europe and North America, going to "assist" people with frequently as good or better training in developing countries. There is very little communication between the people on the firing line within the countries themselves. This must change. Compared to the sciences, those of us working to develop the mechanisms and the philosophy of management lack the societies, the journals and conferences that serve as an avenue for communication.

REFERENCES

Goode, G. B. 1887. The Fisheries and Fishery Industry of the United States. U.S. Dept. of Interior, Commission of Fish and Fisheries, Washington, D.C.

Olsen, S. B. and D. K. Stevenson. 1975. Commercial Marine Fish and Fisheries of Rhode Island. University of Rhode Island, Mar. Tech. Report 34. Kingston, R.I.

PART VIA

DISCUSSION

Lee Kimball: Before opening the floor I'd like to ask Stella Vallejo to clarify the terms, "coastal area management and ocean management" she used this morning. I think some people in the audience would like to hear exactly your distinction.

Stella Vallejo: There is a difference between coastal and ocean management. First, the environmental conditions. Coastal area management involves the planning of a system of land and water, while ocean management has different planning requirements based on different characteristics of the open ocean.

The characteristics of the activities in the ocean areas are different from the coastal areas. The physical limits of the different activities on the open sea are not established in the same manner as on land. Both coastal and ocean management have the same goals, that is to say, the sustainable use of resources and also the planning of the use of those resources in harmony. One of the major issues in coastal management as well as in ocean management is to prevent or to resolve conflicts between activities, whether the activities are related to the use of the resources or the activities are related to the use of space, because space is also a resource. The differences between, for example, open ocean uses and some uses that are directly linked to the land portion of the coastal areas also impose different planning requirements than in the case of ocean management.

Lee Kimball: Thank you, Stella. Would it be fair to say that the extension of coastal state jurisdiction out to 200 miles in the LOS Convention for resource uses, environmental protection, and science, has provoked a lot of the extension of ocean management out into open ocean areas?

Stella Vallejo: Yes, I think that the Convention on the Law of the Sea marks a turning point in the evolution of ocean affairs, as I mentioned this morning.

Niels Rorholm: I wonder, in Steve Olsen's discussion, if perhaps one reason that his team ended up studying coral reefs in Thailand, is that to a considerable extent the values involved in environmental protection, or resource protection, are those that people can more easily agree on, as contrasted with the economic values. I wonder if, perhaps, one of the reasons that so many plans sit on the shelves around the world is that we have not yet managed to discover what the communal consensus is with respect to the value of the coastal zone, what the community, whether it be Thailand or Tiverton or some other place, really considers the important uses of that coastal area. What are the benefits a country wants to get out of it? Since countries differ so drastically it is hard to imagine they all want the same thing.

Steve Olsen: You've said a number of things. The point that I was trying to make was that, though this is exaggerating slightly, in Thailand, when one discusses the need to protect coral reefs, making some economic

arguments: X percent of the tourists who come to Phuket want to look at good coral; the many hundreds of people who make their livelihoods fishing on coral reefs will lose their jobs; those kinds of arguments are important.

That is, coral in Phuket is a sort of classic let's-preserve-it-because-it's-beautiful-and-it's-nice kind of issue which, by and large, in our work we are staying away from.

The issue is better illustrated by the need for economic analysis in the problems facing the shrimp mariculture industry in Ecuador, where that is now the largest private sector activity in that country, and the number two earner of foreign exchange following oil, and has brought wholesale changes to that country's coastal ecosystems. There we are very concerned about water quality. Water quality is going down in the estuaries, and a lot of shrimp farms are experiencing problems which they ascribe to water quality. We would like to be able to mount economic arguments that would show X, Y, Z changes in water quality are likely to bring the following economic impacts on that industry. It's those kind of arguments that might create the ground swell of support to do something about water quality, which the governmental agencies quite certainly will not be able to do on their own.

Niels Rorholm: I was trying to say that even the economic argument, say with respect to shrimp, or with respect to tourism in Thailand, may be totally irrelevant unless one has previously discovered that in fact it is the intent of decision makers to support the conclusions. But this can only be known if their goals for the resources are known. If, for example, it is the intent of those who govern to use coastal resources to earn the maximum foreign exchange, then a plan that shows how to get the most food and local employment would be useful only by coincidence.

What efforts are made to try to determine what the governmental objectives are in the coastal zone before you prepare the maps of resource assessments? Does this come into the picture at all?

Steve Olsen: I certainly agree. In the approach we have used, the maps have not only been useful in creating a basis of discussion, but they have also fostered increased communication among user groups. People who could not, at the beginning of a planning project, discuss policy on a fairly even keel or were uncomfortable with political questions could sit down, and addressing a map, begin to talk. Let's say in the case of Lancaster Sound, traditional Inuit people could talk about where narwhals were found. That could become a vehicle. Then marine scientists could discuss where some upwelling occurred. The mapping provides a forum which opens up communications so that as we move through the inventory and analytical phase, there was a greater feeling of trust and openness. Political issues could be dealt with a little bit more easily.

Dennis Nixon: Steve, I'm fascinated with the transference issue. There is a fundamental difference between our experience in the U.S. and the countries you mentioned in the developing world. We have the luxury of a wealthy country looking at its coastline saying, "there are parts we can afford to rope off and save." For those parts that are not developed yet we will come up with a management regime that will help us develop the rest intelligently.

People buy that because they can afford to see the merits. In the developing world that is an essentially irresponsible position. In a country where hunger is the number one issue, you do not talk about

preserving amenities; it is not high up on the list. But if you go in with the attitude that as a byproduct of the good techniques of effective coastal management, you can improve a resource base, create jobs, and, essentially, just do good natural resource planning, make the place a better place to live, then you've got a way to sell coastal management. But it is an entirely different philosophical basis. The tools may be the same, but your rationale is entirely different.

Steve Olsen: Yes, I would agree. In many cases what people are doing is degrading the natural resource base upon which they depend for a livelihood. Here we were very largely concerned with trying to make life a bit more comfortable for the middle class.

The problem is somewhat different, but I would submit that the challenge of trying to maintain, protect, and in some cases restore the health of the ecosystems is basically the same. For example, Esmeraldas, in Northern Ecuador, is largely populated by artisanal fishermen. They are doing what fishermen do everywhere, they're overfishing. If you spend time talking to them, they fully understand what is going on, and they have some very interesting ideas about what to do about it. They need some help. They need some assistance in enforcing after they have formulated a strategy. I end up feeling almost ridiculously optimistic about what one can accomplish if one is willing to work at that level. I point to the work of Allen White in the Philippines, who worked on two small islands, and went through a process of getting the people living on those islands to agree as to what the problems were, and what should be done about them: creating conservation zones for the fisheries, the primary source of income on both islands. They acted as a buffer zone, to keep out outsiders. On one of those islands a new mayor came in and changed it all around. Now it has become a major issue and is going back again. Exciting things happen, of a kind that you very rarely see, when the program is totally a national program trying from some distant capital to do something about the overfishing or the degradation of forests, or the whatever it may be.

Now it's not one or the other, it is a question of balance, but the imbalance has been very heavily skewed towards capital city bureaucracy. In our project, we are putting most of our resources at the other end. But it is *not* either/or. I think that is a crucial point.

Daniel Elder: Just a comment on the statement about the problem of hunger. From my experience in many countries of the world, hunger was not the basic driving force. The problem was one of economics as far as the national policy is concerned. Many developing countries are trying to earn foreign currency.

The coastal people do not articulate as well as marine scientists, but they probably understand the management problems better than anybody. The point is that they don't have an opportunity to implement what they know. The pressure is basically coming from industries that are earning foreign exchange, like the tourist industry and the fishing industry. In many coastal situations the artisanal fishermen are not the ones that are doing the overfishing. It's the foreign fleets that are coming under licenses from countries outside to a greater extent. I wonder how much of this is being taken on board by countries like Thailand and Ecuador?

Dale Krause: A question for Mr. Carlson. The work that you did in Oman is obviously very thorough. What is the response of the government of

Oman to this work? Does it look like they will follow it up? Is the government in tune with what you've done?

Eric Carlson: I think Dan Elder can answer this since he has been working with the Omanis recently.

Daniel Elder: That particular project was generated by the Ministry of Commerce and Industry and the Department of Tourism. In the beginning the project was of narrow scope. It was to delineate in the capital area of Muscat areas along the coastline that could be developed into formal tourist facilities, recreational beaches, and so forth. As the project developed it has expanded to a coastal zone management plan for the country. It has the support of the ministries and is now being taken over gradually by the Council for the Conservation of the Environment and Water Resources, which is an inter-ministerial commission. They have decided, this year, to develop a national conservation strategy of which this component on the coastal zone will be a major part. I would say, in this case, Oman is quite an enlightened country when it comes to environmental matters. It is being taken on board. They had the idea, so it is not difficult to sell. There are inter-ministerial rivalries and so forth, as in any country, but for the most part we consider it a success. The country is really behind it.

John Knauss: Alasdair, you mentioned the GESAMP reports, first the one you did a few years ago on the state of the ocean in terms of pollution and now you have a new report coming in another year or two. Can you say anything about whether this group is finding a significant change in the ocean over a seven- or eight-year period? Are we going to have an international report in another few years that will raise a boil of concern about the ocean similar to that caused by report on the growing ozone hole, for example?

Alasdair McIntyre: Well, the two reports are very different. The second one is not just an updating of the first which was concerned with the basic structure of ecosystems, and set the scene for what was to come. It dealt with the state of the marine environment for the health of the oceans. It did make some attempt to state just what that health was. The feedback we got was that it disappointed some people, particularly in the United States, where we were told by scientists that some of their budgets were being cut because of the rather bland tone of that first report.

We did identify at that time the beginnings of problems of eutrophication and some of the other issues which I was talking about today. In fact, the second report is indicating very much more clearly that these really are causes for concern. Six or seven years ago even we had suspicions but we weren't quite sure. There is no doubt now that we will be saying that eutrophication is something we have to worry about, not on a hotspot basis, but on a global basis. Pathogens from sewage really have to be taken care of.

As far as looking ahead is concerned, in the second report we will have a chapter on the atmosphere and the effects of climate. This will refer to matters like sea level rise and the ozone hole, but we recognized in GESAMP that there are a large number of current, related international activities. In fact, these were talked about during the last few days here. These are very highly organized, very sophisticated, long-term programs. We recognize that it would be silly for a small

group in GESAMP to comment on these, so we have people to advise us. The third report of the health of the oceans from GESAMP will pick up these points.

John Knauss: Is there any indication of increased eutrophication based on quantitative information or knowledge that there is increase in the amount of fertilizers used on a world-wide basis? Is the primary reason for eutrophication the continual runoff of this material or is it something else?

Alasdair McIntyre: We have increased reports of algal blooms, eutrophication in general, at specific sites around the world. A big concern is, are we getting these simply because more people are taking notice of them? There is a big increase in mariculture, and therefore people are more aware of these incidents. We are now becoming increasingly convinced there is a major problem as we look at particular areas; for example, the southern bight of the North Sea, which is the coastal area from Belgium, Holland up past Germany, and Denmark. For that particular area we have data extending back into the last century and we know that there has been a very substantial increase in the winter levels of nutrients there. Gradually over the years we can attribute much of that to the large rivers of the Elbe and the Rhine. In the Adriatic also, as I mentioned, we can produce a time series which shows that there is an increase not just on a local scale but on a regional scale. We have that well quantified.

Daniel Elder: Do you have any prospects for trying to determine what sort of cumulative or synergistic effects there are from pollution? Will GESAMP be able to tackle that and give us an answer to that?

Alasdair McIntyre: We certainly are very conscious of it. It is not just the synergistic effects. There could be subtle long-term effects from contaminant inputs to the sea which were very difficult to measure. In the last decade or so, we have been accumulating measurements that have enabled us to take the step from small-scale experiments in the laboratory where you expose individual organisms to quite high levels of contaminants to much more realistic experiments including whole ecosystems or significant parts of ecosystems. It is from this sort of experiment that we obtain evidence that there could be subtle effects in the sea. We are quite sure these really take place in big-scale experiments, but when you go back to the sea, they are extremely difficult to detect. There is so much noise in the system, so much natural variability, that we have been trying (and this is perhaps the most intractable problem that this GESAMP group is tackling), to get some handle on just how serious long-term subtle effects may be. We are probably coming up to the rather negative conclusion that it is extremely difficult to detect these things against the natural variability. When you look at natural events like the El Nino, which are causing massive changes in huge areas of the world, the sorts of effects that you might have from these more subtle accumulations of contaminants might not be serious.

Then there is the question of time scale. If the buildup of contaminants is very slow, then the natural ability of organisms to adapt will become relevant. I may quote an example from the U.K. of this, where in northern sediments the levels of copper are low, and if you increase them by a factor of three or four you do begin to detect defects in the marine worms and some other invertebrate ecosystems. Yet in the south, in

Cornwall, where there are many tin mines, the level of copper in the ecosystem is three or four times that in the north, ... but the animals are flourishing quite happily there, illustrating the ability to adapt which is something you have got to take into consideration.

Miranda Wecker: I was interested in Steve Olsen's suggestion that there might be an opportunity for developing countries to assist other developing countries in coming up with more sound conservation programs and policies. Are you aware of any USAID-funded or other developed country-funded programs to utilize that kind of mechanism?

Steve Olsen: No I'm not, but that is not to say that nothing is happening. At the meetings people talk to each other. More could be done. The people who go to the meetings go as a perk, whereas the people we work with work in the most extraordinary isolation. It is a very lonely battle. The opportunity for them to talk to people working within the same context in other nations is pretty close to zero.

Eric Carlson: A working group dealing with international natural resource information management issues has been formed recently in Washington. The objective of this group is to better disseminate natural resource data and to encourage the development of local and regional data centers around the world. These centers would provide information services, from project management to biological databases, to Geographic Information Systems, and would help to decentralize the flow of natural resource data.

Lee Kimball: Do you do any training with the individuals in the countries you work in regarding the systems you are developing? How much do you leave behind for them to take over and operate?

Eric Carlson: PC-based GIS is relatively new but there are some systems now on-line in the developing world. Some project proposals we are now involved in would include in-country use and training on GIS. Hardware and software are reasonably affordable and within the reach of increasing numbers of projects, organizations, and countries.

Steve Olsen: We do fairly well in technology transfer. The problem is more in needing greater exchange and discussion. We need to document cases where attempts to manage areas in an integrated manner is the topic at hand. Certainly, in a place like Thailand, one is overwhelmed by technology, studies, maps, reports, and data, a great sea of data. Most of it is pretty useless, when one tries to apply it to specific problems. It is that other agenda that needs particular attention: not to in any way say that the other isn't important; it is just that quite a lot has happened. There are workshops, and people can learn it in a short course and so on.

Stella Vallejo: When the USAID projects in these three countries are completed -- and I suppose they will be taken over by your counterparts -- how do you envision that these programs are to continue in the future? In what manner, institutionally, as well as in a practical way? How do you assure that in the next 10 years Ecuador, Thailand, and Sri Lanka are going to continue to have a coastal management program set up?

Steve Olsen: It is a primary concern that the program will be sustainable. There are some basic, simple-minded principles. One is that each country's program needs to be under local leadership. We have steered away from long-term U.S. advisers. The person heading up our program in each country is a native of that country and is going to stay. The people involved in doing the work, the research, the planning, writing the reports and everything else are people from that country as much as possible.

It sounds obvious, but when you are running a program there is an enormous temptation to go to someone like you, who I know will come up with a wonderful map pretty quickly, which will make AID and everybody else happy. Or one can go to people in the local countries and say, look, we want to do this kind of thing, and go through the agonies of working it through. But if you can stick to it (and of course there's then a shading that the way that the map or the report will be written and the conclusions that it may come up with are subtly different), it is a collaborative process that one needs to go through. Those very simple-minded principles need to be applied and stuck to.

The real challenge is to articulate a persuasive vision for the future, and to communicate that to build a ground swell of support for the project. If you do not do that, it will most probably die. That means that you are getting into some pretty dangerous territory, but I think it's inevitable that one do so. Selling the ideas underlying a program is crucial.

Eric Carlson: If there is no local proprietorship, (whether it is here in Narragansett Bay or in Thailand), planning projects do not work.

Lee Kimball: What do you think is going to drive the idea of ocean management forward in the next few years?

Stella Vallejo: First, with the adoption of the Convention on the Law of the Sea, countries have new responsibilities and new opportunities. That will be the major driving force behind some kind of ocean management. However, most probably these incipient ocean management programs will run parallel to traditional sectoral programs related to the development of fisheries, maritime transport, etc., I don't think that we're going to have in the next ten years as many programs as we now have in coastal area management. The progress is going to continue to be very slow.

The coastal management programs that exist now will be also a driving force to go offshore. For example, the other day, while preparing this paper, I discovered that the State of Oregon intends to go ahead with an ocean management plan. Therefore, I called the official responsible for that activity and he informed me that the state agency that has the mandate for coastal area management, is in the process of formulating an ocean management plan for ocean resources and uses that will cover the 200-mile exclusive economic zone. A designated Task Force will prepare an interim plan by July 1, 1988 while a comprehensive plan is to be completed by July 1990. I do not know of anybody else who is doing this type of program in the world. In fact, this is going to be the first program that links coastal and ocean management under a single effort.

In terms of management approaches, my next question addressed the differences between coastal management and ocean management, concerning which I was informed that the Oregon Ocean Resources Management Act establishes an overall program and new elements required by the Act. In

terms of State-Federal issues, the Act asserts Oregon's role as a partner with Federal agencies in ocean management both within State waters and beyond.

It seems to me that in the United States, other coastal states undertaking coastal management programs will extend their responsibilities offshore, as in the case of Oregon. I think we are going to see at least five or six initiatives in the next ten years. Another issue worth discussing is the different perceptions that exist with respect to ocean management. For example, the approaches used by some European countries are different from those of the United States.

CONTRIBUTED PAPER

Some Questions of Implication of UNCLOS for Special Agreements on Prevention of Marine Pollution

Valery I. Andrianov
Victor A. Kiselev
Soyuzmorniiproekt
Moscow, USSR

The 1982 LOS Convention (UNCLOS) was drafted and adopted at the time when there were in existence a number of special international agreements covering different aspects of the problem of prevention, reduction and control of pollution of the marine environment. These are, especially, the 1969 Intervention Convention, the 1972 London Dumping Convention and MARPOL 73/78. The special agreements had considerable influence on the drafting of many relevant provisions of UNCLOS. But the latter, as contained in a general treaty, will have an advantage under the competitive provisions of special agreements.

In general the interrelation of UNCLOS and other agreements is provided for in Art. 311 ("Relation to other conventions and international agreements"). In particular, the Article states, that UNCLOS "shall not alter the rights and obligations of States Parties which arise from other agreements compatible with this Convention. . ."

Part XII of UNCLOS contains a special article regulating the relation of UNCLOS and other conventions in the field of protection and preservation of the marine environment. In accordance with Art. 237(1) UNCLOS provisions "are without prejudice to the specific conventions and agreements... ." But the same article affirms the priority of UNCLOS under special agreements: "2. Specific obligations assumed by States under special conventions, with respect to the protection and preservation of the marine environment, should be carried out in a manner consistent with the general principles and objectives of this Convention."

It is quite clear that UNCLOS has no influence on the technical standards contained in the special agreements (e.g., the rates of discharge of pollutants, requirements of construction and equipment of ships, etc.). A quite different matter is in connection with jurisdictional provisions of special agreements, particularly those relevant to the enforcement regime.

The degree of influence of UNCLOS on different special agreements is of course varied. For example, recognition under UNCLOS of the exclusive rights of coastal States to regulate dumping activities within the EEZ and on the continental shelf is quite consistent with the enforcement regime of the London Dumping Convention (LDC) and such an extension of coastal jurisdiction hardly makes it necessary to amend the LDC.

Originally problems arose in connection with the right of intervention by coastal States to avoid pollution arising from maritime casualties. The wording of Art. 221(1) in some details differs from the provisions of Art. 1 of the Intervention Convention and therefore the main conditions for taking of intervention measures may be regarded as easier. Moreover in Art. 221 there is a reference to a right of intervention pursuant to customary international law. The question is: could there be three different regimes of intervention or might Art. 221 be

interpreted in some other way? For example, at UNCLOS III the USSR delegation affirms that the wording "pursuant to international law, both customary and conventional" means nothing but the right of the States which are not Parties to the 1969 Intervention Convention to exercise intervention under the provisions of this convention.

But the most difficult problems may arise in connection with the MARPOL Convention. Here we would like to dwell only on one question of coastal jurisdiction under MARPOL 73/78 and UNCLOS.

According to Art. Y(2) of MARPOL 73/78, "any violation of the requirement of the present Convention within the jurisdiction of any Party to the Convention shall be prohibited and sanctions shall be established therefore under the law of that Party." In accordance with Art. 9(3) "The term 'jurisdiction' in the present Convention shall be construed in the light of international law in force at the time of application or interpretation of the present Convention."

Under Art. 56(1)(b)(iii) of UNCLOS a coastal State is empowered to exercise jurisdiction with regard to the protection and preservation of the marine environment in the EEZ. Detailed provisions concerning concrete rights of coastal States are laid down in Articles 211(5) and 220(1,3,5,6) of Part XII. As it is known, coastal State jurisdiction under UNCLOS in the EEZ is strongly limited. Art. 211(5) specifies that the law and regulations of a coastal State shall conform to "generally accepted international rules and standards established through the competent international organization or general diplomatic conference." Art. 220 provides for different enforcement measures depending on the gravity of the violation and the position of the ship concerned (request for information, inspection, etc.). Of great importance for the enforcement regime under UNCLOS are the so-called "safeguards" provisions, in particular, a preemptive right of the flag State to institute proceedings (Art. 228).

It may be suggested that in the light of UNCLOS (if the relevant provision may be considered as international law in force) the coastal jurisdiction provided for by MARPOL 73/78 extends to the EEZ. In this connection a question arises about the compatibility of rights and obligations of coastal States under these two conventions.

Under MARPOL a coastal State is not only empowered but is obliged to prohibit and penalize any violation of the Convention within its jurisdiction. UNCLOS leaves to the coastal State discretion in the adoption of relevant regulations (only relating to discharge of pollutants) in the EEZ and, consequently, in the enforcement of the regulations.

It is not quite clear if the Parties to MARPOL 73/78 are really obliged to exercise jurisdiction in the EEZ in respect of any violation of this convention (those may be not only discharge by violation of requirements in respect of construction, equipment, etc.). In principle, UNCLOS does not prohibit any such extension between the Parties of a special agreement under the condition that such an agreement "should not affect the enjoyment by other States Parties of their rights or the performance of their obligations under this Convention" (Art. 311(3)).

But even the obligation to establish regulations relating to discharges of harmful substances in the EEZ and to enforce them might be too arduous. Notwithstanding its wishes a State shall enact special legislation on the subject and, consequently, exercise control over shipping in the EEZ.

Similar or even more complex problems arise in connection with the "no more favorable treatment" clause in MARPOL 73/78. The implication of

UNCLOS on special conventions may have in some cases the most unexpected result. Therefore all these questions deserve to be very carefully discussed by the States Parties to MARPOL because only participants can undertake formal and authoritative interpretation. But in any case such interpretation will be in some way one-sided as UNCLOS is not yet in force.

It appears to us that due to differences in the enforcement regimes under MARPOL 73/78 and UNCLOS it would be preferable to consider MARPOL 73/78 only as a source of relevant "international rules and standards" and their extension and enforcement in the EEZ should be completely exercised under MARPOL.

PART VI B

SPECIAL SESSION ON TRENDS IN THE LAW OF MARITIME BOUNDARY LIMITATIONS

PANEL 6B

INTRODUCTION

Lewis Alexander: This special session was planned with the goal of identifying some of the trends evolving in the law of maritime boundary delimitation. Along with my co-Chairman, Robert Pietrowski of Washington, we spent four months seeking four eminent international lawyers and practitioners to discuss a series of pre-arranged questions. By last week it appeared that the session would never materialize, and Mr. Pietrowski accepted other responsibilities. But last Monday two of the invitees appeared -- Professor Philippe Cahier, Graduate Institute of International Studies of Geneva, and Professor Jean-Pierre Queneudec of the University of Paris. We then drafted a third international law expert who came to the conference, Professor Francisco Orrego Vicuna of the Institute of International Studies in Santiago, Chile. I greatly appreciate the work these three eminent law professors have done over the past several days in preparing for this session.

The Sources of Law of Maritime Delimitation

Philippe Cahier
Graduate Institute of International Studies
Geneva, Switzerland

When researching into the sources of law of maritime delimitation, one is confronted with two problems, namely: is there any law in this field of international relations and if there is one, what are its sources?

-I-

To deal with the first problem when speaking of maritime delimitation can seem rather odd. Would it be possible to draw a maritime boundary without applying any law at all? In the *North Sea Continental Shelf* case, the ICJ said that this kind of delimitation required the application of equitable principles. The question therefore is: are these equitable principles different from equity as defined by Article 38, paragraph 2, of the Court's Statute, i.e., are they different from an *ex aequo et bono* judgment?

If one examines the jurisprudence, the answer is surely no. In its decision on the *North Sea Continental Shelf*, the Court said that equitable principles were part of international law and distinct from *ex aequo et bono*. This distinction is found in all the jurisprudence. I will only quote, as an example, the judgment of the Court in the 1982 *Libya-Tunisia* case, which said:

> Equity as a legal concept is a direct emanation of the idea of justice. The Court whose task is by definition to administer justice is bound to apply it. (...) The legal concept of equity is a general principle directly applicable as law. (...) Application of equitable principles is to be distinguished from a decision *ex aequo et bono*. The Court can take such a decision only on condition that the Parties agree (Article 38, paragraph 2 of the Statute) and the Court is then freed from the strict application of legal rules in order to bring about an appropriate settlement. The task of the Court in the present case is quite different: it is bound to apply equitable principles as part of international law, and to balance up the various considerations which it regards as relevant in order to produce an equitable result. (ICJ, *Reports*, 1982, para. 71)

If the equitable principles are part of international law, if we accept them as rules of law, they must have some content, their application must be predictable, and the parties to the litigation must be able to rely on them, otherwise we are outside the system of law, and a judge can decide on his own discretion and from a subjective point of view.

But when looking more thoroughly into the jurisprudence, it is difficult not to get the impression that if there is a distinction between equitable principles and equity, as provided for by Article 38

of the Court's Statute, it is quite a thin one, so thin even that it sometimes becomes invisible.

Some quotations of ICJ judgments can illustrate my point. In the *Libya-Tunisia* case, the Court said for instance, "The equitableness of a principle must be assessed in the light of its usefulness for the purpose of arriving at an equitable result. (...) The principles to be indicated by the Court have to be selected according to their appropriateness for reaching an equitable result." (ICJ, *Reports*, 1982, para. 70).

We found the same idea in the *Gulf of Maine* Case (1984). "(...) Each specific case is, in the final analysis, different from all the others, that it is monotypic and that more often than not, the most appropriate criteria, and the method or combination of methods most likely to yield a result consonant with what the law indicates, can only be determined in relation to each particular case and its specific characteristics." (ICJ, *Reports*, 1984, para. 81).

So the Court appears to have reserved for itself virtually complete discretional power in selecting the criteria and methods. That is particularly true when the Court adds: "(...) that the criteria in question are not themselves rules of law and therefore mandatory in the different situations, but 'equitable' or even 'reasonable' criteria, and that what international law requires is that recourse be had in each case to the criterion, or the balance of different criteria, appearing to be most appropriate to the concrete situation." (ICJ, *Reports*, 1984, para. 158).

Thus one can wonder whether the judges or the arbitrators adopt as a start some boundary line which they believe to be equitable and then select supporting principles which will confirm the equitable line already chosen. In his dissenting opinion, Judge Gros, in the *Libya-Tunisia* case said:

> There is a profound gulf between an equitable solution to a problem of continental shelf delimitation which is founded upon the rules of law applicable to relevant facts accurately and fully taken into account, and an equitable solution which is founded upon subjective and sometimes divided assessments of the facts, regardless of the law of delimitation, through an eclectic approach to a result unrelated to the extant factors and without any verification other than calculations prompted by chance or coincidence. That is a solution not through equity, but through a compromise sought at one and the same time between the claims of the Parties and the opinions held within the Court." (ICJ, *Reports*, 1982, p. 153)

This opinion of Judge Gros is quite severe indeed. However, when looking at the lines drawn by the Court, especially in the *Libya-Tunisia* case, in the *Gulf of Maine* case, or in the arbitration between Guinea and Guinea Bissau (1985), it is hard not to believe that those lines were not the result of a compromise between the claims of the parties. Yet it is important to underline that the parties to a dispute are usually not dissatisfied with the delimitation of their maritime boundaries by the Court or by arbitral tribunals, and I would even add that a rigid application of rules of law is probably not necessarily required for this kind of delimitation.

Now, one can wonder if there is a need to continue this analysis after what I have just said. Yet a closer look at the sources of the law of maritime delimitation seems important for two reasons. First of all,

the Court has said many times that the delimitations were based on law, and this fact cannot be disregarded. Secondly, as there is still some confusion in the jurisprudence about the exact notions of law, equitable principles, factors, or special circumstances, it is worth trying to establish some distinctions.

-II-

Article 83, paragraph 1, of the 1982 Law of the Sea Convention provides that:

> The delimitation of the continental shelf between States with opposite or adjacent coasts shall be effected by agreement on the basis of international law, as referred to in Article 38 of the Statute of the International Court of Justice, in order to achieve an equitable solution.

First of all, one must disregard the idea that this Article is an imperative norm, that is, that the parties to an agreement must reach an equitable result. As States are sovereign, they can, of course, conclude an agreement on maritime delimitation even if what they achieve is seen as an inequitable result. A rule of international law is imperative only inasmuch as it regulates a field that is of particular concern for the international society. Indeed, the international society is not concerned with inequitable delimitations of maritime boundaries as long as they are the result of free consent from the States involved.

Now, as far as the Court is concerned, it does not seem to be very much helped by Article 83, as it is anyway bound by Article 38 of its Statute, which lists the different sources of international law. Of course, if there are already some treaties between the parties to a dispute, the Court will apply them. Otherwise, it will apply customary law. Therefore, we still have to know whether there are any customary rules regarding the delimitation of a maritime boundary. The Geneva Convention of 1958 could help answer this question. You will remember that Article 6 of this Convention provides that "Where the same continental shelf is adjacent to the territories of two adjacent States, the Boundary of the continental shelf shall be determined by agreement between them. In the absence of agreement, and unless another boundary line is justified by special circumstances, the boundary shall be determined by application of the principle of equidistance from the nearest points of the baselines from which the breadth of the territorial sea of each State is measured."

The 1958 Convention seems therefore to set the equidistance-special circumstance principle as a rule. But does this make it a customary rule? It was the thesis supported by Denmark and Holland in the *North Sea Continental Shelf* case of 1969. The Court rejected it. One of the arguments was the possibility for States to make reservations to Article 6 of the Convention. The Court also rejected the idea that Article 6 had become a customary rule, the practice of States not being general enough. In the North Sea case the Court said:

> ...the Geneva Convention was not in its origins or inception declaratory of a mandatory rule of customary international law enjoining the use of the equidistance principle for the delimitation of continental shelf areas between adjacent States,

neither has its subsequent effect been constitutive of such a rule." (ICJ, *Reports*, 1969, para. 81)

You also know that at the Third Conference on the Law of the Sea, a large group of delegations supported the equidistance-special circumstances principle and another the equitable principle, giving way to the compromise of the 1982 Convention.

This hostility of the Court to the equidistance rule appears in all its jurisprudence. Yet it is difficult to understand this since the Court also said, in the 1969 case and in other cases, that:

> It has never been doubted that the equidistance method of delimitation is a very convenient one, the use of which is indicated in a considerable number of case. It constitutes a method capable of being employed in almost all circumstances, however singular the results might sometimes be, and has the virtue that if necessary (...) any cartographer can *de facto* trace such a boundary on the appropriate maps and charts. (ICJ, *Reports*, 1969, para. 22)

Yet it is worth remembering that that very principle was applied twice: once by the French-English Arbitral Tribunal in 1977, and a second time by the Dubai-Sharjah Court of Arbitration in 1981, even though in the latter case neither State was party to the Geneva Convention of 1958; nor was, for that matter, the Federation of United Arab Emirates, of which both were member States. In any case, the equidistance principle is accepted by the Court only as a method, and not as rule of law.

Another rule of customary law which could be invoked is that of the principle of natural prolongation, which was stated by the Court in 1969:

> Submarine areas do not really appertain to the coastal State because - or not only because - they are near it. They are near it of course; but this would not suffice to confer title (...). What confers the ipso jure title which international law attributes to the coastal State in respect of its continental shelf, is the fact that the submarine areas concerned may be deemed to be actually part of the territory over which the coastal State already has dominion, in the sense that, although covered with water, they are a prolongation or continuation of that territory, an extension of it under the sea. From this it would follow that whenever a given submarine area does not constitute a natural - or the most natural - extension of the land territory of a coastal State, even though that area may be closer to it than it is to the territory of any other State, it cannot be regarded as appertaining to that State; (...). (ICJ, *Reports*, 1969, para. 43)

This principle was invoked many times by the parties to a dispute. Libya relied heavily on it. But although the Court referred to this principle, it never applied it. It was even altogether abandoned by the Court in the *Libya-Malta* case in 1985. In this case the Court was supplied by both parties with considerable expert evidence as to the geological history and nature of the area described as the "rift zone":

> The Court is unable to accept the position that in order to decide this case, it must first make a determination upon a disagreement between scientists of distinction as to the more plausibly correct interpretation of apparently incomplete scientific data; for a criterion that depends upon such a judgment or estimate having to be made by a court, or perhaps also by negotiating governments, is clearly inapt to a general legal rule of delimitation. (ICJ, *Reports*, 1985, para. 41)

The reason was that:

> The Court however considers that since the development of the law enables a State to claim that the continental shelf appertaining to it extends up to as far as 200 miles from its coast, whatever the geological characteristics of the corresponding sea-bed and subsoil, there is no reason to ascribe any role to geological or geophysical factors within that distance (...). This is especially clear where verification of the validity of title is concerned, since, at least in so far as those areas are situated at a distance of under 200 miles from the coasts in question, title depends solely on the distance from the coasts of the claimant States of any areas of sea-bed claimed by way of continental shelf. (CIJ, *Reports*, 1985, para. 39)

Yet, when referring to its jurisprudence, the Court adds: "However to rely on this jurisprudence would be to overlook the fact that where such jurisprudence appears to ascribe a role to geophysical or geological factors in delimitation, it finds warrant for doing so in a regime of the title itself which used to allot those factors a place which now belongs to the past, in so far as sea-bed areas less than 200 miles from the coast are concerned." (ICJ, *Reports*, 1985, para. 40).

It seems, therefore, that even though the principle of natural prolongation has been part of customary law, it has now disappeared in so far as sea-bed areas less than 200 miles from the coast are concerned, not so much because of Article 74 and 83 of the 1982 Convention, but as a result of the distance notion of the continental shelf as provided by Article 76 of the Convention. Yet the principle can still find an application beyond the 200 miles from the coast.

Since both principles - that of equidistance and that of natural prolongation - have been disregarded by the jurisprudence of the Court as customary rules, one can wonder if there are any other rules.

In the *Gulf of Maine* case, the Court has tried to define what general law prescribes for maritime delimitation: "No maritime delimitation between States with opposite or adjacent coasts may be effected unilaterally by one of those States. Such delimitation must be sought and effected by means of an agreement."

And if such agreement cannot be achieved:

> In either case, delimitation is to be effected by the application of equitable criteria and by the use of practical methods capable of ensuring, with regard to the geographic configuration of the area and other relevant circumstances, an equitable result. (ICJ, *Reports*, 1984, para. 112)

Therefore, the fundamental rule of customary law is surely that delimitation must achieve an equitable result. But that was after all already provided in Article 83 of the 1982 Convention.

Next, there remains the point of equitable principles. For the Court, in the *Libya-Malta* case, these principles have a normative character. They are, namely:

> ...the principle that there is to be no question of refashioning geography, or compensating for the inequalities of nature; the related principle of non-encroachment by one party on the natural prolongation of the other (...); the principle of respect due to all such relevant circumstances; the principle that although all States are equal before the law and are entitled to equal treatment, equity does not necessarily imply equality (...), nor does it seek to make equal what nature has made unequal; and the principle that there can be no question of distributive justice. (ICJ, *Reports*, 1985, para. 46)

These principles are rather vague and not very useful for the delimitation of maritime boundaries, except for the principle of "non-encroachment by one party on the natural prolongation of the other." The application of this principle was important in the award in the *Guinea-Guinea Bissau* case. But I want to underline that in the *Gulf of Maine* case, the Court dismissed that same principle as a rule of law and states that it was only an equitable criterion.

It must also be noted that these principles differ from what the Court takes into account as relevant circumstances or criteria for the delimitation of a maritime boundary, that is geographical circumstances, general orientation of the coast, islands, practice of the States, historical titles, etc. These criteria, in the view of the Court in the *Gulf of Maine* case, may be used to ensure in concrete that a particular situation is dealt with in accordance with the principles and rules in question.

It is on the appreciation of these circumstances that the Court seems entirely free. However, since we have seen that the equitable principles are rather vague and not particularly useful for delimitation, it is difficult not to feel, as I said at the beginning, that the delimitation of maritime boundaries is not the result of application of precise rules, but rather the result of discretionary power of the judges in order to achieve an equitable result.

As we have seen, in spite of the Court's statements that in the field of maritime delimitation, equitable principles are different from the notion of equity, it appears that no straight and definite rule of customary law can be drawn from the jurisprudence of the Court or arbitral tribunals. Which is well illustrated by the statement made by the Court in the *Gulf of Maine* case:

> ...the Chamber has found that general customary international law is not the proper place in which to seek rules specifically prescribing the application of any particular equitable criteria, or the use of any particular practical methods, for a delimitation of the kind requested in the present case. (ICJ, *Reports*, 1984, para. 114)

The Content of the Law of Maritime Delimitation

Jean-Pierre Queneudec
Universite de Paris I
(Pantheon-Sorbonne)

From the 1969 Judgment of the International Court of Justice (ICJ) in the *North Sea Continental Shelf* case, every adjudication or arbitration provided us with the well-established rule of international law that maritime delimitation must be in accordance with equitable principles. But it has always been added, in the *Tunisia-Libya* and the *Libya-Malta* cases, and in the *Gulf of Maine* case as well as in the arbitrations between France and the United Kingdom and between the two Guineas, that account also has to be taken of the relevant factors or circumstances of each particular case. Almost all of these cases have been settled on the basis of international customary law and, as the Chamber of the ICJ said in the *Gulf of Maine* Judgment, customary international law "can of its nature only provide a few legal principles, which lay down guidelines to be followed with a view to an essential objective."

This essential objective, elucidated by the jurisprudence, is now part of general international law, especially as it has been formulated in the Law of the Sea Convention. Precisely, when one looks at conventional law, even if the United Nations Law of the Sea Convention is not yet in force, it must be underlined that Articles 74 and 83 of the 1982 text determine only the final aim of any delimitation process. Those articles require only one thing, that the delimitation of the exclusive economic zone or of the continental shelf between States with opposite or adjacent coasts shall be effected "in order to achieve an equitable solution."

So, the application of equitable principles and the taking into account of relevant circumstances appear as general guidelines to be followed in view of reaching a solution which must, overall, be equitable for the involved parties.

The content of the law of maritime delimitations consequently seems to me both very simple and also very poor. This content of the law has been summed up in the Judgment delivered by the International Court of Justice in the *Libya-Malta* case on June 3, 1985, when the Court said:

> the delimitation is to be effected in accordance with equitable principles and taking account of all relevant circumstances, so as to arrive at an equitable result.

"Equitable solution", under the LOS Convention, or "equitable result", in the wording of the Court, is the essential and fundamental norm of general international law applicable in this field.

The main character of such a fundamental norm is, of course, its simplicity, a characteristic for which there is no need to demonstrate. It is so simple that one can ask why so many governments are unable to reach delimitation agreements, and why the international judges or arbitrators encounter so much difficulty in order to settle the delimitation problems submitted to them.

The answer to these questions lies, for a large part, in the second character of the fundamental norm itself: the apparent poorness of the rule leads one to say that it is an uninstructive rule of law. And this second character itself derives from the fact that there are apparently no judicial criteria indicating what an equitable principle is, nor what is a relevant circumstance. Neither the equitableness of the principles nor the relevancy of circumstances can be determined, it seems, in advance and on a general level. To a very large measure, they both look subordinated to the result, which is legally required to be equitable. But from this apparent inadequacy of the rule of law derives the feeling very often expressed that maritime delimitations operated by an international court cannot escape what Judges Ruda, Bedjaoui, and Jiminez de Arechaga have called, in their joint separate opinions under the *Libya-Malta* Judgment, "the frustrating tyranny of a certain praetorian subjectivism."

Nevertheless, this does not mean that an international tribunal is allowed, in maritime boundary cases, to do anything it wants, since it has the legal obligation to settle the delimitation problem by application of the rule of law. As a matter of fact, we have to keep in mind that the law of maritime delimitation cannot be reduced to a single fundamental norm of an equitable result.

Progressively the judgments and awards of international courts have brought some precision, if not some certainty, in a body of rules which is still quite rudimentary, but which is evolving, even if slowly. Typical of this slow judicial evolution is the recognition by the International Court of Justice of the normative character of equitable principles.

In its decision on the *Libya-Malta Continental Shelf* case, the Court has clearly assumed that the law of maritime delimitation includes the definition of equitable principles. This decision reminds us that:

> the courts have, from the beginning, elaborated equitable principles as being, at the same time, means to an equitable result in a particular case, yet also having a more general validity and hence expressible in general terms.

In the same judgment, the International Court insists on the point that the application of justice, according to the rule of the law, "should display consistency and a degree of predictability", because it looks beyond the peculiar circumstances of a particular case, "to principles of more general application." Of course, this predictability is only possible when an international court or tribunal is referring to principles of general application and is not limited to looking to the peculiar circumstances of an instant case.

There is something entirely new here in the position taken by the Court in the *Libya-Malta* case, for it proceeds to what my colleague, Professor Weil, has called "a jurisdictional rehabilitation" of equitable principles. Even when the Court does not deny the fact that each case of delimitation is unique, the Judgment of 1985 introduces the equitable principles in the room of normativity. According to the 1985 Judgment:

> While every case of maritime delimitation is different in its circumstances from the next, only a clear body of equitable principles can permit such circumstances to be properly weighted, and the objective of equitable result, as required by general international law, to be attained.

Now, after the position so taken by the Court, it is certainly possible to assess what is the real content of this "clear body of equitable principles." This assessment is made easier today because the Court itself has given some enumeration of those principles in its Judgment of June, 1985, saying that it was just "a glance at some well-known principles."

In doing so, the Court mentioned five principles, which were already quoted by Philippe Cahier and which I recall here very briefly. The first is the principle that there is to be no question of refashioning geography, or compensating for the inequalities of nature. The second principle is that of non-encroachment by one party on the natural prolongation of the other. The third is the principle of respect due to all relevant circumstances. The fourth is the principle that, although all States are equal before the law and are entitled to equal treatment, "equity does not necessarily imply equality", nor does it seek to make equal what nature has made unequal. And the last one is the principle that there can be no question of distributive justice.

There is no doubt that the *Libya-Malta* case is the first step from which the Court may perhaps give greater precision about the normative character of equitable principles applied as part of international law. I say that because I assume, like several international lawyers, that those principles need to be more stabilized.

Let me turn now to the other aspect of the content of the law of maritime boundary delimitation, namely, the obligation of taking into account the relevant circumstances. According to the celebrated 1969 formula of the ICJ, "there is no legal limit to the considerations which States may take account of."

From this *dictum* it has sometimes been said that any circumstance could be taken into consideration by an international court. That is not true, however, for the tribunals have themselves always established some limits. For example, and this is just an example, economic factors like the respective economic situations of the involved parties have always been put aside as irrelevant circumstances. Once more, it is important to emphasize here that in the 1985 *Libya-Malta* case, the Court has clarified the situation of the law on this specific aspect:

> ... although there may be no legal limit to the considerations which States may take account of, this can hardly be true for a court applying equitable procedures. For a court, although there is assuredly no closed list of considerations, it is evident that only those that are pertinent to the institution of the continental shelf as it has developed within the law, and to the application of equitable principles to its delimitation, will qualify for inclusion. Otherwise, the legal concept of continental shelf could itself be fundamentally changed by the introduction of considerations strange to its nature.

The same could be said for the delimitation of exclusive economic zones of fishery zones between adjacent or opposite States.

The Court has also introduced here a certain degree of normativity in the qualification of the relevant circumstances, while the Chamber of the ICJ said the contrary in the *Gulf of Maine* case. In its 1984 Judgment, this Chamber, not speaking of equitable principles but of criteria, took a different position saying that "the criteria in question are not themselves rules of law and therefore mandatory in the different situations, but 'equitable', or even 'reasonable' criteria."

And the Chamber added: "what international law requires is that recourse be had in each case to the criterion, or the balance of different criteria, appearing to be most appropriate to the concrete situation."

So, since the 1985 Judgment in the *Libya-Malta* case, one can say that only the circumstances that are pertinent to the institution of the maritime zone to be delimited may be taken into account as being relevant. The choice made by an international tribunal among the relevant circumstances is not merely a choice made necessarily case by case, on the basis of what the judges think what equity is. In other words - and I disagree on this point with Philippe Cahier - there is no room for an arbitrary or even totally discretionary appreciation of those circumstances by an international tribunal.

The rule of law contains an obligation to take physical geography into account.

In previous cases, the courts, the ICJ as well as arbitral tribunals, were speaking of "geographical circumstances and other circumstances." We find such a tentative consideration to enlarge the concept of relevant circumstances. In the *Gulf of Maine* Judgment, for example, the Chamber said:

> Delimitation is to be effected by the application of equitable criteria and by the use of practical methods capable of ensuring, with regard to the geographic configuration of the area and other relevant circumstances, an equitable result.

It is, first of all, the coastal geography which is predominant and it is predominant, because the coast is the fundamental element of the coastal State's rights.

When you look at the different judgments and awards already delivered, you see always the same kind of circumstances which are declared to be relevant. For example, you find the six following factors or considerations: the general configuration of the coasts, the relationship between the coasts of the two States involved in the case, the distance between the coasts of the parties, the respective lengths of these coasts, the particular characteristics of each coast, and the existence and the location of coastal islands.

Apart from those micro-geographical factors, the courts have also to take account of the broad geographical frame of the case. We have seen that very clearly in the *Guinea-Guinea Bissau* case, when the Tribunal of Arbitration took account of the West African coast including the shoreline of third States, not only of the coasts of the two parties. The same was true again before the ICJ in the *Libya-Malta* case, when the Court put the accent on the enclosed character of the Mediterranean Sea and the necessary overlapping claims of each coastal State in the area.

The task of any court or tribunal, of course, is to weigh and balance up all the geographical factors and circumstances of the case, rather than to rely on one single factor or circumstance. This does not mean however that the judges or arbitrators have no possibility, when balancing up the particular geographical circumstances of the case, of taking account more specifically one of them; because among the peculiar circumstances of an instance, one may be so important a factor that it becomes the most significant issue emerging from the general framework of the case.

But even here, there is a limit put by the law to what an international tribunal can do. This limit results from the necessary application

of the proportionality test, which has been described as follows by the ICJ in the *Libya-Malta* case:

> The need to avoid in the delimitation any excessive disproportion between the extent of the continental shelf areas appertaining to the coastal State and the length of the relevant part of its coast, measured in the general direction of the coastlines.

I come now to my conclusion. Within the context of the law of maritime boundary delimitation, I did not mention two rules that were already quoted by Philippe Cahier, namely the principle of natural prolongation and the principle of equidistance. The reason for this abstention lies in the fact that we have now a new definition of the continental shelf, which is not defined only on the basis of the natural prolongation in a physical sense, but for a large part is submitted to the general principle of the distance of 200 nautical miles.

And concerning the equidistance principle, as it was worded in the 1958 Geneva Convention on the Continental Shelf, the jurisprudence has emphasized the fact that it is not a legal principle in itself, but just a method of delimitation.

The main problem which rests unresolved within the law of maritime delimitation is precisely the absence of any practical method of delimitation as a mandatory one.

COMMENTARY

Francisco Orrego Vicuna
Institute for International Studies
Santiago, Chile

My part of the presentation deals with the application of the law of maritime delimitation that was defined by Professors Cahier and Queneudec, in light of the particular circumstances of the case, with particular reference to the problems of the single maritime boundaries that have been highlighted in recent decisions.

The first remark I would make is that the emphasis, of course, is on the issue of decisions of courts and tribunals, mostly because they have been the most debated and discussed lately; but I should also keep in mind that State practice is still a very important source for this purpose and indeed, State practice has proven to be more straightforward than the decisions of courts. The court decisions are more complex and more elaborate because they are usually the outcome of litigation and they intervene at the stage when States have failed to reach an agreement among themselves. That explains the difference and perhaps it explains why there is so much more interest in the decisions of courts, that have some aura of mystery to them, than to straightforward agreements, which tend to be more simple.

The central point I would like to discuss here, now that we have had explained to us the various sources of the law of maritime delimitation, are the ensuing principles from those sources and the relevant factors we have just heard about.

The basic question to explore is, how are all of these sources, principles, factors and criteria combined in practice to create a specific solution that may be satisfactory for the parties, on the one hand, and for the Court, to some extent, on the other?

The first issue is how will the Court assign weights to the various factors involved which each party will invoke within its own pleadings? How is the balancing in this process taking place? All the theoretical models one can think about have failed in the light of practice. For example, I remember models that have been proposed by Jonathan Charney on the idea of a scheme for balancing interests in the process of delimitation. The model was very rational, but what happened in practice? When the chamber in the *Gulf of Maine* case balanced the various factors, it dismissed all aspects except for one which was the geographical factor we heard about. So the model of taking into account interests failed on the one hand. The ICJ itself has been seeking to develop a kind of theoretical approach to the problem and I would say that gradually one can see steps being taken to more specific answers. We began by very highly abstract rationales, as those were mentioned in the *North Sea Continental Shelf* case, but bit by bit, one can see that those high levels of abstraction have been left behind and the decisions are coming to more concrete steps and solutions in the cases that have intervened.

Now, which is the central frame for these exercises, both in the Courts and in State practice? That central frame, to my understanding, is the influence that has been exercised by the exclusive economic zone on the law of maritime delimitation. The economic zone, once it became

accepted in customary law and then in the Law of the Sea Convention, made two fundamental changes in the approach to the rationale that was applied to delimitation.

First, it changed the basis for the coastal State entitlement over maritime areas and this is what explains the change from natural prolongation, that was typical of the continental shelf criterion, to the application of the distance criterion which is very relevant, of course, to the exclusive economic zone, and has only then to be applied to the continental shelf. But the second step, is also quite interesting. Once the basis of entitlement was changed, one can see that the Courts, and state practice, too, have relied less and less on the degree of geological or other criteria relevant for continental shelf delimitation, and relied more and more on the distance criterion and other factors which are related to the delimitation of the exclusive economic zone. As a result of this process, or this new framework for the exercise, one could predict perhaps today some aspects of the intellectual reasoning of a Court, but not always.

Those that can be predicted, in my view, are first the applicable law, second the basis of entitlement, and thirdly the main factors to be taken into account. But what one cannot predict, and this is perhaps what gives the aura of mystery to the whole exercise, is how the Court will actually combine or balance out all of these elements in the actual decision it will be taking in the case. For example, it was virtually impossible to predict the emphasis that the Chamber of the ICJ would give to geography in the *Gulf of Maine* case. The explanation for this is very simple; every situation is, of course, unique; but in spite of being unique, not all Courts have followed the same reasoning and certainly, not all State practices have followed that particular approach we are now discussing.

So in summing up on this point, I would say that the evolution that one can see, might be called phase one, which is the basis of entitlement. Phase two is relatively clear, that is, what are the factors and relevant circumstances to be taken into account? But what I would describe as phase three, namely the weighing, the balancing of factors in order to reach a specific settlement is still quite unclear. One can see the effort by the Courts to get to a point in which this third phase would even be clear, but this process, I would say, is lagging a bit behind the other two.

Now, it is in the light of this discussion that one can look into some other issues, for example, what are the advantages or disadvantages of arbitration as compared to the intervention by the full ICJ or a Chamber of the ICJ. The Court as such has shown some inclination to rather dramatic shifts in its policies. You may look, for example, from the *North Sea Continental Shelf* case in 1969 to the *Tunisia-Libya* case, where there is already a hint at the change, and finally to the *Libya-Malta* case, where the full change takes place, and then all of that line of reasoning is changed again by the Chamber in the *Gulf of Maine* case. So one could expect that changes might take place again and again in the reasoning of the Court. The Chamber as such, is certainly more flexible, particularly from the point of view of composition, but also in a sense now unstable. We do not yet have the continuity of cases decided by a chamber to be able to judge, but if one looks into the overall framework, my view would be that there is still some instability in the line of reasoning that the chamber might take among various factors because, of course, the composition of chambers will very likely change from case to case.

Arbitration, in this regard, is more flexible both on account of composition, but also, to some extent, because it has been able to take into account more accurately the changing circumstances of a legal nature. For example, in the British-French Channel arbitration, the Court made some very important contributions to the law of maritime delimitation in the idea of qualifying natural prolongation, which the ICJ had announced in an unqualified manner. The role of explaining equidistance as not opposed to equity but as part of a single process for reaching delimitation, and even the first hint that the exclusive economic zone was gaining importance, one can recognize in the British-French Channel case not so much from the decision but from the arguments of the parties.

In the *Guinea-Guinea Bissau* case, one can also find elements of flexibility, taking into account more accurately the circumstances of the case, although it was to some extent very closely related in time to the *Gulf of Maine* case, where there was a strong influence of legal principles.

So if one would rank the role of Courts, I would say there are three possible ideas; first that the full Court would be an excellent forum for the discussions of the questions of law in general, the central principles and elements of law. A Chamber of the Court will contribute in that regard, bringing in some relation to the circumstances of the case, but not perhaps as much as one would wish. Arbitration would mean a step further in terms of taking into account both the law and more of those circumstances of the particular case in terms of weighing and balancing.

There is still the case of conciliation and mediation to be thought of as an alternative. There have been some highly successful cases in the past few years. For example, the Jan Mayen case through conciliation was a very successful one, as was the papal mediation in the Chile-Argentine case over the southern maritime boundary delimitation. Here, in both kinds of approaches, one finds full flexibility, but not necessarily in keeping with the general principles of law. There are also political methods of boundary dispute settlement, but these are more impractical and do not necessarily conform to the reasoning of law up to that stage. Such political methods were suitable in the highly controversial situation, as between Chile and Argentina.

I mentioned at the beginning that State practice was something one should keep a close watch on. State practice, of course, has been very rich and many times ignored in the discussions. It is, of all the sources or precedents one could think of, the most highly adapted to the changing legal and policy environment States will go through in agreeing on what they think it is proper to do. And in that regard, one can see a very important evolution. When one analyzes the text of a continental shelf delimitation, one can see many of the treaties based on equidistance being brought in, and many of the factors that were developed from that practice. But that stage of continental shelf delimitation was followed by a period in which the exclusive economic zone has been the paramount consideration. In this period of the exclusive economic zone, one sees that the single maritime boundary is applicable for both the continental shelf and the superjacent water, or the other way around, depending on the point of departure of the agreement. Some agreements have started from the superjacent waters working their way to the continental shelf. One can see that the practice is continually evolving and that it's even a relatively old one. For example, in 1952, Chile, Peru and Ecuador -- and later Colombia when it joined the system of the

South Pacific -- all agreed on a single maritime boundary for their respective delimitations. So it's quite an old practice.

Today, could a Court ignore this trend even in the absence of specific agreements among litigants? I think this cannot be done. Courts simply cannot ignore what is going on in the practice of States. For example, the vast majority of agreements have relied on a single maritime boundary with the sole exception of Australia and Papua New Guinea for very specific local reasons; even there, the waters and the shelf were subject to delimitation under one agreement in spite of the fact that the lines did not coincide in some parts of the area to be delimited. So I would say it was not difficult to predict some years ago that State practice would lead Courts to the exercise of a single maritime boundary as we have found already in the *Gulf of Maine* case. I think we will find much more of that in the future.

Also relying on State practice, one can address another question, which is that it is very unlikely that States will continue to submit continental shelf delimitations alone to Courts without submitting at the same time the delimitation of the boundaries of the superjacent waters. State practice and the influence on the decisions of Courts could lead one today to predict that the submission of continental shelf boundaries will be every passing day more scarce when they are done alone. They were phased out from State practice and they will be, in my opinion, phased out from Courts. And here is where the conceptual changes that had taken place in the general level of the law development is quite important. First, because there was already the change from natural prolongation to distance, but secondly, because in some of the cases one could recognize some indications of the changes that were already taking place, as for example, in the *Tunisia-Libya* case when Judge Oda addressed a question to the parties about the single boundary line. Both parties replied differently, perhaps not realizing where the question was leading. It was not leading so much to the solution of that case, but to the development of an overall framework of law in order to be applied in the future as has, in fact, happened. In the *Gulf of Maine* case, there were some questions of that sort addressed by the President of the Chamber to both Canada and the United States about the factors influencing the single boundary. Again, the replies were rather different, perhaps because the parties were uncertain as to what was the intention of the question. Anyhow, these are all hints as to how the law, at the more general level, begins to develop out of specific circumstances of each case.

There will, of course, continue to be cases of continental shelf delimitation; but they're becoming less frequent. This leads to one other problem which has been expressed about whether the principles and rules applicable to continental shelf delimitation will be very different from those that are actually being applied to a single maritime boundary. I would say that, indeed, they are very different because of three levels in which change has taken place. The conceptual change I already explained; natural prolongation, referring more to the idea of state territory, or sovereignty, like the territorial sea; and the idea of distance, particularly when one approaches large areas that are more detached from sovereignty and because of that, more flexible. So the conceptual change has a bearing on the change of the applicable law, but there is also a structural change that one needs to be reminded of.

In the 1958 Territorial Sea and Continental Shelf Conventions, the delimitation of both the territorial sea and the continental shelf

basically followed the same model which was that of equidistance. They were identified perhaps because of their attachment to State sovereignty. In the 1982 Convention, the continental shelf left the identification with the territorial sea and passed on to be identified with the exclusive economic zone. There is a change of identification and as a consequence equidistance was abandoned and equity took its place. So the structural change is applicable from the point of view of the change in the applicable law. But the most important, of course, is the one that was explained to us by Professor Queneudec from the point of view that the factors which are relevant for delimitation today are much more varied than the factors that were relevant when the continental shelf was the only area subject to delimitation.

Now, this does not mean that the changes are necessarily adverse. They can add more flexibility and adaptation and above all, they do not mean that the factors related to continental shelf delimitations are necessarily abandoned or cannot be used. For example, in the *Gulf of Maine* case, there was the reasoning that every criterion typically or exclusively associated with the superjacent waters or the shelf would be ruled out. This conveyed the idea that the continental shelf criterion should be ruled out in the future, but that is not true or certainly is not correct. When one relies, like the Chamber did in that case, only on geographical factors, it distorts, in my view, the more complex elements of reality and introduces confusion. For example, today it's quite clear that the exclusive economic zone factors have on occasion predominated over continental shelf factors, depending on the circumstances of the case. But there are also converse cases in which the continental shelf factor has predominated over the exclusive economic zone even today. For example, in the 1984 agreement between Chile and Argentina resulting from the mediation I mentioned, the drawing of the single maritime boundary is based on the limits of the geological continental shelf, and that limit of the geological shelf is also used for the delimitation of superjacent waters, including the exclusive economic zone. This perhaps leads to the suggestion that Courts should not exclude factors beforehand, not even the discussion of the rationale of a given case, because there are many other economic factors and other important aspects to consider.

Finally, let me address two or three other issues in passing. Because of the predominance of a single maritime boundary, one is faced today with a question of whether a line established for the delimitation of a continental shelf can later be used for the delimitation of exclusive economic zone, or if a party to an agreement on the continental shelf can claim a different line at a later point for the superjacent waters. The theoretical situation is quite clear; Judge Gros mentioned it in the *Gulf of Maine* case. The continental shelf and the exclusive economic zone are different in their legal nature and origin and the same approach is very obvious in the Law of the Sea Convention; separate articles saying the same thing. So as a matter of theory, lines could be drawn differently for the shelf and the exclusive economic zone. There would be no theoretical obstacle to it. However, the practice is, of course, different today and will be different in the future because there is no great advantage in separating lines, and on the contrary, complex situations can be created.

But there is also a question of law that I should mention here. If a delimitation is requested or agreed to on the exclusive economic zone, automatically it will involve by definition the delimitation of the sea and subsoil of the exclusive economic zone, which is the same as saying

that it will cover the delimitation of the continental shelf except beyond 200 miles, but the converse exercise is not true. If the delimitation is requested or agreed to in relation to the continental shelf, it does not mean that it will necessarily be extended out automatically to the exclusive economic zone because the shelf has not coincided *per se* with the waters above it. This is where the theoretical difference would come along, although as a matter of practice, any continental shelf delimitation, particularly as has been done in recent years, will have a very strong bearing on the delimitation of the exclusive economic zone. But no Court would ignore a continental shelf boundary, if the line is available, except perhaps for very ancient delimitations which were done at a time when there was not much concern about the superjacent waters.

The next question concerns problems of third-parties' rights to intervene in a case of delimitation. As you well know, there have been two unsuccessful efforts in this respect, proving two interesting points. First, the record proves a need to take into account all circumstances and interests by any Court concerning a continental shelf or exclusive economic zone delimitation. The request for intervention in itself will call the attention of the Court to such interest. So even if the request is rejected, as has often been the case, it will accomplish a purpose; above all, it proves that special geographical circumstances like closed or semi-closed seas are extremely relevant for a delimitation. That, again, will be taken into account by a Court.

Do the third parties have a right to intervene? The problem here is more complex, first because they have to prove a legal interest; that is a general principle of law. Next there is the question that the party would have to accept the ruling of the Court. Here perhaps there is a big difference between institutionalized courts like the International Court of Justice and the International Tribunal for the Law of the Sea, where the right of intervention is to some extent provided for. There is a difference between that and a case of arbitration where normally the Court of Arbitration will not have a right of intervention written into its regulations. So that would make it a bit more difficult. But the point is that if the agreement or the case to be decided is in any way to impinge on the other State's claimed areas, then the right of intervention will necessarily become clearer and clearer as more and more delimitations occur.

If I may conclude with just one thought. In some cases, the Courts have been requested to declare only the principles and rules applicable to the delimitation. In other cases, they have been actually requested to draw the line to effect the delimitation to describe the boundary more specifically. What are the disadvantages or advantages of this? I would say that if what one State or both are looking for what I termed, phase one or phase two, that is, the general rules or sources of law, and the principal criteria to be applied, perhaps the first approach is more advantageous because the Court, in defining only the principles and rules, will judge with some degree of abstraction, and the parties will be able to negotiate the specifics of the case by themselves. But if what the parties, or one party, are looking for is phase three, that is the very specific consideration of the circumstances of the case, then it might be a better idea to request a specific delimitation of the boundary line, since third party adjudication in that category of discussion will take into account the specific problems of the case. This, of course, will depend very much on the confidence of the parties and the ability of the Court to undertake these three phases, but it's a

choice that is, no doubt, available. To this extent, one can really see that phase one and two have been rather successful in a way. Phase three is still a bit more uncertain, evolving, as I mentioned, but not yet quite complete. In terms of predictability, which is always the exercise that lawyers like the most, one can feel fairly confident today about the predictability of phases one and two, the general rules, the criteria or circumstances to be taken into account. But certainly, one cannot predict today with any accuracy what will happen in phase three, or the identification of the specific circumstances to that case, but for that matter, one may ask whether the Court rulings have ever been predictable.

Lewis Alexander: The panelists have agreed to defer from talking to each other so that we have a chance for the participants to get into the proceedings here.

Bjorn Aune: I have to say it was a very good discussion and I was most intrigued about the principles of law.

Two things I'd like to know; one of them is you did not mention much about the very vague description that is found in the Law of the Sea of historic waters which came up in the Libyan situation, *vis-a-vis* Chesapeake and Delaware Bays.

The other point is that in certain maritime areas such as the Bering Sea, which is more of a dispute between the United States and USSR, we refer to very old treaties, using them as the source of delimitation. These old treaties have become quite vague. I would like to know, are you going to refer to an old treaty as a basis for something very old where we weren't as concise and precise as we are now? How would you go about effecting an equitable solution in that case?

Jean-Pierre Queneudec: In the case of historical waters, it is difficult to answer the question because there is no conventional rule defining what historical waters are. We had two reports to the International Law Commission made by the Secretary-General of the U.N., one in 1957, just before the first Law of the Sea Conference and the second one in 1962. But when the question was put to the First Conference of the Law of the Sea, the Conference only adopted a resolution saying, well, that's a very good point. We will ask the General Assembly to put this on the table of the International Law Commission. The question has been on the agenda of the International Law Commission since 1962 or 63, but in 1968 or 69, I don't remember which, the Commission said, we will have to wait to see what would happen about this because the process of developing a new Law of the Sea Conference was going on.

Then the International Law Commission in 1977 adopted one sentence saying, we have to wait to observe the results of this Conference. When you look at what has happened within the Conference on the problem of historical waters, several proposals were made, and a small working group was created in Geneva in 1975 in order to discuss the point. But it appeared that it was an extremely political point because, if I can summarize, you have some historical States and you have some States without history. So the historical States like the United States and France, said, historical bays or historical waters, are those over which, from time to time immemorial, the coastal State has exercised sovereignty. But for the new independent States, my feeling is they are saying, our history has been stolen by the current negotiators. So you have now a new approach to the concept of historical waters from several States, namely that if they had been independent States, for a long time, certain of their coastal waters would now be historical waters. So that's a new legal category, namely historical waters in perspective. I think the problem is there and we have no legal criteria generally accepted by States in order to define historical waters or historical bays. In the *Tunisia-Libya* case, Tunisia claimed the Gulf of Gabes as an historical bay. In the case of the waters around the Cayman Islands, the Court refused to solve the problem of whether they were or were not

historical waters. What we have now is a list of some marine areas which have been historically considered as internal waters, or in some cases territorial waters. I would take just one example, and that is between India and Sri Lanka. Here you have two delimitation agreements between those two States in 1974, one for the delimitation line in the Gulf on the east side of what is called Adam Bridge; in this area the boundary line is a line dividing historical waters, and the historical waters are internal waters. On the other side, the west side of Adam Bridge, you have another line, but this line divides both internal waters, territorial seas, economic zones and continental shelf. One State claims its territorial waters in this part of the Gulf of Manaar as being also historical waters. I have no concrete data on this, but I think that for this certain delimitation line, Sri Lanka based its claim on the discussion and negotiation with India on the historical title which they can claim in this part of the Gulf of Manaar.

Bjorn Aune: Do you think it is a good idea that we try to work on a current agreement of boundary delimitation on old treaties? Or should we decide to do away with the old and go with the new?

Francisco Orrego Vicuna: This is a very simple question; old treaties under international law are as valid as new treaties and even the Law of the Sea Convention has reference to these treaties. So to some extent, if they refer to boundaries, they constitute objective regimes and even the Convention on the Law of Treaties excepts boundary treaties from the operation of changed circumstances, precisely in order to give them stability. There are two aspects that I would think would be relevant for your concern; one is an aspect of international law. So far as international law is defined, it is the whole question of how you exercise a right in terms of the changing law, which would eventually reach some form of understanding; in any event, in many cases in which historical rights have been in play, there have been special regimes assigned in order to build in some equitable result. For example, perhaps the most clear case would be the British Channel Islands in the U.K.-French arbitration where the special regime in relation to the overall delimitation was recognized. In the case of Chile and Argentina, there's a similar mechanism in that both the Argentinian and Chilean territories in the area in dispute are assigned territorial seas of three miles for each party. It is only three miles, but *vis-a-vis* third-parties, it's twelve. And of course, there are the areas of joint cooperation in which special arrangements have been made for fisheries or even the continental shelf which tend to be built into the old system.

Bjorn Aune: Recognition of old treaties as long as they are complementary?

Francisco Orrego Vicuna: Yes, but that would again depend on negotiations or some other procedure.

Richard Bilder: Could one argue that what the international community really wants from the Court in this area is, in a sense, unpredictability; that the kind of cases that States can't settle themselves and want to submit to the Court are cases where they are trying to get rid of the dispute, and they don't know how to do it politically themselves? Perhaps they are really looking for politically acceptable compromises,

compromises which they don't have to bear responsibility for. Of course, the Court has to decide by law, but to that extent the Court makes something look like law when they know what they're really going is some kind of compromise, which is really what they want. In that sense, perhaps as much as we lawyers would like predictability and consistency, maybe the Court would be doing exactly the right thing if it continued a very vague regime. Canada and the United States knew very well that the line was going to be somewhere in the middle; that the factors were not that clearly spelled out, we didn't really reach phase three and everybody was quite happy with that kind of result.

Philippe Cahier: I agree with Professor Bilder. I said that after all the parties were satisfied by the judgment in the *Gulf of Maine* case, by the idea of a compromised line; as lawyers, we would like to have very clear principles, very clear rules, but maybe it is a mistake, and your observations seem to me to be quite correct.

Jean-Pierre Queneudec: Yes, that's logical too, but nevertheless, even if the International Court is requested to draw a line, the States themselves could have been able to draw it if they had reached an agreement. But if it is not possible to reach an agreement, what is asked of the Court is to draw such a line. In some instances there is the impression that the Court may say, this is your claim and this is yours so we shall divide the area in half. But I think even when doing that, an international tribunal must have some basis, some legal basis. When finding these bases perhaps the Court is not in any case obliged to have this kind of compromise.

Francisco Orrego Vicuna: I think that in that situation, to go before a Court is always risky because the Court might be so unpredictable that it would not even provide a compromise, but could eventually lead to a decision that would be particularly unacceptable. If that's the case, in which someone looking for a compromise to put into a third-party's pocket so that he will bring it out, it might be better to try concilation or mediation, where the role of the parties is still decisive and you still have the third one to put forth a solution. Otherwise, I think the unpredictability applies, but of course, it depends on how sensitive the issue is.

Tullio Treves: I would like to make a couple of statements, but not to provoke comments from the panel. I think that the starting point should be the observation made by Philippe Cahier at the beginning, that the borderline between equity and equitable principles, if there is one, is very thin. I think that we can see this as we start to pick up some of the interesting things that we're seeing from an observation that was not made, but probably will find the agreement of everybody. Imagine that two States agree on an inequitable delimitation between their sea areas. The line is inequitable because, for instance, one State gives up most of its adjacent sea for some reason, perhaps it is strapped for cash. I'm sure this delimitation would be valid in international law. Professor Cahier has said that the rule calling for an equitable result is not a rule of imperative law, so this would stand. We are in a field where, in fact, parties can do what they want.

There are no real rules for overcoming the power of the parties in agreeing among themselves. The Court has said, and Jean-Pierre Queneudec has reminded us of it, that there is a difference between the circum-

stances of which the Court can take account and the circumstances of which States can take account. States can take account of any circumstances, including those I mentioned before, for arriving at a inequitable solution. The Court is more limited. It has to take account of circumstances that somehow are near the question of delimitation, they cannot concern general economic or political aspects of the relationship between the two concerned countries.

So, we seem to be in a situation in which the applicability of the rules depends on the fact that you go before a Court, any Court -- arbitration, third-party settlement -- and this distinguishes between this kind of rule and the usual rules. Usually when you go before a Court, you say to the Court, we are not in agreement as to what the law is, or how to apply the law, but we do know that there is a law and there is one of us which has the protection of the law; please tell which is which.

The parties come to the Court and ask to put in motion a special set of rules, more or less precise, in order to create a new law. It is similar to a case in which the obligation of so-called general principles of law applied by the civilized nations, if this expression is still acceptable, is involved. There are people that would say these principles function only when one is before a Court or an arbitration tribunal. So it is for the kind of rules we are talking about here, which indeed, may be somewhere halfway between rules of customary law (which I don't think they are, because they're by definition functional, only restricted circumstances when you're before a tribunal) and a simple application for equity.

Francisco Orrego Vicuna: I agree with the substance of the comment, except there is one thing that I think cannot happen. States, although they can do whatever they like, have a limit. This limit is set by international law, and this is precisely what I think is the importance of the reference to international law in Articles 74 and 83 of the Convention. For example, you mentioned an equitable result and your example would be a valid one, but what would happen if a State threatens another State that unless there is an agreement on a given delimitation, there will be consequences ranging from sanctions of some kind to warfare?

Unknown Person: Violence and fraud are the exception.

Francisco Orrego Vicuna: The problem is that the threat in that particular case would violate the idea that you have to do this through a peaceful settlement of disputes or a general agreement, and in that case the limit is set by international law itself. Although, it may be a very general limit, it would prevent unlawful forms of delimitation.

Jean-Pierre Queneudec: May I add something to what Francisco just said? Of course under law, in this case, you impose some limitation, but this need not be specific to maritime delimitations. I think the comment was about absence of any limitation. One example I have is an example from the grandfather of international law, Grotius. You know, two States can agree where a delimitation line is going, for example, west because the main direction of the coast is there; it's possible.

John Craven: I will try to set the stage for the question I have to ask. One of the things we observe is that this boundary delimitation process

parties to some solution of the problem they are facing. So to the extent, that you might have conciliation and arbitration and other steps, you are facilitating the process, either by direct agreement or, if that fails, arbitration. In other areas in the settlement of disputes you find a real cascade of procedures, leading one to the other, as the first might fail.

From the point of view of different cultural approaches, I agree with you. Third-party settlement has been a very important part of the western tradition, not necessarily shared by others, relying more on the procedure for negotiation, even if that might take a long time. This cannot be described as typical of the developing countries because you have examples of every sort from developing countries that have been very reluctant to submit to third-party settlement. Take the case of Honduras and its neighbors, and there are many others that have relied on the idea of approaching third-party settlement. So I think it is a problem of dividing western from other approaches. In general, one can see that there is a different trend according to the urgency of the settlement.

Dolliver Nelson: In discussing natural prolongation principles, Professor Cahier rightly observed that in the *Tunisia-Libya* case the Court came to the conclusion that there is no geological basis for allowing for the 200 miles of continental shelf. In a disturbing citation from the Court, the Court seemed to suggest that natural prolongation still has a role to play. Of course, I agree with Professor Cahier, that the continental shelf extends beyond 200 miles because Article 76 has relied on geological criteria to determine the limit of the outer continental shelf. My question is whether, in fact, natural prolongation has no role to play within the 200-mile zone in the light of the principle of nonencroachment. What do we mean by nonencroachment in this sense?

Philippe Cahier: I don't remember exactly the quotation of the Court, but you are right. It seems to me that the Court was fed up with all the technical aspects of the case, which were evoked by the parties, and the Court said that after all, a legal question cannot be based on technical considerations like these. Therefore, I think that natural prolongation has disappeared, even if there is this kind of passage. After all, if you take the jurisprudence, it has never applied, even when it was possible to establish the continental shelf.

Jean-Pierre Queneudec: I think that when one speaks about natural prolongation, we have to be precise as to what type of natural prolongation we are speaking about. One is physical natural prolongation, which the new definition of the continental shelf given by Article 76 of the Convention is based on; physical natural prolongation beyond 200 nautical miles. But within the 200-mile zone the concept of natural prolongation, which is part of the legal definition of the shelf, is taken in another sense. If you look at Article 76, the continental shelf of the coastal State extends beyond the historical territorial sea throughout the natural prolongation of its land territory; and then we have two separate rules for the outer limits of the shelf, 200 miles or the outer edge of the continental margin. In itself, we have discussed the legal concept of prolongation of the land territory and, you know, in the beginning we saw the Tribunal of Arbitration saying it is important to note that the maritime zones in question are the prolonga-

tions of the land territories of the two States out to sea. That is not where the physical natural prolongation is, of course. But what is important now is the legal concept of natural prolongation for the definition of the shelf and it is quite safe to take this into account in cases of delimitation.

No one here spoke about security considerations; of course, the EEZ or the continental shelf are not areas of sovereignty, but nevertheless, there is the question of security and what is your natural prolongation. Perhaps in this way, you can have not only security considerations, but some rights for marine scientific research in your economic zone; security and research are sometimes closely related. There are also perhaps economic security questions and it may be through the issue of the security of your natural prolongation at sea that you can have the introduction of non-geographical factors, and a new resolution in the concept of relevant circumstances. These new factors may in time be introduced into the reasoning of the International Court.

Lewis Alexander: How about pollution security?

Jean-Pierre Queneudec: Of course, ecological security, perhaps.

PART VII

IS THE LOS CONVENTION ADDRESSING TODAY'S CHANGING MARINE SCIENTIFIC, TECHNOLOGICAL, ECONOMIC, LEGAL, AND POLITICAL ISSUES?

PANEL VII

INTRODUCTION

Thomas Clingan: Our topic for discussion is posed as a question: Is the LOS Convention addressing today's changing marine scientific, technological, economic, legal, and political issues? This is obviously a very broad topic. It is a very appropriate one, however, for discussion at this annual meeting of the Institute here in Rhode Island. In some ways, it is reminiscent of the earlier days of the Law of the Sea Institute, when the then existing law was examined in the light of changed circumstances, and new policies were discussed and developed.

At that time, there was a growing recognition that the 1958 Conventions on the Law of the Sea were becoming, or had become, outmoded due to changed circumstances. The inability to properly manage fisheries in the light of new technologies and procedures was one key issue. Technology advances also forced a re-examination of the definition of the outer limit of the continental shelf. The expectation of deep seabed mining called for consideration of new norms. These, and other similar issues absorbed much of the attention of the early LSI meetings, and it was at those meetings that many new theories, such as the Patrimonial Sea, the forerunner of the EEZ, were sired.

Now we are faced with a new period of evolution in the wake of the conclusion of the Third United Nations Conference on the Law of the Sea. And it is now time to begin to assess whether the 1982 Convention is reflecting the kind of flexibility that was hoped for, so that it might continue to provide good guidelines for ocean uses as they change and evolve with time. Discussion of these issues is intended to lay the groundwork for tonight's banquet speech. If the answer to the question before the panel is negative, then we may well be looking at the prospect of preparing for another conference in the not too distant future, or, at the very least, calling into play the amendment procedures provided in the present treaty when it goes into force.

To look at these questions from a variety of perspectives, we have an extremely well-qualified group of speakers. The panel will address the topic from military, shipping, environmental, marine science, fishing, and mineral perspectives.

Is the LOS Convention Addressing Today's Changing Marine Scientific, Technological, Economic, Legal, and Political Issues?

The Military Perspective

Geoffrey Greiveldinger*
Office of the Secretary of Defense
Washington, D.C.

Introduction

This panel embraces a wide range of issues and problems all having, to one degree or another, military implications. I intend to address only a few aspects of the Convention which are of importance to the military, and which in my view illustrate the role of the Convention in today's law of the sea and its responsiveness to the changing demands of science, technology, economic activity and politics.

My discussion can be broken into three segments: one dealing with an area in which the Convention pretty well covers the territory, one dealing with an area in which the Convention has articulated a framework to be fleshed out with State practice, and the last dealing with two areas in which much has been done outside the Convention.

First, an assessment of the navigational provisions of the Convention -- this aspect of the Convention not only is of crucial military importance, but also impinges directly on our economic, scientific, and technological endeavors, and on our political relationships. In this arena there is still a need for more work, but in most respects the Convention works, providing a sound basis for maritime freedoms.

Second, marine scientific research -- an area of interface between the developing law reflected in the Convention and the developing technology being exploited by science. Here, the Convention provides a starting point, but leaves *some* room for State practice in determining what constitutes Marine Scientific Research (MSR) and in determining the circumstances under which States will allow such research to be conducted within their jurisdictions. In this arena, the Convention has provided a framework, but the adequacy of the MSR regime in meeting changing scientific needs depends on State practice filling in "gaps" left by the Convention.

Last are two areas not fully dealt with by the Convention. Here there is a need for additional rules, to be developed by emerging customary law or conventional norms developed outside the Convention. I speak primarily of the International Maritime Organization and its work, for example, in the areas of offshore platform removal and maritime security. In these areas, the Convention may be viewed as inadequate for its failure to articulate in detail State rights and responsibilities. However, in one of these areas -- platform removal -- the Convention articulates the basic principle, but leaves to another forum the development of detailed standards. In the other -- maritime security -- the Convention clearly contemplates the existence of international agreements that, as between the parties, vary from traditional principles such as those pertaining to jurisdiction over shipboard crimes.

Navigation and Overflight

The most favorable assessment of the Convention's impact pertains to its navigation and related articles. Here the Convention serves to codify customary rules which either existed prior to the convening of the U.N. Conference or emerged during its negotiations as widely accepted rules of international law. These rules provide, for the first time, the comprehensive reference point for evaluating the legitimacy of maritime claims. More importantly, they serve to confirm and further define particular legal regimes which are vital to maritime freedom and mobility. Several aspects of the Convention illustrate this point.

First, the Convention codified the maximum breadth for territorial sea claims. This is one of the Conference's notable accomplishments, not only because it succeeded where the previous two U.N. Conferences failed, but also because it came at a time when excessive and unjustifiable claims were on the rise. By 1982, thirty nations claimed territorial seas greater than 12 nm; since then, the number has dropped by about 25 percent (to 23).

Second, the Convention defines archipelagic States and delineates archipelagic sealane passage rights and responsibilities. Again, demonstrating the reasonable balance between the interests of archipelagic States and those of maritime States, the Convention's provisions have met with widespread compliance. States such as Indonesia, Fiji, Papua New Guinea, the Solomon Islands, and others have demonstrated through their domestic legislation, and especially through their practice, an intent to abide by the Convention's terms.

A third area is the transit passage regime. Prior customary practice combined with a broad consensus during the negotiations to yield an undeniable right of passage with corresponding duties which ensure the security of littorals bordering straits. Transit passage, which permits aircraft, surface vessels, and submarines unrestricted rights to continuous and expeditious passage, is of crucial importance to military mobility and flexibility. Moreover, since it is an international right which the coastal State can neither grant nor deny, it insulates the coastal State politically from disputes elsewhere in the region or world. U.S. and foreign submarines and aircraft, as well as surface ships, use transit passage without notice throughout the world.

Other illustrations of the Convention's impact lie in the Exclusive Economic Zone and Continental Shelf provisions. Here again, the Convention reflects and supports State practice by providing specific guidelines upon which claims are made. Most nations have, in fact, implemented such claims in a manner consistent with these provisions, thus maintaining critical maritime freedoms in and over such areas.

Despite these accomplishments, some aspects of the Convention have not been fully effective in influencing State practice. For example, the Convention confirms the right of innocent passage and exhaustively lays out the activities which are inconsistent with that right. No mention is made of prior notice or authorization. Nevertheless, coastal States in significant numbers (38 at last count), continue to impose prior notice and/or prior authorization requirements.

But, notwithstanding such shortcomings, the Convention's articles on navigation and other traditional uses of the oceans by and large work! The Convention *is* essentially adequate and responsive to our concerns -- not only from a military perspective, but from *any* perspective -- economic, scientific, political -- which values mobility and freedom on, over, and under the seas. These rules reflect customary practice, and *are* essentially responsive to changing technological,

economic, and political concerns precisely because they *do* balance the competing interests of coastal States and the world community's concern for freedom of mobility.

Marine Scientific Research

One aspect of the Convention more closely linked to scientific and technological development is that of marine scientific research (MSR). Here, the Convention codified a fairly detailed regime, but leaves coastal States some flexibility concerning the conduct of such activities in their EEZs and on their continental shelves.

As you know, the Convention articulates a consent regime tempered by language and a philosophy that promotes, rather than inhibits, research. The Convention declares that States shall normally grant their consent without reasonable delay, and it enumerates the few situations in which a State may exercise discretion in denying consent. On the other hand, requesting States and organizations must provide advance notice and must comply with certain conditions. The Convention also reflects the responsibility of States and competent organizations to cooperate through the conclusion of bilateral and multilateral agreements to create conditions favorable for the conduct of MSR.

What the Convention does *not* do is explicitly define MSR. One is left, therefore, with determining what MSR *is* by considering the kinds of Convention-recognized activities that MSR is *not*: such as hydrographic surveying, and data collection functions peculiar to the military. Even when there is agreement on what MSR comprises, there are differences in how States view the permissible extent of their regulatory perogative. Some countries (such as the U.S.) assert that the Convention's terms limit the maximum permissible extent of a coastal State's authority and of its discretion in denying consent. Others maintain that the Convention articulates a baseline of coastal State controls to which other controls can be added. Still others promulgate regulations basically consistent with the Convention, but administer them in a manner which unduly restricts MSR in their jurisdiction.

One study in contrast is illustrated by a comparison of U.S. and Soviet regulation of MSR in their respective EEZs. In President Reagan's Exclusive Economic Zone Proclamation of March 10, 1983, the U.S. sought to encourage MSR around the world by disclaiming jurisdiction over MSR occurring in its EEZ. On the other hand, while Soviet MSR legislation ostensibly conforms in most respects to the Convention, Soviet practice has been to deny most U.S. applications for research in the EEZ. Thus, Soviet authorities have tended to impede MSR, rather than promote it, as envisioned in the Convention regime. The good news here is that we are discussing the issue with the Soviets. As recently as this April, technical-level discussions with Soviet representatives on MSR practices within our respective jurisdictions yielded some promise for improvement.

Why is the MSR regime important to the military? The simple fact is that we have a deep and abiding interest in ensuring that the overall integrity of the non-deep-seabed provisions of the Convention are preserved. Specifically, we must ensure EEZ claims do not evolve into infringements on high seas freedoms otherwise enjoyed outside territorial seas.

The Convention addresses the essential importance of MSR and states some basic ground rules. Inevitably, however, individual states have the task of applying and interpreting the rules in a manner consistent with traditional maritime freedoms. If the Convention is to successfully address the need for scientific discovery, it will be incumbent on the

leading maritime nations to continue efforts to arrive at mutually satisfactory terms for conducting MSR and to use their influence to persuade other countries to do the same.

Disused Platform Removal and Terrorism at Sea

Thus far I have discussed the navigation provisions of the Convention -- which provide a comprehensive set of rules that recognize our essential maritime freedoms -- and I have discussed the framework which exists in the Convention for the MSR regime. Now, I will touch upon two issues which illustrate how State rights and responsibilities will be defined by international agreements and understandings that go beyond the provisions of the Convention. I refer here to the development of standards and procedures for the removal of disused offshore platforms and the prosecution of violence and terrorism at sea.

Platform Removal

The problem associated with platform removal illustrates how legal norms have been outpaced by developing technology. The 1958 Geneva Convention on the Continental Shelf required total removal -- a palatable requirement given that 1950s technology produced platforms that were relatively few in number, light in weight, and restricted to shallow waters. Today, large numbers of massive rigs located in deeper waters, e.g., the North Sea, have created a more difficult and contentious problem. There are now significant practical and economic obstacles to implementing a comprehensive rule of total removal.

The 1982 Convention mandates the removal of abandoned or disused structures "to ensure safety of navigation, taking into account generally accepted international standards established ... by the competent international organization." For these purposes, the term "competent international organization" has been understood to mean the International Maritime Organization (IMO). Upon conclusion of the 1982 Convention, no agreed-upon criteria or standards existed. They have had to be developed in IMO.

IMO deliberations began in early 1987. Discussions at several IMO sessions, as well as in inter-sessional consultations, led to proposed standards which were ultimately adopted by the IMO's Maritime Safety Committee in April of this year. These standards call for total removal as a general rule for all structures, and in particular for structures standing in less than 75 meters of water and having a jacket weight of less than 4,000 tons. Exceptions exist for platforms to remain in whole or in part under certain circumstances, e.g., when the coastal State determines that removal is not technically feasible, or would involve extreme cost or unacceptable risk to the environment or to personnel. Further, new installations shall be designed and constructed to ensure the feasibility of removal. These guidelines will now be circulated to the IMO membership and ultimately considered by the Assembly.

This development is significant from several perspectives. First, it illustrates how the Convention has promoted international cooperation on issues left unresolved by the UNCLOS process. Second, it demonstrates the importance of fora such as the IMO for providing a means by which goals stated in the Convention are realized and developed over time, given the changing circumstances that are often dictated by new technology and new economic endeavors. And finally, it exemplifies the interface between science, technology, navigational interests, and the law.

From a military perspective, such developments are particularly promising -- measures which eliminate existing hazards to navigation and

which ensure their ultimate removal only enhance our operational freedom and safety at sea.

Terrorism and Violence at Sea

Another recent example of international cooperation, also under the auspices of the IMO, is the Diplomatic Conference on Maritime Security held in Rome in March. This addressed a critical area, left virtually untouched by the terms of the Convention: the combatting of the illicit uses of the sea as a place to carry out terrorist acts against unarmed ships and innocent people.

The LOS Convention, of course, enumerates traditional principles of international law, including the essential exclusivity of flag State jurisdiction on the high seas, limitations on coastal State criminal jurisdiction over vessels in innocent passage, and the historical concept of piracy as acts committed by one ship or aircraft against another on the high seas for purely private ends. Nowhere does the LOS Convention deal explicitly with the range of issues attendant on the kind of barbarous activity demonstrated during the *Achille Lauro* episode. Fortunately, a number of Convention provisions (e.g., Arts. 92(1) and 311(2)) contemplate the conclusion of treaties to fill in such interstices.

The *Achille Lauro* incident highlighted the uncertainty which surrounds assertions of jurisdiction over individuals who commit terrorist acts on the high seas. It ended with Italy asserting a recognized basis for jurisdiction over most of the offenders -- commission of an offense on an Italian-flag vessel. Nevertheless, it illustrated potential shortcomings in having no maritime equivalent to the Hague and Montreal Conventions, which also address criminal jurisdiction over terrorists. The Maritime Security Convention (MSC), drafted and adopted under the auspices of the IMO, fills the gap. Under the MSC, jurisdiction over such offenders may be exercised by the flag State, the State of nationality of the offender, the State in whose territorial seas or archipelagic waters the offense occurred, or the State of nationality of any person seized, threatened, injured, or killed. States shall have a duty to apprehend offenders, then prosecute or extradite to any country having a basis for jurisdiction. This agreement, once in force, will be a vital component of the law of the sea which will complement and promote the maritime freedoms and protections set out in the LOS Convention.

The LOS Convention itself is not, nor was it ever intended, to provide *all* the answers or prescriptions which properly comprise the law of the sea. On the other hand, in my view the Convention has contributed -- both directly and indirectly -- to an international climate of cooperation which is addressing through various fora the relevant problems which are part of an evolving law of the sea.

Summary and Conclusions

Obviously, there are other examples (pollution control, resource management, and boundary disputes, to name just a few) of where the Convention provides only a framework or starting point for the legal standards necessary for addressing changing circumstances -- but they are of less direct interest to the military.

Permit me, then, to sum up. In the navigational arena, the Convention is essentially adequate because it reflects, codifies, and clarifies existing norms which were already well established in customary

international law, and which essentially cover the gamut of navigation-related activities.

In other respects, where the Convention fails to articulate all the necessary criteria and definitions -- for example the MSR regime -- the Convention provides a needed framework upon which State practice can build. In yet other areas, the Convention contemplates an international climate where progress can be made in other fora, such as the IMO.

The basic issue, though, is whether the Convention is adequately addressing the changing circumstances and interests which bear upon the development of the law of the sea. My answer -- from a military perspective -- is, yes. The Convention has played, and will continue to play, a positive role, irrespective of whether and when it enters into force. It is a major milestone in a continuing process. We must, however, be vigilant in ensuring that the progress achieved by and through the Convention continues to keep pace with the changes and advances made in our political, economic, and scientific endeavors.

* The author wishes to thank LCDR David L. Grimord, JAGC, U.S. Navy, for his assistance in the preparation of this paper.

Is the 1982 Convention on the Law of the Sea Addressing Today's Changing Marine Scientific Technological, Economic, Legal and Political Issues?

The Shipping Perspective

Thomas A. Mensah*
International Maritime Organization
London, U.K.

A superficial reading of some of the academic writing before the Third United Nations Conference on the Law of the Sea would lead one to believe that the developing countries considered "freedom of navigation" as one of the out-dated principles which needed to be abrogated - or at least radically changed - in the new and revised international legal regime of the seas.[1]

However, a more serious examination of the matter should make it fairly clear that the objections of the new States against the general doctrine of "freedoms of the seas" did not in fact extend to the principle of freedom of navigation. Indeed, the notion of freedom of navigation was largely irrelevant to the objectives which the new and less powerful nations sought to achieve through a new law of the sea; and there was no reason to suppose that the abolition, or drastic diminution, of freedom of navigation could, of itself, eliminate or reduce the fears and anxieties of the developing countries about the traditional law of the sea. These arose from the desire of the economically weak and technologically less advanced nations to prevent unequal exploitation of the living and non-living resources of the sea, from their concern to prevent developed-country monopoly of the benefits of marine scientific research and from their fears of threats or political blackmail resulting from the deployment of naval forces by the great maritime powers.[2]

To deal with these fears and anxieties, the developing countries (and some other small States) had demanded radical changes to some of the traditionally accepted principles of the law of the sea by advocating, *inter alia*, an increase in the breadth of the territorial sea, the recognition and more liberal definition of archipelagic waters, the extension of the areas within which the coastal State would have jurisdiction in such matters as fishing and fisheries management and greater emphasis on the protection of the marine environment. Some of these claims could have significant implications for the exercise of the freedom of navigation, but none of them was, in substance, incompatible with the essential spirit behind the principle of freedom of navigation; and there is no evidence that any of those claims were made with the desire or intention to impede, or even seriously inconvenience, the bona fide movement of shipping engaged in international transport and trade.[3]

Indeed, "freedom of navigation for the ships of all nations" was one of the major principles which the developing countries recognized as being of immediate relevance to their interests. As the representatives of a leading developing country stated at the beginning of the Conference, "our shipping and trade interests would require assurances of freedom of navigation, to ensure our economic development."[4]

It seems clear, therefore, that neither the claims of developing States nor the demands from other sources for a change in the law of the sea were in any way intended to deny the right of States to freedom of navigation in the seas and oceans. Indeed, it is perhaps safe to say that the general interest of all States in the use of the seas for navigation was widely recognized. This interest had already found "expression in the right of innocent passage" as broadly formulated in the 1958 Geneva Convention on the Territorial Sea and the Contiguous Zone.[5]

But it is one thing to recognize freedom of navigation as a general principle, and accept that it does not in essence prejudice the essential coastal State rights or conflict with basic community interests; it is quite another thing to agree on the precise definition of the freedom or on a delineation of the parameters within which the freedom may be exercised without jeopardizing other fundamental rights or creating new difficulties.

That is what the 1958 Geneva Convention attempted to do with the principle of innocent passage, whose purpose was to "reconcile the conflict between claims of the coastal States on the one hand and those of other States generally on the other."[6] It is, however, a well-known fact that the 1958 Convention attempt was not fully successful. Although this failure was due mainly to matters unrelated to the issue of navigation, some of these unresolved issues were bound to impinge on the freedom of navigation. Moreover, the period after 1958 had witnessed a veritable revolution in shipping and related maritime activities which had seriously undermined some of the basic assumptions which had underlain the principle of freedom of navigation since the middle ages. Apart from the radical changes in the size and capacity of ships, the unprecedented increases in the frequency of shipping movements and the changes in the varieties and quantities of goods transported therein, there was greater awareness of the danger which ship-borne substances posed to the resources of the sea, to the health and security of coastal States and to the marine environment as a whole. Accordingly, many of the ideas related to the right of free navigation, which had previously been conceived in terms of the minimal requirements for ensuring that ships "make progress only in an orderly way,"[7] had acquired new meaning and significance.

Thus, by the time the Third United Nations Conference on the Law of the Sea was convened, questions regarding the freedom of navigation had assumed much greater importance and had joined the ranks of the major "unsettled problems" of the law of the sea. Hence, the new Convention on the Law of the Sea had to address these problems, taking account of the new dimensions which they had acquired as a result of recent developments in science and technology, the changes in the uses of the sea and its resources and, above all, the new attitudes which States and the peoples of the world had developed in relation to the protection of the sea and the global environment in general.

Since freedom of navigation was universally acknowledged as a basic and acceptable norm of international law,[8] and since all States had a clear interest in the maintenance of that norm, the discussions on the principle of freedom of navigation were of necessity confined to the conditions which could or should be attached to the exercise of that right in the various maritime zones to be established or defined in the new Convention. In more concrete and practical terms, the issues to be resolved related to the rights and responsibilities which States of different categories should have in relation to ships at sea. Therefore,

the success or otherwise of the 1982 Convention may be assessed in terms of how far it was able to identify these rights and responsibilities, and how clearly or satisfactorily it has been able to define the limits of the responsibilities, and extent of the obligations, in order to eliminate or at least reduce the possibilities of conflicts.

The principal shipping issues which needed to be addressed in the 1982 Convention on the Law of the Sea may be enumerated and categorized by reference to the rights and obligations of States in the operation or regulation of shipping activities. Shipping activities are undertaken for different reasons. It is, therefore, necessary and useful to deal with their regulation in the context of the two main objectives, namely:

(a) shipping for peaceful uses, which covers in general all shipping engaged in international transportation for trade and commerce, and

(b) shipping used for military and other public non-commercial purposes, i.e., ships not "engaged in international trade."

Since the interests of States in relation to shipping are not the same in all maritime zones, the rights and obligations appropriate to States need not be the same in those zones. Hence, it is necessary to consider these rights and obligations in relation to particular activities in specific maritime zones.

On this basis we may summarize the major shipping issues for international solutions according to the following scheme.

1. The powers and responsibilities of States in operating or permitting merchant ships to operate under their authority (the powers and responsibilities of flag States) in:

(a) the territorial sea
(b) archipelagic waters
(c) straits used for international navigation
(d) the exclusive economic zone
(e) the high seas.

2. The powers and responsibilities of States in operating or permitting non-merchant ships to operate under their authority in the same maritime zones, *viz*:

(a) the territorial sea
(b) archipelagic waters
(c) straits used for international navigation
(d) the exclusive economic zone
(e) the high seas.

3. The rights and obligations of States in regulating or controlling the operation of merchant ships of other States in maritime areas within their jurisdiction, including their ports and off-shore installations, the powers and responsibilities of coastal and/or port States in:

(a) the territorial sea
(b) archipelagic waters
(c) straits used for international navigation

(d) the exclusive economic zone
(e) the high seas.

4. The powers and responsibilities of coastal and port States in regulating or controlling the operation of the non-merchant ships of other States in:

(a) the territorial sea
(b) archipelagic seas
(c) straits used for international navigation
(d) the exclusive economic zone
(e) the high seas.

Regulation of Merchant Shipping

With regard to merchant shipping, there appears to be general agreement that the 1982 Convention on the Law of the Sea provides a comprehensive and reasonably adequate legal regime outlining the nature and extent of the powers and responsibilities of States, other users of the sea and the international community.[9] The clarifications and reformulations of some of the rules regarding innocent passage in the territorial sea, and the provisions on States' rights and obligations in relation to navigation and in the exclusive economic zone, are widely accepted as either codifying existing customary law or introducing the required changes in a way which takes due account of the new technological and political realities. Similarly, the prescriptions concerning the national and international measures and procedures for the development of rules and standards to regulate navigation for safety and pollution prevention are considered to be both right and reasonably clear in their general import. Thus it can, with a measure of justification, be asserted that the Convention has established a generally sound international legal regime by reference to which States and the international maritime community can expect to organize the business of merchant shipping on the basis that vessels engaged in legitimate international transport and trade can expect to enjoy the necessary freedom to traverse the seas, so long as they do not pose unreasonable threats to the clearly identified interests of coastal States, or endanger the safety of other ships, or unduly interfere with other legitimate uses of the sea, or present a hazard to the marine environment or significantly jeopardize or undermine certain basic community interests and values.[10]

The Convention has achieved this overall success by the adoption of a number of innovative mechanisms and, in some cases, a careful but far-reaching elucidation of concepts which had previously been ambiguous. There are many such special features of the Convention; but only a few can be cited for special mention in this context.

The first is the forthright affirmation of the principle that all State powers and responsibilities are to be exercised or discharged by reference to international rules and standards.[11] This subjection of State power to international regulations and standards extends even to "the laws and regulations" adopted by States to regulate innocent passage through their territorial seas and to prevent pollution of the seas in their territorial sea and exclusive economic zone, and also to traffic separation schemes and other routing arrangements in sea areas admitted to be within the jurisdiction of States.[12]

The second major feature of the Convention is the clear assertion of the requirement that the international regulations, rules and

standards and procedures are to be established and revised by States "acting through competent international organizations or general diplomatic Conferences".[13] This ensures, firstly, that such regulations will represent the distillation of the views and expertise of all interested States, and, secondly that the resulting rules, regulations, and standards will take account of all relevant scientific, technological, economic and political considerations. Furthermore, this reliance on competent international institutions and standards shall "be examined from time to time as necessary".[14] Regulations which are not examined and reviewed in the light of changing situations and needs will hardly be adequate or attractive to States; nor can a timely and meaningful review be left to the initiative of individual States, given the divergences of views and interests of States in the contemporary world situation.[15]

A third important special feature of the 1982 Convention is the unequivocal recognition it gives to the concept of coastal/port State jurisdiction in implementing and enforcing national and international regulations against foreign ships. Without doubt, one of the features of the law of the sea which was unanimously criticized prior to the Third United Nations Conference on the Law of the Sea, was the principle of the "exclusive jurisdiction" of the Flag State in respect of ships flying its flag.[16] Developments in shipping and ship registration practices had for a long time made it unrealistic to expect that all flag States could control the behavior of their ships with any degree of effectiveness. Furthermore, there had been a marked increase in the legitimate interest of other States (and the global community as a whole) in the preservation of the environment; and it had become only too evident that ships had the capacity to harm the marine environment in areas which are far removed from their flag States. Consequently, the notion that the flag State should have a complete or virtual monopoly of control over the activities of a ship appeared to be clearly untenable, and even detrimental to the interests of other States and the community in general. Although the role of the port/coastal State had been recognized in some previous international treaties, there was a need for a clear affirmation of a general principle of port/coastal State jurisdiction.[17] Furthermore, it was necessary that the precise scope and limits of that jurisdiction, and the conditions of its exercise, should be set out in a generally agreed form. This, the 1982 Convention attempted to do; and there is some justification for saying it has done so, with a large measure of success.[18]

The fourth major innovative feature of the 1982 Convention is the systematic and full clarification of the limited rights of navigation in specified maritime zones. In particular, the Convention specifies the conditions applicable to ships (including the nature, scope and purposes of coastal State regulation) when navigating in territorial seas, in archipelagic seas, in straits used for international navigation, in the exclusive economic zone and in other areas of the high seas.

Previously, the law of the sea divided ocean space into two main areas, namely, the territorial sea (with its contiguous zone) and the high seas. Ships enjoyed the right to innocent passage through the territorial sea (and coastal States had rights to enforcement extended to their contiguous zones) and on the high seas more or less unlimited freedom of navigation was available to the ships of all States.[19] Developments in shipping practices and changes in the perceived interests of States made this rather simple scheme of things wholly unsuitable and unacceptable to the majority of States. It was, there-

fore, necessary to have a much more realistic scheme which would promote and facilitate the necessary freedoms for shipping while, at the same time, recognizing and safeguarding the legitimate concerns of other interested parties such as the riparian States. The only way this could be done in a meaningful way was to deal with the subject in the context of discrete areas of the sea, since this made it possible to take due account of the specific considerations which were relevant in the respective areas and to exclude matters which might have practical significance, but only in other areas. Thus, for example, the genuine and legitimate concern of coastal States for the environmental health of their exclusive economic zone could be fully accommodated without in any way interfering with the "high seas" freedom of navigation which ships were entitled to enjoy in that zone.[20] Similarly, the concept of "transit passage" made it possible to qualify the rights of ships in straits used for international navigation in a way which avoided the dilemma of, on the one hand, applying the full blown system of innocent passage (which would have been unacceptable to the maritime States) and, on the other hand, treating such straits as part of the high seas (which would, in turn, have been totally rejected by the coastal States concerned).[21]

But, while it is true that the 1982 Convention has successfully addressed most of the major issues of navigation which required solution, there is no doubt that some of the solutions in the Convention's provisions are not sufficiently clear to obviate completely all possible conflicts in their interpretations. It is also arguable that some pertinent and important problems may not have been addressed fully, or at all, in the Convention.

In assessing the clarity or adequacy of the 1982 Convention it is essential to distinguish between, on the one hand, the possibility that some States may act in clear disregard of applicable provisions or that some State action may be based on patently untenable interpretations of the Convention. In an area which affects the political and economic interests of almost all States, it is only to be expected that no international treaty can be so constructed or drafted as to prevent altogether situations in which different parties will disagree on the applicability of the treaty, or on the meaning of provisions even when these provisions are agreed to be applicable in a particular situation. It is, therefore, not necessarily a valid criticism of the Convention to note, as has been done by some commentators, that certain "claims of unilateral rights in excess of the Convention articles" may or will be made or that States may for a number of reasons adopt and enforce rules and regulations concerning navigation at variance with the Convention.[22]

Similarly, it does not appear realistic to expect that the Convention on the Law of the Sea (or any other Convention for that matter) will be able to formulate general principles or detailed prescriptions which are so clear and so completely accepted in substance that they leave no room at all for differences of interpretation or difficulties in application. Because multilateral treaties represent compromises between divergent views of substance and have to be formulated for application in the context of different systems of law and socio-political arrangements, they are bound to contain provisions which may mean different things to different parties. Indeed in some cases success in the negotiating process depends on the conscious use of ambiguous terminology or expressions. In this, the 1982 Convention was not, and could hardly be expected to be, an exception. It is, therefore, not a

major defect of the Convention that some of the solutions in the provisions are not as clear-cut as they could have been.[23]

Nevertheless, there are a number of possible criticisms of the 1982 Convention which deserve more serious consideration in any assessment of the Convention's impact on shipping.

The first criticism is that some of the Convention's provisions concerning the limits of the various maritime zones are not sufficiently clear and could, therefore, lead to uncertainties as to the legitimacy or otherwise of certain assertions of State rights or claims to control over shipping. Since the powers and obligations of States are different (and sometimes conflicting) in different zones, it is essential for all concerned that there be clear and objective criteria for determining where the different zones begin and end.

For example, it is claimed that the criteria for measuring the breadth of the territorial sea (and for determining the extent of archipelagic waters) are not clear enough; and that, consequently, States may manipulate the ambiguity to claim jurisdiction over larger areas than the Convention envisages. This would not only place foreign shipping under unwarranted control, but it would also make it impossible for ship operators to determine where they are subject to national regulations and where the full freedom of navigation applies.[24]

It may well be true that some States will, in genuine or pretended reliance on the Convention, claim more than they are entitled to under the Convention. However, in many cases, it should be possible for the situation to be rectified by consultation between the interested Parties and, ultimately, recourse may be had to the dispute settlement procedures in the Convention. But even where such disputed claims cannot be resisted, it is unlikely that extension of areas of the territorial sea or the increase in the area within archipelagic waters can seriously affect the freedom of navigation of merchant ships which are operating in accordance with the laws and regulations adopted by their flag States and in compliance with the provisions of the 1982 Convention. The limits placed on the powers of coastal and archipelagic States to regulate foreign shipping within their jurisdiction have been so formulated in the Convention to ensure that they cannot, in practice, present unreasonable constraints on legitimate merchant shipping. Such State regulations are intended to adversely affect only ships which do not fulfill the internationally prescribed conditions for innocent passage or archipelagic passage.[25]

Moreover, most of the claims of States to exercise jurisdiction over maritime areas are made for purposes other than the control over legitimate merchant shipping. Thus, it is extremely unlikely that any such claims, however unjustified they may be, will significantly affect the right of law-abiding merchant ships to navigate in such areas.

A second criticism which may be levelled against the 1982 Convention is that some of its major principles are not sufficiently precise and may, therefore, lead too widely divergent interpretations. One such principle is in the provision of the Convention which states that "there must exist a genuine link between the State and the ship."[26] This provision is, in essence, identical to the equivalent provision in the 1958 Geneva Convention on the High Seas. It may, therefore, be objected that since the 1958 provision was not considered to be adequate or helpful, its retention in the 1982 Convention could only perpetuate serious and undesirable uncertainty in a matter of fundamental importance for the effective regulation of international shipping. But such a criticism would ignore two important facts. The first is that the 1982

Convention did not just reproduce the 1958 provision; it also supplemented this provision with much elaborate and comprehensive provisions on the duties of the flag State.[27] Admittedly, these additional provisions do not give, and do not purport to give, a definition of the concept of "genuine link". Nevertheless, they provide a fairly clear indication of what the genuine link between a ship and its flag State should entail. The second factor worth mentioning in connection with the 1982 Convention is that it was consciously conceived as an "umbrella" convention which was to be supplemented by more detailed agreements in specific areas. This is expressly stated in many Articles of the Convention.[28] Moreover, the world set-up in the 1982 Convention made it realistic, indeed necessary, to leave the process of concretization of the general principles to "competent" or "appropriate" international institutions and fora. Accordingly, it is not surprising that the 1982 Convention considered it sufficient, in some important areas, merely to formulate general principles on which it was possible to reach agreement, while leaving the details to be worked out subsequently in specialized institutions. In the event, the concept of "genuine link" has been further elaborated and clarified - to the extent possible by the international community - in the 1986 Convention on Conditions for the Registration of Ships.[29] The fact that the 1986 Convention, after such extensive and careful expert consideration, has had to leave many areas ambiguous, would seem to suggest that the approach adopted in 1982 was not only expedient but also actually unavoidable.

A third objection that may be raised against the 1982 Convention is that although much of its prescriptions are based on, and presuppose the existence of international regulations, rules, standards, procedures, etc., these regulations and rules are not determined and in many cases there are no clear criteria by reference to which they may be identified.[30]

This is, without doubt, a serious criticism of the 1982 Convention, and the eventual effectiveness and general acceptability of the Convention will, in large measure, depend on how well that criticism is dealt with by the Parties to the Convention. The difficulty is compounded by the fact that the Convention, obviously for well-considered reasons, chose to use so many different and sometimes confusing expressions for the international regulations on which most of the provisions are based. Apart from the wide variation in the terms used (laws, regulations, rules, standards, procedures, recommended practices) the Convention adopts different qualifying epithets for the regulations, etc., ("generally accepted", "applicable", "internationally agreed").[31] Moreover the relationships that are expected to exist between national "laws and regulations" and the international rules, etc., vary considerably. Thus States are required or empowered to adopt laws and regulations which "give effect to" or "implement" or "take account of" or "conform to" international regulations, rules, etc.[32]

The only mitigating factor, in what would otherwise have been an impossible situation, is the fact that, as far as navigation is concerned, the 1982 Convention envisages that most, if not all, of the international regulations will be developed in "the competent international organization" or through "general diplomatic conferences."[33] It is hoped therefore, that the competent international organization will provide a forum or mechanism by which the international community will be able to reach agreement on some definite criteria for determining which rules, regulations, etc., fall into the various categories referred to in the Convention.[34]

In this connection, it was at one time thought that another major weakness of the 1982 Convention was the absence of clear identifications of the international organizations which were considered to be "competent" or "appropriate" for the development of international regulations on particular matters covered by sections of the Convention. However, as far as navigational issues are concerned (and certainly as far as merchant shipping is concerned), there is now general agreement that "the competent international organization" referred to in the Convention is the International Maritime Organization.[35] And it is, perhaps, arguable that the few direct and indirect references in the text of the Convention, coupled with elements of consensus which emerged during the negotiations of the Law of the Sea Conference, are adequate to identify the major international organizations which may be deemed to be appropriate or competent in most of the articles of the Convention.[36] At all events, there is little chance that the once-feared jurisdictional controversies will in fact materialize. One reason for this is the fact that the discussions on the follow-up action on the Convention will, for the foreseeable future, continue to take place in the context of the United Nations system. In that system there is now a good machinery for the allocation of responsibilities and coordination of work on ocean affairs.[37]

Finally, it is only too true that the dispute settlement provisions in the 1982 Convention cannot constitute a fully dependable mechanism for dealing with the major issues on which controversy can reasonably be expected.[38] As indicated earlier, not all of the provisions of the Convention which specify, and attempt to delineate the extent of, State powers and obligations can be considered to be sufficiently clear to avoid the possibility of controversy in specific situations. In such a situation the perfect solution would be to have a dispute settlement system and definite procedures, and easily identifiable judicial bodies with jurisdiction to receive and adjudicate on disputes and the power to enforce their decisions. Unfortunately, it was not possible to have such a system in the 1982 Convention. The reasons for this are well-known; and the situation in the 1982 Convention is by no means unique in this regard. As things stand, it is not at all unreasonable to assume that some disputes of real substance and importance which may arise in connection with navigational questions will not be submitted to, or satisfactorily and conclusively settled by, the judicial bodies established under the 1982 Convention. Nevertheless, the fact that these bodies have been established and, more importantly, the existence of so many alternative arrangements under the Convention should serve to underline the general wish of the world community that such disputes should be settled by peaceful means and through bilateral or multilateral consultations rather than by recourse to unilateral action or measures of coercion.[39] Moreover, many of the matters on which disputes are likely to arise are also covered by specific international treaties and agreements which incorporate much more detailed dispute settlement procedures.[40] In some of these cases, considerations (and possibilities) of reciprocity will probably lead States to stay within the spirit of the applicable principles in the Convention.

Thus, the absence of a comprehensive and fully mandatory system for dispute settlement in the 1982 Convention may, in the end, not be as crucial a defect as it might appear.

Regulation of Non-Merchant Shipping

It has not been the purpose of this paper to examine the provisions of the 1982 Convention as far as they relate to navigation by non-commercial vessels.[41] The objectives and factors which apply to this aspect of navigation are, in many cases, essentially different from those which relate to navigation rights of ships engaged in international transportation for trade. While some of the criticisms of the provisions on merchant shipping will undoubtedly apply also to non-merchant shipping, many of the considerations which might create problems for war-ships and other State vessels used for non-commercial service will pose no special difficulties for merchant ships. It is, therefore, considered necessary and useful to deal with navigational issues involving non-commerical ships separately.

NOTES

* Assistant Secretary-General, International Maritime Organization (IMO). The views in this paper are solely those of the author, and should not be attributed to IMO or to its Secretariat.

1. Edgar Gold, *Maritime Transport: The Evolution of International Maritime Policy and Shipping Law*, (Lexington Books, 1981).
   Also Louis Henkin, "Old Politics and New Directions" in Churchill, Simmonds, Welch, *New Directions in the Law of the Sea*, Oceana Publications, 1973; Vol. III, pp. 3-5.
2. Eduardo Ferrero Costa, "Peru and the Law of the Sea Convention", *Marine Policy*, no. 1 (January, 1987), pp. 45-57.
   Also Frank X. Njenga, "Historical Background of the Evolution of the Exclusive Economic Zone and the Contribution of Africa" in Giulio Pontecorvo, ed. *The New Order of the Oceans: the Advent of a Managed Environment*, Columbia University Press, 1986, pp. 125-157.
3. "Claims ... to an extensive territorial sea were not concerned to deny the countervailing claims of other States with respect, to say, navigation." D.W. Bowett, *The Law of the Sea* (Manchester University Press, 1967), p. 6.
4. Statement by the leader of the Indian Delegation to the Conference on the Law of the Sea, Second Session, Caracas 1974. Reprinted in Indian Journal of International Law, Vol. 14, no. 12 (April-June, 1974), p. iii.
5. George P. Smith II, *Restricting the Concept of Free Seas*, Robert E. Krieger Publishing Co., (1980), Chapter 2. The Concept of Innocent Passage in International Law.
6. Bowett: *op. cit.*, page 6.
   Also Oscar Schachter, "Concepts and Realities in the Law of the Sea" in Giulio Pontecorvo, *op. cit.*, (note 2 above), pp. 43-50.
7. Colin Warbrick, "The Regulation of Navigation", in Churchill, Simmonds, Welch, *New Directions in the Law of the Sea*, (Oceana Publications, 1973), p. 137.
8. "Freedom of the high seas and in particular freedom of navigation is one of the oldest and most widely recognized principles of international law." Ruth Lapidoth, "Freedom of Navigation and the Law of the Sea", *Israel Law Review* 10, no. 4 (October, 1975), p. 458.

9. The United States Administration announced that the provisions of the Convention "especially those relating to international navigation and the rights and duties of coastal States, have now become customary international law and, as such, binding on all States ...". Louis B. Sohn and Kristen Gustafson, *The Law of the Sea*, (West Publishing Co., 1984), pp. XIX-XX.
10. "The military issue and freedom of transit in the pursuit of trade and commerce were broadly agreed upon, and protection against interference with commerce was built into the treaty." Giulio Pontecorvo, *op. cit.*, (note 2 above), p. 13.
11. Article 24 of the Convention.
12. Articles 22, 41, and 53 of the Convention.
13. Article 211 of the Convention.
14. Articles 207, 210, and 211 of the Convention.
15. "International machinery should be strengthened to ensure that international standards are developed in a timely and responsive manner." Bernard H. Oxman in Gamble and Pontecorvo (eds.), 'Law of the Sea: The Emerging Regime of the Oceans', (Ballinger Publishing Co., 1974), p. 345.
16. "Traditionally, the enforcement of applicable rules and regulations had been the exclusive prerogative and obligation of the flag State ..." J. Peter A. Bernhardt, "A Schematic Analysis of Vessel-Source Pollution: Prescriptive and Enforcement Regimes in the Law of the Sea Conference", *Virginia Journal of International Law*, 20 no. 2 (1980), p. 268.
17. For example, Article VI of the International Convention for the Prevention of Pollution from Ships, 1973. Also, *International Convention for the Safety of Life at Sea, 1974* chapter I, regulation 19; *International Convention on Training, Certification and Watchkeeping of Seafarers, 1978*, Article X.
18. Richardson, "Law of the Sea", 32 *Naval War College Rev.*, 3, 10, 1979.
19. In the old Law of the Sea, "two maritime areas were recognized as applicable to the whole sea which were, on the one hand, a narrow territorial sea with the 3-mile limit, established for reasons of security and defence of the coastal State and, on the other hand, a large zone of High Seas which covered the remainder of the oceans in which the classic shipping and fishing freedoms operated." Eduardo Ferrero Costa, "Peru and the Law of the Sea Convention" *op. cit.*, (note 2 above), p. 46.
20. Charney, "Exclusive Economic Zone and Public International Law", *Ocean Development and International Law* (1984), Vol. 15, pp. 233-288.
21. J.N. Moore "The Regime of Straits and the Law of the Sea", *American Journal of International Law* (1980), Vol. 74:1, pp. 77-122.
22. Mark J. Valencia, "Law of the Sea in Transition: Navigational Nightmare for the Maritime Powers", *Journal of Maritime Law and Commerce*, 18:10 (October, 1987).
23. Jonathan I. Charney: "The Unfinished Business of the Law of the Sea Conference" in Pontecorvo, *op. cit.*, (note 2 above).
24. Lewis M. Alexander, "The delimitation of Marine Boundaries", *Political Geography Quarterly*, Vol. 5, no. 1, (January, 1986).
25. George P. Smith II, *op. cit.*, (note 5 above), pp. 37-38.
26. *1982 Convention on the Law of the Sea*, Article 92, paragraph 1.
27. *1982 Convention on the Law of the Sea*, Article 94. This is noticeably more detailed than the equivalent provision (Article 10) of the 1958 (Geneva) Convention on the High Seas.

28. For example, Article 21, paragraph 2, concerning international rules and standards on the design, construction, manning or equipment of foreign vessels; Article 60 concerning international standards on the safety of artificial islands, installations and structures and Article 211, paragraph 1 concerning international rules and standards to prevent, reduce, and control marine pollution from vessels and routing systems to minimize accidents.
29. S.G. Sturmey, "The United Nations Convention on Conditions for Registration of Ships", *Lloyd's Maritime and Commercial Law Quarterly*, 1987, Part 1, February, 1987, pp. 97-117. On the question of "the genuine link" in general, see Ebere Osieke, "Flags of Convenience Vessels. Recent Developments": *American Journal of International Law*, (1979), 73:4, pp. 604-627.
30. Bernhardt, *op. cit.*, (note 16 above), pp. 278-279.
31. *Ibid.* See also Schachter, *op. cit.*, (note 6 above).
32. "Implications for the United Nations Convention on the Law of the Sea, 1982, for the International Maritime Organization (IMO): Study by the Secretariat of IMO", *IMO Document LEG/Misc/1*, pp. 2-3. See also Schachter, *op. cit.*, (note 6 above), pp. 39-40.
33. Article 211 of the Convention.
34. Bernard J. Abrahamsson, "The Law of the Sea Convention and Shipping", in *Political Geography Quarterly*, Vol. 5, no. 1 (January, 1986), pp. 13-18.
35. J.D. Kingham and D.M. McRae, "Competent International Organizations and the Law of the Sea", *Marine Policy* (1979), Vol. 3, no. 2, pp. 114-115.
36. Bernhardt, *op. cit.*, (note 16 above), p. 274.
37. Thomas A. Mensah, "Environment Protection: International Approaches", *Marine Policy* Vol. ---, no. --- (April, 1984), p. 95. On the fears for possible jurisdictional disputes among organizations see *Marine Policy* Vol. 3, no. 2 (April, 1979), p. 78.
38. L. Sohn, "Peaceful Settlement of Disputes in Ocean Conflicts: Does UNCLOS III Point the Way", *Law and Contemporary Problems* (1983) 46-195; and E. Miles, "Problems of Dispute Settlement" in E. Miles and J. Gamble, eds. *Law of the Sea: Conference Outcomes and Problems of Implementation*, Cambridge, Ballinger, 1977, p. 223.
39. Sohn, *op. cit.*, (note 38 above).
40. For example, Protocol II (Arbitration) of the International Conventions for the Prevention of Pollution from Ships, 1973. Also Article VIII and Annex 8 of the International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties, 1969.
41. Giulio Pontecorvo, 'Note: Military Uses of the Ocean and the Law of the Sea Conference', in *op. cit.*, (note 2 above), pp. 60-62. On the impact of the Convention provisions relating to "transit passage" on warship movements, see W. Michael Reisman, "Regime of Straits and National Security: An Appraisal of International Lawmaking", *American Journal of International Law*, Vol. 74:1, (January, 1980), pp. 48-76; John Norton Moore, "Regime of Straits and the Third United Nations Convention on the Law of the Sea", *ibid.* (note 21 above). See also Valencia, *op. cit.*, (note 22 above).

Is the LOS Convention Addressing Today's Changing Marine Scientific, Technological, Economic, Legal, and Political Issues: *A Fisheries Perspective*

Lee G. Anderson
College of Marine Studies
University of Delaware

Introduction

With respect to fisheries the answer to the question posed by the title of this session is, with one major qualification, yes. I suspect that the authors of the other perspective papers will not be able to make such a clear-cut affirmative answer. The reason the analysis is relatively simple from a fisheries perspective is twofold. First, the LOS Convention provides the potential for a fundamental solution to the basic problem of oceanic fisheries utilization. Because all coastal States have regulatory control, within certain limits, over the fish stocks in their EEZs, they have the potential to halt the international race to harvest fish and the stock depletion which has frequently accompanied it. Second, there have been few if any changes in the technology of harvesting, processing, or even fisheries management or enforcement that would do anything but reinforce the positive effects of State control.

The one major qualification to this generally sanguine evaluation is the management of highly migratory species, particularly the Pacific tuna resources. The problem of inter-jurisdictional stocks is similar in kind but not degree, and there are some positive signs that it can be solved within LOS agreements.

The paper will proceed as follows. The second section will provide a discussion of the major problems facing fisheries management and development in developed and developing nations. It will be shown that while the solutions are difficult and may be a long time in coming, the fault lies in the institutional and/or developmental structure of the countries involved and not with weakness in the LOS agreements in providing for potential solutions. The third section will analyze the problems involved with highly migratory and inter-jurisdictional stocks. A summary section will conclude the analysis.

Problems Not Related to LOS

The actual problems facing fisheries managers the world over are the same today as they were before the implicit LOS agreement on EEZs, and indeed the same as they have been for centuries. With fully utilized fisheries it is important to guard against the over-exploitation of the stocks, to ensure that catches, or at least opportunities to harvest, are equitably distributed, and to maximize the net value of production. That "over-exploitation" is hard to objectively define and to measure in a day-to-day operational sense, that it is difficult to achieve a consensus on an "equitable distribution", and that the three objectives are conflicting in any event, makes the management problem all the more enigmatic.

With under-utilized stocks it is necessary to determine if fishery development is socially beneficial in terms of product output and income

generation. If so, it is necessary to arrange for government development projects or for programs to assist and facilitate private investment. Whichever procedure is used, it should be done in a cost-effective way that will not adversely affect equally beneficial land or other marine-based economic advancement.

Frequently, an important part of the fishery development question is the decision to move forward independently or to engage in joint ventures with other nations which have comparative advantages in harvesting or processing technology, or in market access. Although such arrangements carry price tags, the potential gains in accelerated expansion to full domestic utilization (or, if appropriate, to the optimal mix of domestic and foreign nation partner operation) can be well worth the cost.

Without the LOS agreement, each of these problems was virtually impossible to solve. Since the fleets from other countries could come in and reap the benefits of reductions in domestic effort, incentives for home-based regulation were greatly reduced. The potential for international agreement was always there and countries in many parts of the world took advantage of this option. However, even though some gains were secured through such institutions, they had many faults. It was hard to get consensus on what programs to follow and often the negotiated result was a political compromise that sacrificed much of the integrity of the original management goals. There was little to prevent countries that were not party to the agreement from coming in and skimming off the benefits of the reduction in effort of others. Finally it was difficult to obtain proper implementation and enforcement of agreements because of delicate issues of national sovereignty. Therefore, under single or international management, prior to the LOS agreement, issues of stock viability, domestic catch distribution, and productive efficiency were often moot.

Likewise, incentives for fisheries development were impaired because of the possibility of losing the benefits to other participants whose entry could not be blocked. Similarly, joint ventures were not very likely prospects because other countries could come in on their own with or without agreement.

With the LOS agreements and the subsequent almost universal adoption of EEZs, the potential to solve these problems was provided. Nations had control over the fisheries in their zones in much the same way that they had control over their land-based resources. Domestic management was possible because other countries could be prevented from fishing if it adversely affected the domestic industry. Similarly, viable development programs became rational because the home country could be sure of accruing the gains. Further, the domestic countries were then able to negotiate joint venture programs from a position of strength.

How the various countries of the world have taken advantage of the potential benefits offered by the LOS agreements is an interesting topic, but one which goes far beyond the scope of the present paper. In general, however, most countries have done fairly well with the control of foreign fishing. Because foreigners have relatively little input to or effect on domestic policy making, they have been eliminated from local waters or they have maintained access only if domestic fishermen do not want all or part of the particular stock or if they pay an entrance fee in terms of cash or fishery development aid.

The way in which the various countries have addressed domestic management under the LOS agreements is more of a mixed bag, however. In many instances, the political problems which existed under international

agreements have remained. Although the influences of other countries have been removed, the views of different segments of the industry and sometimes of different types of gear within the same segment are so diverse that it is difficult to reach accord. As a result, the potential gains of fisheries management have not been achieved. Professor Edward Miles described such a situation in a paper presented at the LSI meeting in Oslo. In other instances, however, the management agencies and the industry representatives have been able to face the hard choices that must be made and have utilized the potential from the LOS agreements to build biologically and economically rational management systems. New Zealand and Australia and some fisheries in Canada and Iceland provide good examples of the latter. Mr. Philip Major discussed the benefits of the New Zealand Individual Transferable Quota program in a paper presented at the LSI meeting in Cardiff.

The formation of fisheries management in developing nations is fraught with many difficulties. They face the same issues as presented to developed nations. However, they have the additional complications of fewer resources to develop and implement policies for a clientele of fishermen who are often among the poorest of the poor where mistakes in policy can mean starvation, not just a missed boat mortgage payment, widely dispersed harvesting and landing points which are difficult to monitor, and, all too often, many small interdependent stocks about which it is very difficult to obtain biological information. While all of these problems have not been solved, the blame cannot be placed on the LOS agreements. If anything, the strengthened position of the domestic country under these agreements has helped to obtain international assistance to begin to solve the problems. The difficulty lies with the political will or economic ability to tackle the problem.

Problems Related to LOS

While the control over fish resources provided by the LOS agreements has afforded the potential to solve many problems, its usefulness is spread quite thin with respect to highly migratory stocks. The success of management of transnational stocks is somewhere in between, depending upon the number of stocks and countries involved.

The reason there are difficulties with these types of stocks is that the basic problem of a need for strong control over the stocks has not been satisfactorily solved. At best it has been reduced. If a stock migrates between the zones of only a few countries and never goes into high seas areas, those nations are in a better position to bargain for privately and socially beneficial management programs than they would be if they had to deal with all other interested parties. They will likely have more trouble developing rational management policies than any of them would have if they could operate independently, but nowhere near the trouble they would have without an LOS agreement. However, as the number of nations involved in management and the number of stocks which migrate into high seas areas increase, the potential for gain offered by the LOS agreements diminishes rapidly.

The agreement between Australia, Japan, and New Zealand regarding the harvest of Southern Bluefin Tuna (SBT) is a success story in this regard. The countries have agreed to significant reductions in total catch and upon how the reduced catch should be distributed between them. The chance for a successful agreement was enhanced by the small number of participants (because New Zealand takes such a relatively small part of the catch, most of the hard bargaining was between Australia and Japan) and by the fact that there was only one species. The fact that

Japan takes its catch on the high seas shows that complete sovereignty is not essential for successful agreements.

The development of the EEC fisheries policy is another example that merits study. Given that there are many countries and many fish stocks and given the overlay of other political and economic issues that surround EEC negotiations, in some sense it is a wonder that any agreement was reached at all. As far as truly successful fisheries management is concerned however, it is important to realize that it is the content and enforceability of an agreement that is important, not just its mere existence. Several commentators have concluded that in this regard the EEC fisheries policy leaves something to be desired, (see Cunningham and Young (1983), Quin (1983), and Underdal (1980)).

At the other extreme from the SBT agreement are the problems of Tuna Management in the Pacific islands region. In a detailed study of this problem, Copes (1987) has made the following conclusions which support the general argument of this paper.

> Other UNCLOS articles spell out a requirement for cooperation among all participating states - RANS (resource adjacent nations) and DWFNs (distant-water fishing nations) - in managing the stocks of highly migratory species (including nine species of tuna) for purposes of conservation and optimum utilization. The necessity for international cooperation in managing the migratory species is obvious: if such a stock is to be conserved so as to yield optimum catches, it must be managed at restricted levels of effort. Hence an effective management regime requires that all RANs harboring the stock during its migration and all DWFNs fishing the stock at any time submit to a commonly agreed limit on total effort compatible with the TAC.
>
> To call for such cooperation is one thing; to achieve it is another. The UNCLOS offers no guidelines for structuring a cooperative management regime and no process of compelling agreement. In the case of the tuna resource in the Pacific islands region, four circumstances make it particularly difficult to structure a management regime and achieve agreement on it; (1) the wide range of stock migration, (2) the complexity of stock composition and migration patterns, (3) the large number of RAN and DWFN participants, and (4) the fact that many stock components spend considerable time in the waters of the high seas. (Page 14.)
>
> ... The process of negotiation (of an agreement) can be formidable, quite apart from the difficulty of achieving consensus when so many competing interests are at stake and when the benefits can be divided in innumerable ways. A "fair" compromise is hard to define - and even harder to negotiate - when the contending national representatives hold self-serving notions of what is fair and are driven to demonstrate to their governments and their compatriots that they have bargained effectively. Negotiations can end in stalemate or in a flawed compromise that fail to optimize collective benefits from the fishery, that is difficult to implement, and that is open to disruptive disputes over interpretation and enforcement. (Page 16.)

One of the specific things that can be a problem in these negotiations is the status of the DWFNs with respect to any one RAN and the status of one RAN in relation to the others. Should RANs strive for joint ventures or should they fall back on the simple expedient of

leasing out access rights? While there is always the potential for developing a domestic industry, it is likely, given the relative efficiencies of Pacific area RANs and of the DWFNs, that the largest gains will come from leasing access rights (Waugh (1987a)).

Given the decision to lease, the problem then becomes one of setting an appropriate access fee. The right to fish tuna is valuable and the RANs should strive to get the maximum amount they can. However, because there are many places a DWFN can fish (both within the region and elsewhere) setting an access fee too high can drive the fishers elsewhere. RANs may reduce this possibility by joining together to set prices in common as has been done under the auspices of the Forum Fisheries Agency and the Nauru Agreement. However, this can lead to problems if various aspects of harvest in the different zones are dissimilar (Hudgins (1987)). For example, if there are differences with respect to density of tuna resources, distance from home ports and processing plants, and fuel and unloading costs, certain RANs may be at a disadvantage with common access fees.

There are other problems as well. One, of course, is that the United States, one of the most prominent DWFNs, does not recognize many of the important issues of the LOS agreement that deal with tuna. This problem has been partially removed by a recent treaty between the U.S. and the Forum Fisheries Agency, but there is a long way to go before a final solution is found (Waugh (1987b)).

Another problem, which has been discussed in some detail in an earlier session of this conference, is the difficulty and expense of enforcing fisheries agreements when there is so much territory to police. The RANs in this area are relatively low income countries with little or no Coast Guard apparatus, and as such, find it extremely difficult to tackle this Herculean task.

Summary

While there are many problems facing fisheries management today, most of them are capable of being solved within the system set up by the LOS agreements if the nations have the will and the resources to do the job. The current system does leave some holes in those instances where it has not, and probably cannot, reduce the number of entities responsible for management to a small enough number that successful multilateral negotiations are likely.

REFERENCES

Copes, Parzival, 1987 "Tuna Fisheries Management in the Pacific Islands Region." in David J. Doulman (ed.) *Tuna Issues and Perspectives in the Pacific Islands Region*. East-West Center, Honolulu, HI.

Cunningham, S, and J. Young, 1983 "The EEC Common Fisheries Policy: Retrospect and Prospect." National Westminster Bank Quarterly Review (May):2-13.

Hudgins, Linda L., 1987 "Negotiating Fishing Access Rights in the South Pacific: an Economic Framework." Asia Pacific Economies: Promises and Challenges, Research in International Business and Management, Volume 6, Part a, pp. 243-257.

Quin, J., 1983 "E.E.C. Fisheries Policy." Journal of Agricultural Economics 34 (3):337-47.

Underdal, A., 1980 *The Politics of International Fisheries Management: The Case of the North-East Atlantic*. Oslo: Universitetsforlaget.

Waugh, Geoffrey, 1987a "The Collection of Rent in the South Pacific Tuna Fishery." Islands/Australia Working Paper No. 87/3. National Centre of Development Studies, The Australian National University, GPO Box 4, Canberra, ACT, 2601.

Waugh, Geoffrey, 1987b "The Tuna War in the Pacific: The State of Play." Paper delivered at the Symposium on Economic Development in the South Pacific, Center of the South Pacific, University of New South Wales, October 28, 1987.

ance envelopes were explored. These tests proved that the OMA engineering concepts worked at their mid-Pacific Ocean site of intended application (Kaufman *et al.*, 1985).

During these tests NOAA placed scientist observers, or monitors, aboard the *R/V Deepsea Miner II* to observe the mining tests and the attendant discharge phenomena. Additionally, scientists aboard the NOAA vessel *Oceanographer* observed the test and sampled its surficial plume. Several years later, the Scripps Institution of Oceanography initiated a study of the test equipment tracks, the resulting sediment plumes, and the effects on benthic macrofauna. These observations, and similar observations made during tests by other domestic ocean mining consortia, led to useful findings regarding both surficial and benthic plumes. However, the findings were of limited utility only, due to the lack of opportunity to observe sustained operations (Ozturgut *et al.*, 1981) (Speiss *et al.*, 1987).

In the light of on-going ocean mining activities in the U.S., France and Japan, at least one international organization, the International Union for Conservation of Nature and Natural Resources (IUCNNR), early on recognized the need for a program to set aside seabed reference areas to facilitate environmental monitoring of commercial mining operations. In 1978, at Ashkhabad, USSR, the IUCNNR General Assembly resolved as follows (IUCNNR, 1978, 1981, 1984):

> The (IUCNNR) General Assembly ... URGES all nations engaged in, or considering, deep seabed mining activities to:
>
> (a) precede commercial mining operations by commissioning a comprehensive ecological survey to determine the impact of such mining activity;
> (b) designate appropriate areas of the deep seabed as base line reference areas and resource zones in which no mining will be allowed;
> (c) designate the size and shape of such area or areas to ensure that their stability will be maintained; and
> (d) establish guidelines for scientific research to ensure minimum disruption of the natural state of such areas.

The U.S. Congress became aware of the IUCNNR resolutions at an early date. At the time, domestic ocean mining legislation was being drafted based upon the legal theory that ocean mining is a legitimate exercise of the freedom of the seas doctrine, which doctrine imposes duties as a corollary of the rights so asserted. As a result, Section 109(f) of the Deep Seabed Hard Mineral Resources Act of 1980 (DSHMRA) contained a requirement that the U.S. government seek to establish internationally recognized Stable Reference Areas ("SRAs") in the CC-Zone in which no mining can occur. Recognizing that the SRA concept required balance so as not to encourage politically inspired moratoria or unreasonably exclusionary set-asides, Congress provided that the SRA requirement shall not be construed as an authority to withdraw substantial portions of the DOMES area (DSHMRA, 1980).

At the U.N. level, however, the IUCNNR concept fell upon less fertile ground. Part XI (the Area) of the 1983 U.N. Conference on Law of the Sea (UNCLOS) was negotiated in the 1970s to regulate deep seabed mining, applying the politicized solutions of the 1960s to the hypothetical problems of the 1950s. It should be no surprise that the final text of Part XI, finalized in 1980, bears little relevance to present

(or past) realities and contains no mention of the IUCNNR Stable Reference Area concept or its functional equivalent.

Noting this, the IUCNNR tried again. In its 1981 General Assembly resolution, IUCNNR specifically called upon UNCLOS's Preparatory Commission ("PrepCom") to develop and implement the concept. Failing to detect any responsive movement upon the part of PrepCom in the next three years, the IUCNNR General Assembly, at its 1984 Meeting in Madrid, resolved with continuing vigor (but more precision) as follows:

> The (IUCNNR General Assembly ... RECOMMENDS that the Preparatory Commission adopt at the earliest opportunity draft rules, regulations and procedures which adequately reflect the concept of protected areas and other appropriate environmental measures.

As of 1987, PrepCom was awash in draft rules. However, there was no indication that any PrepCom draft rule yet addressed the environment or responded to ten years of persistent IUCNNR resolutions on the subject (PrepCom, 1987).

To be fair, UNCLOS gave no mandate to PrepCom to draft environmental regulations or to incorporate the stable reference area concept into its resource management scheme. It is unreasonable then to expect PrepCom to do so; bold U.N. organizations do not flourish. However, this revealed lack of vision in Part XI, and related institutional inflexibility, can only serve as an excellent example of why there is good reason to sever Part XI from the otherwise equitable and widely accepted provisions of UNCLOS. Meanwhile, modern solutions to current deep seabed mining problems must be sought elsewhere.

Under the authority of DSHMRA, the Administrator of NOAA set up the Office of Ocean Minerals and Energy (now the Ocean Minerals and Energy Division of the National Ocean Service, NOAA, U.S. Department of Commerce) which, in 1981, requested the assistance of the Ocean Policy Board of the National Academy of Science's National Research Council (OPB/NRC) to evaluate the scientific validity of the SRA concept, and to recommend a cost-effective implementation strategy. The resulting study report, issued in 1984, concluded that the SRA had two purposes:

(1) to serve as preserves to ensure (maintenance of) a representative and stable biota of the deep seabed, and
(2) to be used as a reference zone or zones for purposes of resource evaluation and environmental assessment of deep seabed mining (impacts).

The OPB/NRC panel of experts concluded that the concept as outlined by IUCNNR in 1978 only had scientific validity if two areas were established; one in which to study impacts and the other to serve as a preserve. The panel stated its belief that existing knowledge was insufficient to allow immediate designations of SRAs, but urged "provisional" designation of such areas as early as possible to provide the loci for further necessary research and to aid in the definition of criteria for final designations (OPB/NRC, 1984).

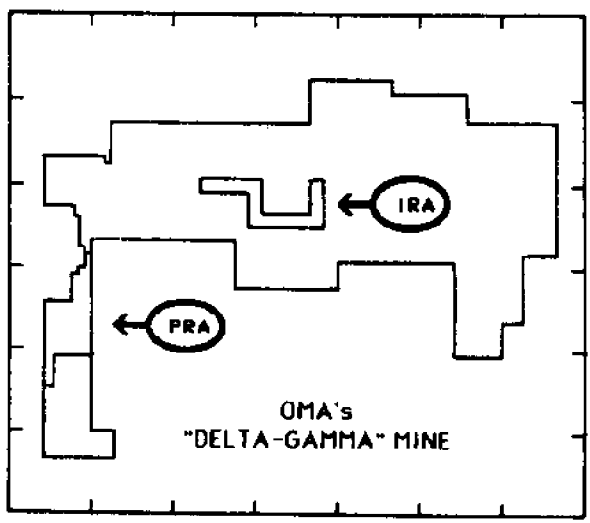
Based upon the OPB/NRC study, NOAA accepted the scientific validity and the utility of the two-area SRA concept by incorporating such concepts in proposed Commercial Regulations published in 1987. These regulations would require designation of both preservational and impact monitoring sites prior to issuance of any commercial ocean mining permit, and monitoring of such sites thereafter (NOAA Regulations, 1987).

OMA believes that early establishment of preservational and impact reference areas in its ocean mining License Area DELTA-GAMMA will aid in its planning for initial mining operations and future environmental monitoring, if established according to scientifically valid criteria. Additionally, it is our belief that the earliest *provisional* approvals will substantially aid NOAA's efforts to establish such criteria for *final* establishment and approval of such areas, if applied in an objective manner to achieve a valid scientific experiment.

Accordingly, OMA has petitioned NOAA to approve, on a provisional basis, two reference areas within its license area; one area of 6,520 square kilometers for use as an interim preservational reference area, and the other of 4,630 square kilometers to serve as an interim impact reference area. Upon provisional approval by NOAA of each such reference area, proprietary data associated with such area would be released to NOAA for verification and use by NOAA in making findings and judgments leading to final designation of such areas (and final approval of OMA's mining permit, when and if appropriate).

The location of these two proposed reference areas in DELTA-GAMMA are shown in *Figure 2*. The total area encompassed within these reference areas aggregates to approximately 11,150 square kilometers, or about 4,300 square miles. For purposes of comparison, this is roughly double the size of the state of Delaware.

FIGURE 2



OMA's environmental reference area proposals attempt to hew to the spirit of the IUCNNR resolutions, the letter of the DSHMRA provisions, the direction of the proposed commercial regulations, and the detail of the OPB/NRC findings and recommendations set forth as follows:

OPB/NRC Findings	OMA Proposals
1...SRA concept scientifically valid	Agreed & incorporated
Impact and preservational areas;	
PRA to be located to ensure biota not affected;	Agreed & Incorporated
IRA to be located close to mining.	Agreed & incorporated
2...Small-scale resuspension experiment required (highest priority research need).	OMA IRA includes location of NOAA experiment planned early 1989. Data offered.
3...Divide CC-Zone into 9 "characteristic environments", each with 1 PRA; modify if indicated by further data.	OMA feels areas may be consolidated in certain circumstances. Provisional area boundaries should be responsive to new data.
4...Map drift of bottom waters so PRAs are placed "upstream" of mining.	Multilayer current and sediment excursion data needed. "Core" of IPRA is well within outer limit.
5...Use future mining tests to redeposition to determine PRA separation criteria.	This is why OMA proposes an "interim" designation. See #8 below.
6 & 7...Encourage industry to disclose data and samples, study existing photos and samples, and use ships of opportunity, for cost-effective inventory of benthos to aid in PRA designation.	OMA has offered data and samples (data and samples showing biota already furnished).
8...Make initial designation of *provisional* PRAs as soon as possible, using data from #2, 4, 5, and 7 above.	This is the purpose of OMA's first proposal.
9...Designate permanent PRAs upon issuance of first Commercial Permits using data from #2, 5, 6, and 8.	OMA may wish earlier issue, if possible.
10...Continue long-term monitoring of selected PRAs.	OMA has no present comment.
11...Designate one IRA per Permit is issued;	OMA feels designation should be earlier, if requested by license holder.
shape and size designed to maximize potential of experiment.	OMA's proposed IPRA is so shaped and sized, subject to verification and change by NOAA if future research so warrants.

12...Promote international consultation to maximize data collection and to minimize conflict.	OMA agrees.
13...Committee did not address issues associated with processing at sea.	OMA does not contemplate such practice in its approved exploration plan.

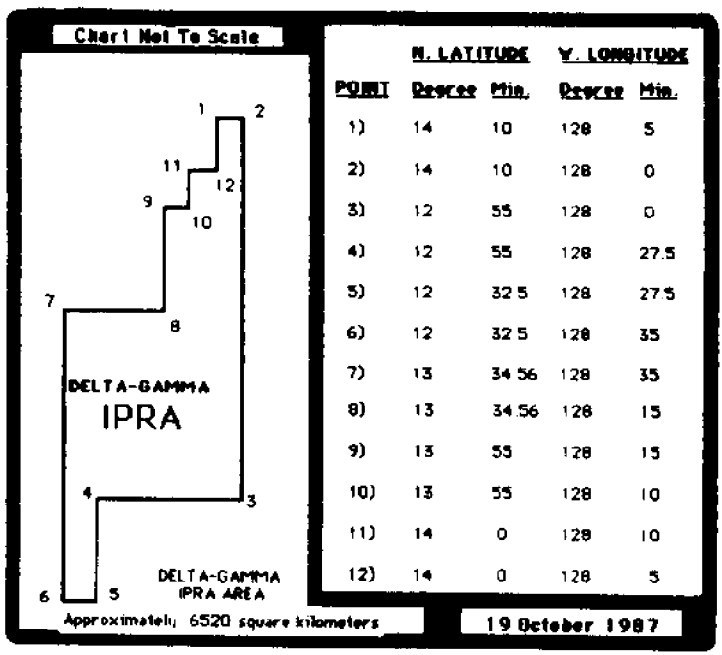
OMA's formal proposals to NOAA took the form of letters setting forth OMA's selection of two areas, one as a candidate preservational reference area and the other as a candidate impact reference area. These proposals are set forth in full as follows:

1. OMA Interim Preservational Reference Area Proposal:

19 October 1987 letter from OMA to James P. Lawless, Chief, Ocean Minerals and Energy Division, National Oceanic & Atmospheric Agency:

OMA herewith requests consultations with your offices with the objective of early designation by OMA of an area of approximately 6,520 square kilometers within (OMA license area) DELTA-GAMMA to be reserved or surrendered as an Interim Preservational Reference Area ("IPRA"), as follows (*Figure 3*).

FIGURE 3



POINT	N. LATITUDE Degree	N. LATITUDE Min.	W. LONGITUDE Degree	W. LONGITUDE Min.
1)	14	10	128	5
2)	14	10	128	0
3)	12	55	128	0
4)	12	55	128	27.5
5)	12	32.5	128	27.5
6)	12	32.5	128	35
7)	13	34.56	128	35
8)	13	34.56	128	15
9)	13	55	128	15
10)	13	55	128	10
11)	14	0	128	10
12)	14	0	128	5

Said proposed IPRA represents a characteristic nodule mining environment in DELTA-GAMMA and contiguous license areas. OMA's database in the proposed IPRA is rich in proprietary data, comprising raw data and samples originally collected by OMA or acquired from other sources and integrated by OMA into compatible formats. OMA is prepared to familiarize you on a confidential basis with the data in the proposed IPRA prior to approval of such designation, and therefore to provide all such proprietary data on a non-confidential basis, reserving only the right to withhold identification of certain non-OMA sources of such proprietary data until December 16, 1988.

This proposal is made at this time in the belief that early designation of OMA's IPRA best meets the needs of commercial planning, basic science, and public policy. This action was contemplated in our Exploration Plan, does not affect OMA's License Area, Logical Exploration Unit, ownership or capabilities, and thus is not an application for amendment of our license. We understand that any NOAA approval of our designation under present circumstances may be tentative in nature, but trust that permanent status will be forthcoming in time to provide predictability to OMA's exploration phase planning for at-sea commercial recovery operations. Also, we believe that this proposal could serve as the catalyst for, and nucleus of, a constructive, cooperative program of research applicable to much of the CC-Zone nodule province. Additional benefits to industry, the Nation, and the international community would accrue should such a research program acquire multinational participation. We solicit an appointment in your offices at a time convenient to you to begin these consultations relating to our planned license activities.

NOAA responded to the above proposal by noting its consistency with the approach NOAA is pursuing for monitoring the environmental effects of deep seabed mining, and by stating that it would be beneficial to pursue the proposal and the potential for designation of the proposed reference area (NOAA Federal Register Notices, 1988).

This NOAA response, and subsequent consultations, prompted OMA to supplement its IPRA proposal as follows:

14 March 1988 letter from OMA to James P. Lawless, Chief, Ocean Minerals & Energy Division, National Oceanic & Atmospheric Agency:

We note with pleasure the language of your 3 March 1988 Federal Register notice, stating that your office believes it beneficial to pursue OMA's 19 October 1987 IPRA proposal and to further examine the potential designation of the proposed OMA environmental monitoring site as a reference area for purposes of environmental research and monitoring.

We interpret this language to mean that you intend to seek the administrative procedure and scientific basis which you consider necessary to approve the proposed OMA interim preservational reference area ("IPRA") as an interim environmental monitoring site for base-line research work and planning of a monitoring program during the term of OMA's exploration license, leaving the question of permanent status for future determination. If it does not mean this, please so inform us.

As stated in our 19 October 1987 proposal, once the IPRA is so approved, we will provide the proprietary data in the area, which derives from a broad spectrum of commercial sources and includes:

(a) results from more than 300 free-fall grabs, box cores and dredge hauls, including abundance estimates, 5-metal assays, and pulps for a majority of samples,
dredge hauls, including abundance estimates, 5-metal assays, and pulps for a majority of samples,
(b) bathymetric data for a significant portion of the IPRA,
(c) data regarding nodule concentration and size, and obstructions along specific tracks, extracted from more than 100 nautical miles of video observations.

As you have been informed, the IPRA is classified by OMA as a characteristic mining area in accordance with criteria established by OMA to identify future subareas with acceptable topography, soil mechanics, and nodule abundance /assay to qualify as competent mining areas in a commercial mining plan. The only OMA criterion in which the IPRA is marginal is that of total extent of the mineable resource; a contiguous area encompassing roughly 1/3 of the total IPRA contains nodules of acceptable abundance and assay in what we have judged in a preliminary way to be acceptable terrain (more detailed bathymetry of mining plan areas being a future exploration need). It thus ranks below other larger mineable OMA subareas which, collectively, are considered sufficient to meet the needs of any OMA 20-year mining plan.

According to our data, the IPRA mineable resource is effectively surrounded by IPRA terrain that lies well below several OMA criteria. It thus seems eminently qualified as the core of a preservational reference area. In addition, the IPRA is in relatively close proximity to several larger mineable areas, sharing with those areas all characteristics except abundance above the commercial threshold. A caveat is necessary; the OMA criteria mentioned above do not include judgments related to biological populations. While we have insufficient data to indicate that the biota of the IPRA is characteristic, we have no data to the contrary.

That the proposed IPRA is of characteristic quality in economic and geological terms is confirmed by the fact that every known nodule mining operator who explored there ultimately claimed all or part thereof. These claimants included OMA, OMI, OMCO, KCON, IFREMER, DORD, and YUZHMORGEOLOGIYA. In fact, the IPRA was the area most overlapped in the conflict resolution process embracing the RSA, the FSA, the SSA, and recent understandings concerning the USSR areas of interest in the C-C Zone.

To facilitate your future analysis of the above-summarized IPRA data, we will be most willing to disclose OMA's mining area criteria on a confidential basis after acceptance of the proposal. We will also be willing to discuss the terms of provision to NOAA of (1) the numeric data in IBM PC-compatible format, where appropriate, and (2) training in technical and analytical methodologies to aid in the interpretation and use of data obtained by NOAA from OMA and other sources in the future.

OMA's preliminary mining plans (the primary objective of the exploration plan being to finalize initial mining plans) do not

envision mining activity in the IPRA, a fact which inspired our proposal that it be approved (on an interim basis, given statutory language and the state of the art) as a preservational reference area.

We are aware that the emerging stable reference area concept also contemplates the utilization of an impact area to complete the data required to judge the scale of the impact of human activity in virgin territory. Accordingly, we are preparing a proposal which will set forth a further environmental monitoring site in the OMA operating area to be dedicated as an interim impact reference area, taking into account prior NOAA activity in the OMA license area and our planning for mining activities under a Permit. It is our view that with these two approvals in hand the monitoring and research plans will be greatly facilitated.

On May 16, 1988, NOAA designated the proposed IPRA as an environmental monitoring site and solicited expressions of interest from the public (NOAA FEDERAL REGISTER NOTICES, 1988).

2. OMA Interim Impact Reference Area Proposal:

During April and May of 1988, NOAA and OMA entered into consultations regarding the selection by OMA of an Interim Impact Reference Area. NOAA pointed out that its proposed commercial recovery regulations listed two criteria for selection of a Impact Reference Area:

(1) the area should be representative of the environmental characteristics of the site, and
(2) it should be located in a portion of a Permit area tentatively scheduled to be mined early in the Permit term.

After consultations on the subject, NOAA and OMA agreed that:

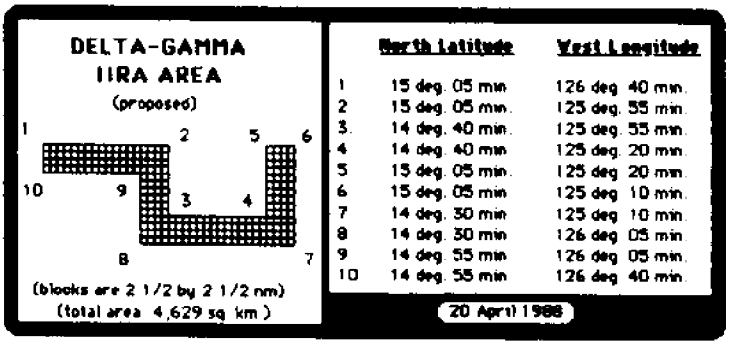
(1) The Impact Reference Area should be sized and shaped to be proximate to, and to include portions of, at least two potentially early mining blocks to facilitate examination and/or monitoring of areas being mined, or mined out, or dusted with sediment,
(2) It should not lie exclusively within a previous test area, although it could contain a test area,
(3) Its boundaries should be somewhat flexible to ensure that a dusted area just outside would not be excluded from examination, and
(4) Its location, size and shape should be selected by the licensee/permittee, taking into account (1) to (3) above.

On the basis of these consultations, OMA submitted the following formal proposal of an impact reference area to NOAA:

19 May 1988 letter from OMA to James P. Lawless, Chief, Ocean Minerals & Energy Division, National Oceanic & Atmospheric Agency:

Thank you for your letter of 13 May 1988. OMA herewith requests further consultations with your offices with the objective of early designation of an area of approximately 4,629 square kilometers within DELTA-GAMMA to be reserved as a Provisional Interim Impact Reference Area ("IIRA"), as follows (*Figure 4*):

FIGURE 4



This proposal is a supplement to our proposal dated 19 October 1987 to designate, on a provisional basis, an Interim Preservational Reference Area. It is intended to flesh out our environmental monitoring site proposals to you to aid in the establishment of criteria and locations for a scientifically valid Interim Stable Area(s) in OMA License Area DELTA-GAMMA, and to facilitate timely governmental research programs and industrial planning for environmental monitoring therein.

Said proposed IIRA contains the following categories of sub-areas:

(a) NOAA's "DOMES SITE C", in which NOAA and academia have conducted, and plan further, nodule related environmental research,
(b) areas including or impinging upon OMA's "TEST SITE", which:

  (1) OMA utilised to conduct multiple tests modelling a commercial nodule mining ship and system in all principal respects
  (2) NOAA and academia have become quite familiar with, having monitored test operations and measured post-test impacts therein,
  (3) OMA may choose as an "early" mining site (i.e.: one in which to conduct limited or full-scale operations during prototype testing and/or early mining,
  (4) OMA classes as characteristic or representative of planned OMA nodule mining areas and environment,

(c) area(s) proximate to and impinging upon at least one other potential OMA early mining site, and
(d) additional area shaped so as to have a high probability of containing at least some "downstream" area (i.e.; area swept by currents originating in any nearby early mining site selected by OMA).

OMA's database in the proposed IIRA contains much raw data and many samples originally collected by OMA or acquired from other sources and integrated by OMA into compatible formats. During the

term of its Exploration License, OMA is prepared to make available to you all biological data and samples in its possession originating in the proposed IIRA, and to familiarize you, as needed and on a confidential basis, with proprietary data in category (a) sub-areas of the proposed IIRA, reserving the right to withhold identification of certain non-OMA sources of such proprietary data until 16 December 1988.

This proposal is made at this time in the belief that early provisional designation of OMA's IIRA best meets the needs of commercial planning, basic science, and public policy. This action, as a supplement to our proposal for provisional designation of an Interim Preservational Reference Area, is intended to further facilitate research and environmental planning, was contemplated in our Exploration Plan, does not affect OMA's License Area, Logical Exploration Unit, ownership or capabilities, and thus is not an application for amendment of our license.

We fully understand that any NOAA approval of our selections under present circumstances may be tentative or provisional in nature, but trust that permanent status will be forthcoming in time to provide predictability to OMA's planning for mining operations in its initial commercial mining sub-areas. Accordingly, we solicit an appointment in your offices at a time convenient to you to continue these consultations relating to our planned license activities.

At the date of this writing (June 1, 1988), NOAA is considering the designation of the proposed IIRA as an additional OMA environmental monitoring site.

OMA is not an environmental society. It is a marine mining R&D company attempting to create efficient technical assets and to marshall a business and regulatory environment that will impose the lowest level of investment risk during future commercial operations. Early implementation of a carefully crafted stable reference area program, in association with reasonable monitoring obligations, appears to offer substantial advantages in assuring that environmentally responsible operations will yield the minimum of costly future "surprises".

This will be true, however, only if the further development of the SRA concept is exposed to the earliest and broadest scientific enquiry and an absolute minimum of industrial, bureaucratic, or political bias. Accordingly, the process of establishment of the first "provisional" SRAs must be clearly understood by industry, government, and public interest groups to be a classic scientific experiment. As such, all parties engaged in development and implementation of the SRA concept must be careful to avoid the introduction of bias into the experiment. Should the data or conditions be deliberately skewed, or the "moratorium tendency" introduced into the process, the concept will lose utility. The victim would be the possibility for cooperation, constructive consensus and useful result.

If NOAA can institute a procedure by which concerned scientists may participate with government and industry in the identification of the characteristics implicit in provisional designation of preservational and impact reference areas, the result will be:

(1) the design of a new, valid and defensible resource management tool (the SRA concept) to assure environmentally responsible domestic government policy and actions,

(2) the creation, through early participation, of a broad consensus to support such concept, policy and actions,

(3) the provision to industry of a predictable and reasonable set of environmental guidelines and obligations upon which to base its present planning and future operations, and

(4) the availability of an economically rational, environmentally responsible resource management tool for consideration by other nations and international institutions concerned with "shared" resources.

REFERENCES, ABBREVIATIONS AND ACRONYMS USED

C-C ZONE: The seabed area between the Clipperton Fracture Zone and the Clarion Fracture Zone of the northeast equatorial Pacific Ocean.

DELTA-GAMMA: OMA's minesite in the C-C Zone, NOAA Deep Ocean Mining Exploration License Area USA-3.

DOMES, 1981: The Deep Ocean Mining Environmental Study, a long-term environmental research program funded by NOAA. The final DOMES report was published as Volume 3, No. 1/2, Marine Mining Journal (1981), Crane, Russak & Company, Inc., 3 East 44th Street, NYC, NY, USA, 10017. A compendium of over 150 individual domestic environmental research projects and reports funded by NOAA and supporting the DOMES report or building upon its data and results may be obtained from the Ocean Minerals and Energy Division, OCRM, NOAA, U.S. Department of Commerce, Room 704, 1825 Connecticut Ave., NW, Washington, D.C., USA 20235.

DORD: The Japanese deep seabed mining entity.

DSHMRA, 1980: The Deep Seabed Hard Mineral Resources Act of 1980, U.S. Public Law 96-283, 30 USC 1401.

IFREMER: The French deep seabed mining entity.

IIRA: Interim Impact Reference Area.

IPRA: Interim Preservational Reference Area.

IUCNNR, 1978, 81, 84: The International Union for Conservation of Nature and Natural Resources, Gland, Switzerland. The IUCNNR is an independent, non-profit, international, natural resources-oriented organization with a General Assembly of members, and a permanent secretariat. At the time its 1984 General Assembly resolution was passed, IUCNNR had 501 members from 114 countries, in three categories: 57 nations; 123 government agencies; 315 non-governmental organizations; 6 non-voting affiliates.

Kaufman et al., 1971: R. Kaufman, J. Latimer, "The Design And Operation Of A Prototype Deep-Ocean Mining Ship"; Proceedings of SNAME Annual Meeting, Honolulu, Hawaii, U.S.A. (May 25, 1971), Society of Naval Architects and Marine Engineers, 74 Trinity Place, NYC, NY, USA 10006.

Kaufman et al., 1985: R. Kaufman, J. Latimer, D. Tolefson, S. Senni, "The Test And Operation Of A Pacific Ocean Deep-Ocean Mining Test Ship:

RV Deepsea Miner II"; Proceedings of the 17th Annual Offshore Technology Conference, Houston, Texas, USA (May 6, 1975).

KCON: The Kennecott Consortium, a U.S. seabed mining consortium.

NOAA Federal Register Notices, 1988: National Oceanic and Atmospheric Administration, "Deep Seabed Mining; Approval Of Revisions To Mine Site Areas And Publication Of Revised Coordinates"; Federal Register, Vol. 53, No. 42, Pgs. 6858-9, Thursday, March 3, 1988; "Deep Seabed Mining; Designation Of Deep Seabed Mining Environmental Reference Area"; Federal Register, Vol. 53, No. 94, Pgs. 17237-8, Monday, May 16, 1988.

NOAA Regulations, 1987: National Oceanic and Atmospheric Administration, "Deep Seabed Mining; Regulations for Commercial Recovery and Revision Of Regulations for Exploration; Supplemental Proposed Rule"; 15 CFR Part 971; Federal Register Vol. 52, No. 177, Monday, September 14, 1987.

OMA: Ocean Mining Associates, a U.S. seabed mining consortium.

OMCO: Ocean Minerals Company, a U.S. seabed mining consortium.

OPB/NRC, 1984: Ocean Policy Board, Commission on Physical Sciences, Mathematics, and Resources, National Research Council; "Deep Seabed Stable Reference Areas"; National Academy Press, Washington, D.C. (1984).

Ozturgut et al., 1981: E. Ozturgut, J. Lavelle, R. Burns, "Impacts of Manganese Nodule Mining On The Environment: Results From Pilot-Scale Mining Tests In The North Equatorial Pacific"; Chapter 15, Marine Environmental Pollution, 2, Dumping and Mining, R.A. Geyer (Ed.) Elsevier Publishing Company, Amsterdam, Netherlands (1981).

PrepCom, 1987: Preparatory Commission for the International Seabed Authority and for the International Tribunal for the Law of the Sea, "Statement By The Chairman Of The Preparatory Commission"; U.N. Document LOS/PCN/L.54/Rev. 1 (September 4, 1987). In the nature of U.N. documents, what is not said is frequently more important than what is said.

Roels et al., 1972: O. Roels, A. Amos, "Environmental Impact of Mining Tests"; Manganese Nodule Deposits Symposium/Workshop, Honolulu, Hawaii (October 16, 1972).

RSA: The "Reciprocating States Agreement" (Provisional Understanding Regarding Deep Seabed Matters), signed among the governments of the USA, U.K., Canada, Belgium, Italy, France, Japan and the Netherlands on August 3, 1984.

Spiess et al., 1987: F. Spiess, R. Hessler, G. Wilson, M. Weydert, "Environmental Effects Of Deep Sea Dredging"; (unpublished) NOAA Contract No. 83-SAC-00659, NTIS Accession No. PB 87-138319/AS (1987).

SRA: Stable Reference Area, a new concept to serve as a tool for resource management and environmental protection.

SSA: The Supplementary Settlement Agreement, a private overlap settlement signed among OMA, OMI, OMCO, KCON, AFERNOD, AMR and DORD on September 15, 1983.

UNCLOS: The Third United Nations Convention on the Law of the Sea, opened for signature at Montego Bay, Jamaica on December 10, 1982, U.N. Publication Sales No. E.83.V.5.

YUZHMORGEOLOGIYA: The USSR deep seabed mining entity.

COMMENTARY

Brian J. Hoyle
U.S. Department of State
Washington, D.C.

Thank you very much, Tom. Coming as the last speaker in a four-day conference is daunting. I know most of you are probably thinking, "Why couldn't that guy have choked on the ice in his drink during the coffee break and have had to be carried out of here? We'd now be gone to have a proper drink." Well, I could say I agree with everything that has been said by all the speakers this afternoon because, basically I do, and we would all leave. On the other hand, I feel that a Garden of Eden without a snake would be imperfect. So let me say, "Yes, but --" and go on from there.

Five years ago, I appeared here as an advocate for a new oceans policy of President Reagan. For the past five years I have been involved in implementing the international law of the sea reflected in the non-seabeds parts of the Law of the Sea Convention. What I would like to do today is not to advocate but to reflect on and share with you certain experiences that I have had over the last five years. I would say the rules of international law set out in the Convention can continue to meet the challenges posed by continuing change in technology and science and legal and political issues.

If I may, I will take the liberty of quibbling a little with the title of this discussion. The 1982 Convention on the Law of the Sea is not yet in force. Therefore, the Convention is incapable of meeting any challenges. Nevertheless, States are totally asserting their claims pursuant to the rules of international law as articulated in the Convention and are evaluating the conduct of other States in light of those rules. Thus, while it is technically incorrect to ask whether the Convention is meeting challenges today, as a matter of shorthand, the title of this session provides a useful means of assessing how well current rules of customary international law are working. The basic balance of the Convention, other than the seabed mining regime, is good but I would agree wholeheartedly with an earlier speaker who proposed that vigilance is the watchword. We need to nurture, conserve, and promote those rules of the Convention upon which there is consensus among the world community. The position of this administration, on the seabed mining part of the Convention, is very well known and need not be restated here except to say that, like some of the other issues the Convention is not an end in itself, it is a means to an end. A major purpose or objective of the Convention is to provide predictability and stability in the law and to resolve conflicts or prevent potential conflicts from ripening into real ones. The Convention's success will depend on how well it accomplishes this. The basic conflict in oceans law has been and continues to be between Coastal State jurisdiction and control and user rights. As President Reagan said, in 1983, in his Oceans Policy Statement, on balance, the 1982 Convention serves United States interests, and indeed, from our perspective, those of the world community on those parts of the Convention applying to traditional uses, meaning the non-seabed parts, upon which the consensus appears to have existed at the time that the Conference was concluded.

Even though the Convention is not yet in force, the rules articulated in it are being implemented extensively. Over the last five years I have had the good fortune to travel to a good part of the world to discuss the Convention and its implementation with many government people who are involved in implementing the Convention in their various countries. The basic conclusion I would share with you from this is that the Convention is being implemented in good faith by States consistent with the way they view their interests and their rights and duties under the Convention. This is where the nurturing becomes important. To the extent these rules reflect the law we would like to preserve for some time, we must work to ensure that the law not change out from under us by "creative" interpretation. This is where stresses on the integrity of the Convention are occurring right now. The basic perspective of the United States is that of both a coastal State and State with global interests. Like any other country we want as much sovereignty as we can get near our coasts but we also want broad access to distant waters and unlimited mobility on the high seas.

These objectives may be unreconcilable. Certainly, maintaining a balance will be very difficult. The balance struck in those parts of the 1982 Convention dealing with traditional uses and coastal jurisdiction is excellent, but the balance could be destroyed by State practice. We have encountered a number of such problems recently. One is the growing use of straight baselines. The Conference achieved notable success in agreeing upon maximum breadth of the territorial sea of twelve nautical miles coupled with transit passage through straits. But many States are using creative straight baselines to enclose ever greater quantities of water as internal waters and thus pushing the twelve mile territorial sea seaward. These States ignore the general requirements and prerequisites to the use of straight baselines. International law provides that they should only be used where the coast is deeply indented.

A second source of stress is historic water claims. When one looks at the convention for some guidance on determining historic waters one finds no guidance. Paragraph 6 of Article 10 more or less says that if you can cobble together an historic bay claim, you may ignore the rules for establishing baselines. We have, in recent years, been confronted with what I would call "instant historicity." By this I mean recent claims to historic waters status that ignore the need to fulfill such fundamental prerequisites as longstanding and continuous demonstration of sovereignty over an area. While international law does provide some guidance on historic water claims, the Convention fails to do so.

Another stress is use of the term "unique" in cases not well covered by the Convention. Almost every country, whether it has an ice-covered area, a tropical zone, or a temperate zone, has what it considers to be a particularly unique environment that should be preserved but is not well-addressed by the rules in the Convention. States use "uniqueness" to except themselves from the rules of the law of the sea that they find overly confining in their particular set of circumstances. While we might all agree that the environment in question is important, we must be skeptical of the argument that the unique situation justifies exemptions from the rules. I would submit it is a very dangerous concept. Unfortunately, it is a trend that could easily become an epidemic.

Another stress I see growing is regionalism. Regionalism presents a danger of coastal State control over a sea area to the exclusion of non-littoral States. It is a threat to the Law of the Sea Convention that

was designed to be global in scope. We find regional claims under the guise of zones of peace, nuclear-free zones, and areas of "confidence building measures." All of these are designed to exclude or control the conduct of non-littoral states from a particular sea area. Each in and of itself may be a perfectly laudable objective. None of them are evil, none of them present morally or ethically negative values, but each of them either of itself or in combination, has the potential to decrease or limit global mobility or impair the rights provided for under customary and Conventional laws of the sea.

"Creative" interpretation of the Convention threatens the integrity of the Convention as we thought we had negotiated it. For example, the provisions on innocent passage through the territorial sea are found in part III, particularly Articles 18, 19, 20, and 21. For the United States a major purpose of the 1982 Convention was to provide objectivity to transit through the territorial sea. It was on this basis that the United States and many other countries were able to accept the extension of the territorial sea from three to twelve miles. If one looks at those articles, one finds the enumeration of activities which are considered to be prejudicial to the peace, security and good order of the coastal State. Many of those activities relate to actions that can only be conducted from naval vessels. Therefore, from the United States' perspective it can be contemplated that naval vessels enjoy the right of innocent passage. If naval vessels are restricted to certain sea lanes or "traditional routes", there is no innocent passage. The very notion of innocent passage is that it is the right to exercise point-to-point transit through the territorial sea and not a privilege granted by the coastal State. The passage does not have to be a necessity and it may not be restricted to particular routes.

Another area of stress is conservation of marine resources. Martin Belsky gave an excellent presentation on ecosystem management of fisheries. But ecosystem management of fisheries could be a tremendous stress on the notion of 200 miles as the maximum breadth of the exclusive economic zones. It may encourage coastal States to claim control over the high seas beyond the EEZ. For example, a problem we've encountered in the United States is that foreign fishing vessels displaced from the economic zone fish for similar species just beyond the exclusive economic zones in high seas. An example of the problem may be found in the Bering Sea fisheries. Over a million tons of fish are now taken a year out of the high seas "Doughnut Hole" in the Bering Sea. The Doughnut Hole in the Bering Sea at present time is not managed. I am told by persons expert in fishery conservation that it is considered unconscionable that a fishery of that magnitude should not be subject to a conservation scheme. There is a strong suspicion that a take of that magnitude will adversely affect the conservation measures being carried out now within the United State Exclusive Economic Zone off Alaska. As one turns to the Convention provisions on straddling stocks and high seas fisheries provisions, one finds that the fishing State is obligated to cooperate with the coastal State to conserve straddling stocks when fishing for such stocks on the high seas. The best and correct solution to protection of straddling stocks should be through multilateral arrangements. But as one knows, the reason why we have a 200-mile economic zone as a matter of international law today, is that multilateral solutions have not always worked well in the area of conservation. Therefore, Coastal States feel the need, as a matter of necessity, to conserve the resource by taking unilateral measures. We have a scientific study going on now on the ecosystem and long term

management of the Bering Sea fishery. The success of the fisheries provisions from the Law of the Sea Convention may very well depend upon the cooperation between the coastal States, such as United States and Soviet Union, and distant water fishing states, such as Japan, Poland, Korea and Taiwan.

Another possible stress is "creative" application of Article 76 by States attempting to establish the outer limit to the continental shelf. Some States are ignoring the geologic criteria and skipping to the 350 mile limit. This is in direct conflict with the rules of the Convention that permits the continental shelf to extend to 350 miles only where the outer edge of the margin geologically extends to that point. What we may have done is simply set a target which States will shoot for in establishing their continental shelves. Those marine geologists, such as Hollis Hedberg, may have been correct when they said Article 76 is too complicated to apply. New areas of ocean use and new problems may not be adequately provided for in the Convention.

An area of the Law of the Sea that was not well developed in the Convention is drug enforcement. The only reference to drug enforcement in the convention is an obligation among States to cooperate to suppress drug trafficking. This is probably inadequate. In the United States and many other countries, drug enforcement is becoming a vital issue for which we are in search of a solution.

Maritime terrorism is another area that has taken on new significance since the conclusion of the 1982 Convention. Captain Greiveldinger cited a recently concluded IMO agreement on maritime terrorism. That agreement may or may not provide adequate tools to deal with the problem. It is certainly a good step in the right direction. Some people at this conference have mentioned to me that they thought that maritime terrorism will eventually be treated as a universal crime such as either piracy or the slave trade.

The United States is sufficiently satisfied with the implementation of the rules articulated in the Law of the Sea Convention that we are considering extending the terrritorial sea of the United States to 12 miles. This is a major step. This step is in a sense revolutionary because we were for a long time one of the greatest opponents of the 12 mile territorial sea. Indeed in 1983, Secretary of Navy John Lehman opposed explicit recognition of the 12 mile territorial sea, because of concern about how the straits provisions of the Law of Sea would be applied. Five years later, I think it is safe to say that we are sufficiently pleased with State practice that the United States may without concern feel comfortable in extending our territorial sea. [The territorial sea of the United State was extended by President Reagan on December 27, 1988, from 3 to 12 miles.]

With that I would conclude with the following thought. Whether a country is or is not a ratifier of this convention, if that country likes the rules negotiated during the Law of the Sea conference, that country would do well to nurture those rules, because if those rules are not protected scrupulously we will find that the rules that we worked so hard to achieve have slipped out from under us and we will be confronted with quite a different law of the sea regime than what we desire and indeed must have to protect our interests.

Burdick Brittin: I would pose for the panel three interrelated questions; they are: Is it to the advantage of the United States to have a great majority of developed and developing countries ratify the Law of the Sea Convention? The first related question is what are we, the U.S., doing to facilitate that ratification goal? If the answer to that question does not show a demonstrable and energetic program, then the closing question is what should we be doing to reach the goal noted in question one?

Brian Hoyle: I'll answer the question if you really want an answer to the question; I thought it was a statement, though. I think it's to this country's advantage that the rules in the Convention be accepted as widely as possible, outside of the seabed mining part. Obviously the position of this administration is that the seabed part needs to be changed. So it's to our advantage, on the one hand, that the non-seabed part of the convention be widely implemented and the seabed part not be implemented. If the Convention were implemented by a hundred developing countries and no developed countries, certainly the seabed part could not be implemented. I think universal acceptance one way or the other of the regime rules on navigation, overflight, continental shelf, EEZ and so on are advantageous and that means ratification of the Convention. It's certainly in our interest that that be done. We have never opposed ratification of the Convention, as I said last year in Honolulu.

Burdick Brittin: I note that there is no answer to the question of what we are doing or should be doing to facilitate the ratification of other countries, both developed and developing.

Brian Hoyle: I suppose it depends on what you consider to be facilitation. Does it mean understanding what the rights and obligations are of working with those countries so that when they make their archipelagic claims, or EEZ claims, or territorial sea claims they do it correctly, with the maximum amount of information and consultation among ourselves and with other user countries? The answer is, I think, we are facilitating implementation of the Convention and trying to facilitate countries' feeling comfortable with those rules, and comfortable that those rules achieve the balance that they thought they had achieved when they negotiated those rules.

That is what is most important. Countries will adhere to this Convention, ratified or unratified, as long as they feel that the Convention's rules satisfy the balance of interests that they have in the oceans. When it no longer does so, then the Convention will fall apart and we will be off to UNCLOS IV, V, VI or what have you, but it will work as long as the balance is maintained. I don't know that ratification is the most important point here.

Lee Kimball: I will direct this to Brian and Geoff Greiveldinger. Brian, you mentioned the importance of nurturing the rules of the Convention. Geoff, you mentioned that the rules continue to deal with change in scientific, technological, economic circumstances. My question is,

assuming limited resources on the part of the U.S. government, both in funding and staff, is there any clear set of priorities as to what would be done next within the U.S. government in that process? What would you stress, say, in relation to the IMO's study on further things that IMO can do, the U.N. Regional Seas Programme, the development of regional and global environmental protection, and other issues we've talked about here today and in the whole purpose of the conference?

Brian Hoyle: I can give you a glib answer and say one good thing about the territorial sea issue is we don't have to go away and don't need a travel budget to implement it.

Lee Kimball: I think that is domestic.

Brian Hoyle: -- but in all seriousness, each one of the issues that you cite are areas of implementation, and those don't necessarily require separate personnel and separate budgets; they are issues that we work on as they arise. There are a whole host of environmental negotiations going on, lots of safety negotiations, and IMO --

Lee Kimball: But is there a clear set of priorities as to how you develop what you will place more effort in?

Brian Hoyle: I don't know that we target specific areas. What we intended to do is target areas of opportunity. For example, on the implementation of Article 60.3 that Geoff mentioned, we had wrestled internally with that issue through 1980-81, had held extensive consultation with the oil industry and with government agencies that were interested and never really achieved any U.S. proposal we wanted to push forward. Then the Oslo Commission had the decency to submit a request to IMO that IMO take up the issue, which galvanized us into action and we were able to reach agreement, and then ultimately, agreement with the U.K., Norway, and with other interested parties in the IMO, so that in that sense a lot of what we do is to seize targets of opportunity.

Geoffrey Greiveldinger: I don't know that is I am in much of a position to respond since I come here on behalf of OSD, and I don't have the overall responsibility that Brian does. I am puzzled by the question, Lee, because the fact of the matter is that in as large an organization as the United States government and in as a large a country as the United States there are, as you well understand, a variety of interests and perceived impetuses for actions going on all the time. You are sitting next to Tucker Scully. Tucker's people have responsibility for marine scientific research within the State Department. Expanding opportunities for MSR for U.S. scientists is a priority with them and they are carrying on that responsibility, I think, in an admirable fashion, working on a bilateral basis with a couple of countries that have been particularly difficult. Is that on an itemized priority? I think Brian's right -- nobody that I know of has sat down and done a list but that is an item that is getting a great deal of attention now and I think it is going to bear some fruit in the fairly near term.

Brian Hoyle: Lee, I think one tends to look at what particular problem is either beneficial or even fixed in any particular time. One of the reasons why we did the EEZ at the time we did was in order to demonstrate to the rest of the world that we are playing with the same set of rules

that are in the Convention. The 12-mile territorial sea issue has been motivated by a number of reasons, not least of which is that after one of the well known incidents earlier this year a lot of confusion seemed to exist in this country about what the U.S. position was, what rules apply, and whether or not we're all operating under the same rules in this country and overseas. We tend to focus on problems that are in need of a fix and present an opportunity to fix. Some problems just *don't* present an opportunity to fix and you have to live with them until they are ripe to solve.

BANQUET SPEECH

Preparations for UNCLOS IV?

Edward L. Miles
Institute for Marine Studies
College of Ocean and Fishery Studies
University of Washington
Seattle, Washington

I have been assigned the theme of this address by the organizers of the 22nd annual meeting of LSI, but I want to insist that in my version of the title there exists a question mark and that question mark is crucial. This means that the general policy problem I wish to address is whether or not it is useful or desirable for the world community, and particularly the United States, to entertain the notion of setting in train preparations for UNCLOS IV. Since my answer to this question turns out to be negative, I pose the issue of what should be done in the alternative.

I shall attempt to answer these two general questions by posing and responding to five questions of greater specificity. These are:

1) what conditions drive States to pursue large-scale codification and progressive development of international law in general and the law of the sea in particular?
2) do these conditions exist now?
3) if not, is it useful to talk about UNCLOS IV?
4) if not, how do we stabilize and facilitate entry-into-force of the 1982 Convention?
5) specifically, how do we get over the hurdle of U.S./U.K./FRG accession which acts as a significant constraint on widespread ratification of the Convention?

While my initial audience is that microcosm of the world community represented by those of us attending the 22nd annual meeting of LSI, I want to make it clear that my primary target is the next Administration in the United States, be it Republican or Democrat. It should be appreciated at the outset that what the United States decides will have particular significance for the way in which events will unfold in the near future. In this sense, to borrow a phrase from Ambassador Alan Beesley, we are at a "hinge of history" (Beesley, 1988) who stole it from Churchill.

What Conditions Drive States to Pursue Large-scale Codification and Progressive Development of International Law in General and the Law of the Sea in Particular?

Historically, at the level of the nation-state, national authorities pursued the process of codification of law as a means of facilitating the centralization of judicial administration and thereby their span of control. (Seagle, 1946). The method of doing so was to attempt a systematic presentation of existing law which would fuse the many and diverse interpretations into unitary rules. At the global level, however, there were continuing conflicts between those who perceived codification as responding solely to differences in existing

law and those who saw codification as necessarily including a law-making dimension.

In spite of this tension, participants were generally agreed on the functions of codification in the international system. States pursued codification in the international system. States pursued codification and development of international law because they sought greater precision in the norms devised to regulate particular types of behavior. Precision was sought not for its own sake but because it was assumed that agreement on what the law was removed a serious cause of conflict among them and increased the probability of compliance.

There has always been a very close connection between patterns of technological advance and global attempts to pursue codification and what is now known as progressive development of the relevant international law. It is worth recalling here that, as long ago as 1931, the late Judge Manley O. Hudson coined the term "international legislation" as he considered the output of a multitude of international conferences which attempted to regulate the use of new technologies requiring the detailed cooperation of States (Hudson, 1931). These began with the International Telegraphic Conference at Paris in 1864 and those which followed in the nineteenth century responded primarily to the introduction of steam transportation and telegraphic communication.

Today we would say that this process continues and is inevitable in a decentralized global system having to face up to the consequences of dealing with collective goods types of problems. Cooperation is necessary because full production of the benefits of the technology are often beyond the capabilities of any single State. At the same time, utilization of the technology produces negative externalities which must be minimized, controlled or compensated for.

The codification and progressive development of international law is therefore a process of authoritative decision-making in the global system. The decision to trigger this process in any particular instance is not one which States undertake lightly. It is costly in both time and money; the choices to be made with respect to particular norms bear directly on the interests and values sought by States and their constituencies; while uncertainty as to ultimate outcome is ever a fact of life, too much uncertainty means the problem is not yet ripe for solution at that particular moment in time. Remember that the objective to be served is facilitating agreement on what the law is or on what law to create as a means of reducing conflict and increasing compliance. The outcome is an international convention which awards rights and imposes obligations on States and international organizations *vis-a-vis* particular types of interactions.

But we have here a dilemma. Because the outcome of codification attempts is usually an international convention requiring intergovernmental agreement and acceptance to be binding, this "...has greatly added to the difficulty of obtaining such agreement in the formulation of general rules or principles." (Liang). Given this difficulty, the rule of thumb which emerged early in the U.N. experience with codification was that the convention method should be attempted only when the need for legislative reform was so obvious and pressing that it cannot be ignored or when the international community is faced with the concerted demands of a significant group of States.

Do These Conditions Exist Now?

I submit to you that it is patently clear that the conditions which justify triggering yet another codification conference on the law of the

sea do not now exist and would exist only if we were to allow the United Nations Convention on the Law of the Sea of 1982 to disintegrate. The world has recently completed ten years of arduous and often acrimonious work on a new regime for the oceans. Most of that Convention achieved consensus among 155 nation-states, a feat which I certainly did not think was possible for most of those ten years.

It is very difficult for me to see how, given that experience, one can entertain hopes of achieving a better balance of competing interests in any alternative forum or process. To put one's hopes on customary international law is to lend support to forces which already are working in the direction of eroding the consensus and the balance which was achieved. The inevitable result of this will be further creeping jurisdiction.

It should be admitted here that the dynamic of creeping jurisdiction is always with us and would be at work even if the Convention of 1982 were now in force. This dynamic arises out of the conjunction of technological advance and people's expectations about the effects of technological advance *vis-a-vis* the interests they are seeking to protect or enlarge. But, I think that John Knauss is right when he says that a generally accepted Convention is the best means we have of slowing down the rate of creep. (Knauss, 1985). Customary international law as a process fertilizes rather than constrains the rate of creep.

We should keep in mind that only Part XI of the Convention is at issue; that only three important States in this regard are non-signatories; and that there is not likely to be any commercial deep seabed mining outside national jurisdiction within the lifetimes of anybody attending this Conference, even the youngest student among us.

If Not, Is It Useful To Talk About UNCLOS IV?

I would say two things in this connection. First, it is not useful to talk now about UNCLOS IV. What we face is *unfinished business* from UNCLOS III. There was, in April, 1982, a large dog which did not bark in the night. I refer here to a negotiation between the U.S. and the Group of 77 on President Reagan's Six Points, which by then had become Ten. The negotiation did not occur as a result of a fierce, and sometimes near violent, internal war in the U.S. Delegation which produced the counterproductive "Green Book." The Group of 11 or "Friends of the Conference" stepped into this breach but the negotiation with the U.S. never took place. This is what I think we should aim at facilitating but before I deal with this issue, I wish to make a second point.

Not only is it not useful to talk now about UNCLOS IV, in fact, it is downright dangerous. It is dangerous because there are significant points of potential instability within the consensus underlying the rest of the treaty. These points of potential instability would encompass the interests of the coastal States and territorialist groups vis-a-vis the status of the EEZ, some of the straits States group *vis-a-vis* the concept of transit passage, all of the above *vis-a-vis* the issue of passage of warships in the EEZ and in Straits, and the land-locked and geographically-disadvantaged group.

Let us recall for a moment that when the USSR suggested to the U.S. in 1966 that a Conference be convened to settle the issue of the territorial sea left unresolved by the 1958 and 1960 Conferences, the only other major complications foreseen by the U.S. were the questions of straits and coastal State jurisdiction over fisheries beyond twelve miles.[1] I have been told by former U.S. government officials that only the U.K. was consulted by the U.S. at that point and the U.K. argued

that convening such a Conference was a Pandora's Box which, if it was not concluded in two years, would probably go on for ten. This was a remarkably prescient observation by Her Majesty's Government because the nature of the international system was changing decisively at that point. It was another "hinge of history" which neither the U.S. nor the USSR fully appreciated and the result was a List of Subjects and Issues which put the entire law of the sea on the agenda.

My point is that an UNCLOS IV will be another Pandora's Box in which *no one* will have control of the agenda but in which groups having significant quarrel with parts of the 1982 Convention would be seeking to renegotiate their interests. The tactics of the Latin American Group on the 200-mile regime and the Archipelagic States Group on the archipelagic regime between 1958 and 1974 are instructive lessons in this regard. One can predict with virtual certainty that if an UNCLOS IV were to be convened, it would *not* be limited to a renegotiation of Part XI and it is difficult to see how the U.S. could do better than it did in UNCLOS III.

If Not, How Do We Stabilize and Support Entry-Into-Force of the 1982 Convention?

The question as posed here assumes that there is a problem and that the urgency of the need for a concerted response is growing. One finds this position in recent work by Lewis Alexander (1986) at least by inference, and Alan Beesley (1988) who states his concerns directly. I share their concern. The current U.S. position denies that there is a problem. The U.S. argues that the dire predictions which were made when the U.S. rejected the treaty in 1982 have not materialized, that the U.S. is not disadvantaged by not being a signatory, and that U.S. interests can be protected by relying on evolving customary international law as represented by the non-Seabed portion of the treaty.

I wish to argue that there is a time-bomb and it is ticking away in the very engine of customary international law, i.e., state practice, on which the United States purports to rely. And it must be said bluntly that the U.S. claim that all of the non-seabed portion of the treaty represents customary international law simply cannot be supported and therefore costs the U.S. credibility. Concepts like transit passage, archipelagic sealanes passage, the regime of archipelagos,[2] the exclusive economic zone and the like did not exist prior to the Third United Nations Conference on the Law of the Sea and are indistinguishable from it. These could not have been customary international law prior to the 1980s. The development of customary international law is a slow and diffuse process and is always messy since there are always disagreements on what the law is. It is not an express train. These concepts, to which I referred, have clearly been the result of the progressive development of international law which get their force from the parent Convention of 1982.

But, even if, for a moment, we were to accept the U.S. position and put our faith in customary international law we would find it to be a very frail reed instead. Alexander's recent exhaustive survey concludes that, with respect to restrictions on navigation within the new ocean regime, the world is in a period of regulatory uncertainty and that it is likely to move in the direction of widespread inconsistencies with the Convention, as far as State practice is concerned. He also hypothesized that these "illegal" rules and regulations would be driven by a variety of concerns ranging from environmental protection to national security, political/ideological protests, and limited wars, *inter alia*.

Alexander's prediction takes on especial urgency when one looks at the actual record of recent State practice. One finds regulation and statements of policy inconsistent with the Convention with respect to the following list of items:

1) Passage of warships in the territorial sea, limitations on innocent passage. (National Legislation).
2) Declarations of policy concerning limits on transit passage and archipelagic sealanes passage in straits used for international navigation.
3) Enactment of territorial seas beyond twelve miles. (National Legislation).
4) Impermissible baselines. (National Legislation).
5) Enactment of continental shelf limits beyond permissible widths. (National Legislation).
6) Declarations of policy and regulations concerning limits on navigation in the exclusive economic zone.

How is it possible to find any comfort in this list and how can one infer that things are going well and there is no need to be concerned?

There is an even bigger problem looming on the horizon which has to do with straddling stocks. Fisheries interests have been the major driving force of pressures for extensions of coastal State jurisdiction since the Hague Codification Conference of 1930. These pressures are once again emerging over the problem of distant-water fleets fishing on stocks which straddle EEZs and high seas areas. As the conflicts heat up, parties on both sides become emotional and there are great pressures on the coastal State to extend its jurisdiction over fishing beyond 200 miles. One can see this now with respect to Canada in the Northwest Atlantic, the U.S. and the USSR in the Bering Sea and Chile and Argentina in the Southeast Pacific and Southwest Atlantic. So far governments have resisted these pressures but, even within the superpowers, who have most to lose in terms of their navigational interests, one sees the most bizarre kinds of bases to claims being entertained internally.

As I watched in some detail the development of the conflict in the Bering Sea between Japan, on the one hand, and the U.S. and USSR on the other, I was driven to the reflection that following the termination of UNCLOS III, most coastal States have dismantled their teams and have thereby lost the capability to look at the whole package of issues affected by particular incidents. This loss of capability means that nuanced responses are hard to achieve. All application is now driven by sectoral interests most of whose representatives were not involved in negotiating the Convention. As such, these interests are defined very narrowly and are uninformed by the larger context of what is at stake. The general tendency of implementing the new law of the sea by coastal States is therefore always subversive of the balance achieved in the text of the Convention. Eternal vigilance is the price of maintaining that balance.

The United States Government has itself issued more than forty protests between 1981 and the present on all of the items identified above, but how significant are these protests when the U.S. rejected the treaty and its claim that the non-seabed portion of the treaty represents evolving customary international law is rejected by most of the rest of the world?

Apart from symbolic protests, the U.S. has only two other instrumentalities available. The first is exercise of and insistence on its

rights by U.S. vessels, particularly warships and aircraft, in particular situations and the second is the use of force. Both have been resorted to recently. Exercise of rights is an effective instrument at the price of some escalation in the conflict. But the use of force has high costs attached and cannot be resorted to on a routine basis. By not being a signatory to the treaty, the United States has discarded two other instrumentalities: the first is concerted action with other major treaty partners to apply diplomatic pressure to achieve desirable shifts in State practice in conformity with the Convention; and the second is use of the dispute settlement procedures contained in the Convention *vis-a-vis* navigational issues particularly.

But even with respect to U.S. protests, we have available only a partial U.S. list of protests sent, but we have no information on replies received. More importantly, we have no information on other protests sent to the U.S. especially as a result of U.S. exercise of its rights. The U.S. continues to claim that there are no untoward consequences which flow from its rejection of the Convention, but even a cursory inspection of the evidence will refute this claim.

The clock is ticking. If we allow the Convention to disintegrate we will most assuredly end up with an ocean regime based on the national lakes approach sooner rather than later. One cannot achieve a better balance of coastal State and international law. On that dimension, coastal States hold almost all the cards. Since one can only be worse off, from a global and many national perspectives, without a Convention than with one, it is better to safeguard what we have than "...to be done out of altogether", to use the thirteenth century phraseology of the Bishop of Tyndale. We can safeguard what we have, and thereby slow down the rate of creeping jurisdiction, only if all major maritime countries are parties to the Convention and are willing to act in concert to preserve the balance contained therein.

We therefore cannot stabilize what we have achieved without the accession of the U.S., U.K., and FRG. But what does stabilization mean exactly? I have already conceded that the dynamics of creeping jurisdiction are always with us and would be at work even if the Convention were now in force. Some parts of the Convention are clear and unambiguous while others are anything but. Where ambiguity prevails, the meaning of the Convention will evolve from State practice but, as my colleague Professor William Burke argues,[3] the significance of the Treaty is that it helps to put a boundary around behavior and to constrain peoples' expectations about what is permissible. This serves to constrain authority and to limit the range of differences. Furthermore, to the extent that the dispute settlement mechanisms are utilized, this will also serve to moderate interpretations of the Convention. It is only in this way that we can slow down the rate of creeping jurisdiction.

How, Then, Do We Get Over the Hurdle of U.S./U.K./FRG Accession Which is Importantly Linked to Facilitating Widespread Ratification of the Convention?

The first step is a small one. The U.S. must participate as an observer in the deliberations of the Preparatory Commission (PrepCom) which is charged with elaborating detailed rules and regulations concerning seabed mining. As a signatory of the Final Act of UNCLOS III the U.S. has the right to participate as an observer of PrepCom even though it has refused to sign the treaty. The U.K. and the FRG have always exercised this right. But what should the U.S. do there and how should it be approached?

It should be noted first that the conditions underlying the push to seabed mining in the world of industry have now completely changed, and this would have occurred had the U.S. signed the treaty. As a result, many of the underlying assumptions of Part XI and Annex III no longer hold and would have to be revised. Since there is no likelihood of large-scale commercial mining of manganese nodules from the ocean floor in the near future, the primary lesson which we should learn from these drastically changed conditions is the great desirability of making flexibility in institutional design a basic criterion. Indeed, this is a point argued at some length in Caracas in 1974 by the Jamaican Delegation but it was the U.S. delegation who insisted on a detailed set of rules and regulations as a means of straight-jacketing the Seabed Authority.

The fact is that, *from a commercial point of view*, the net present value of manganese nodules is zero. However, the Group of 77 does not believe this for a least three reasons:

1) They distrust the advanced industrial countries who once sold them on the very bright near-term prospects for seabed mining. They see the current lack of enthusiasm in the industry as a means of inducing the Group to make major concessions in Part XI and Annex III primarily for the benefit of advanced industrial countries. Projections of a prolonged slump in the prospects for seabed mining are therefore dismissed as being tactically motivated.

2) The comprehensive Australian paper on the economic viability of seabed mining, introduced into PrepCom in 1986, which assesses very negatively the prospects for seabed mining, is seen to be primarily a device for dampening enthusiasm. While they think the model used, *per se*, is sound, they think that projects are very sensitive to the particular years which were chosen for analysis. The fact that 1986 was used as the base year, they argue, shows the selectivity of the model which, after all, was done in consultation with industry. 1986 represented the ebb of the market and does not reflect the situation when mining, in their opinion, is likely to take place, say 1995-2005. The group takes heart from the fact that prices of metals in the world market are now rebounding and are almost as high as in 1975.

3) The Group thinks that subsidies are highly likely in some quarters, particularly in Japan and, to a lesser extent, France and India. The real question then is who will mine, irrespective of commercial profitability? Japan has announced its intention to make a Go/No Go decision in 1991. The first date of mining, therefore, may be related more to technology development, where the U.S. has already been left behind, than to commercial criteria. What is most important is the question of State motivation and objectives, not the decision-making procedures of private consortia.

These differing perceptions are significant and should be kept in mind when we come to consider tactical approaches for facilitating resolution. The point to be made here is that the Group of 77 thinks that significant gains were made on Part XI and Annex III in the negotiations of UNCLOS III. They do not now agree that these gains have been devalued by changed market conditions facing seabed mining. The U.S. industry thinks that the net present value of nodules is zero and has dismantled its teams and fired Vice-Presidents. But to ask the Group of 77 to renegotiate particular items in Part XI and Annex III is to ask them to make concessions in principle without any commensurate conces-

sions being made on substantive items in return by advanced industrial countries. The only real concession is U.S./U.K./FRG accession to the treaty.

But, one could ask, if the net present value of nodules is zero from a commercial point of view, why should the U.S. bother with this issue at all at this time? Why not go along with the fiction that the rest of the Treaty represents evolving customary international law and ignore Part XI and Annex III? My reasons for insisting that the U.S. get back into the process are that the U.S. claims about customary international law will not withstand scrutiny; that there are already incipient trends of significant divergence from the norms enshrined in the treaty now evident in State practice; and that U.S. capability to respond to these trends while rejecting the treaty itself is weakened. Since there will be no large-scale commercial mining of manganese nodules until well into the twenty-first century (if then), the only reason to be bothered with Part XI now is to get the U.S. and others to accede, thereby facilitating widespread ratification within the coastal State community. This will go a long way to locking in the rest of the treaty as the law and it can be used to slow down the rate of creeping jurisdiction.

Furthermore, it is worthwhile noting that the definition of the limits of The Area as defined in Art. 1(1) and implied by Art. 76 would effectively control the problem of "creeping jurisdiction" beyond the continental margin. As such, this solution serves major U.S. security and commercial interests. The legal status of The Area, (Art. 137(1)) also serves these interests in that any claim or exercise of sovereignity or sovereign rights is proscribed. Articles 136 and 137 also establish and operationalize the principle of "the common heritage of mankind" in relation to mineral resources of The Area. The U.S., by stating its intention to pursue seabed mining unilaterally, outside the Treaty, rejects this status for manganese nodules. However, the U.S. has not declared an unqualified rejection of the common heritage principle relative to The Area, nor is it in the interest of the U.S. to do so. The point again is that this principle effectively serves U.S. security interests on the seabed beyond national jurisdiction and the U.S. may therefore wish to encourage its widespread use for other resources. Should a later accommodation on the current regime be possible, the principle should and would also apply to manganese nodules for the U.S.

Given the distribution of interests that I have just outlined, how should we frame the bargaining situation to produce the desirable result?

This question really breaks down into two issues: a) forum; and b) approach. With respect to the forum one could ask: Should it be the PrepCom or not? If not, what are the alternatives? An informal group attached to PrepCom? Completely outside PrepCom? If so, how do we transfer the results? I do not have the time here to go through the analysis of each of these questions individually, so I will simply state my conclusion and the justification for it. Because I am very sensitive to the problem of controlling the agenda, the asymmetrical interests surrounding the issue of renegotiating parts of Part XI and Annex III, and the intense passions and conflicts this issue generated at UNCLOS III, I think the renegotiation should be approached *through* Prepcom but not initially in it. The leadership of PrepCom would have to orchestrate both the current discussions inside and the informal discussions outside but, in this way, discussions outside could be brought inside whenever they were sufficiently ripe. To be sure, PrepCom has a narrow mandate at

present but that should not necessarily constrain informal discussions conducted outside PrepCom but under its auspices. Since PrepCom is a body established by the General Assembly, at the point at which agreement on a package of Treaty revisions were agreed upon by the principals, the matter could be taken to the Assembly for a decision on the procedure to be adopted. I think any approach which did not include PrepCom as the mechanism, would incur the severe distrust of the 77 and there would, as a result, be serious difficulty in transferring the results of the informal negotiations.

With respect to the approach to be adopted, one hears a wide range of alternatives being discussed on the circuit:

1) Negotiate outstanding items from the U.S. point of view.
2) Seek to achieve radical surgery of Part XI which, given very different conditions, is substantially flawed.
3) Try to find a means for "selectively applying" Part XI in which the basic ingredients of the treaty would be retained but the Annexes (especially the mining code) would be suspended in whole or in part.
4) Use the process of amendments to Resolution II to institutionalize an Interim Regime for the long term and ignore Part XI altogether.

I do not have the time to evaluate each of these alternatives in detail. Let me say, first, that I do not think any attempt at radical surgery, i.e., to roll back the operationalization of the common heritage idea contained in Part XI, would succeed. It would be perceived as the height of bad faith by the Group of 77; it would completely close this window of opportunity we now have in PrepCom for making changes; it would re-ignite the emotional confrontation which bedevilled the Conference on this issue for ten years; and it would threaten the balance in the Convention as a whole because it would create an incentive among opponents for re-opening the entire agenda to present rather unpleasant trade-off possibilities to advanced maritime countries. In a word, it would trigger UNCLOS IV.

With respect to the alternative of modifying Resolution II to institutionalize an Interim Regime in the long run, I think there are two serious shortcomings attached to this idea. There has recently been in PrepCom substantial flexibility in the Group of 77 on questions of amending parts of Resolution II to accommodate the interests of Pioneer Investors. This is certainly very helpful. But if this were to be seen as an attempt to take back the common heritage guarantees, it would be perceived as an attempt at radical surgery through the back door and would lead to a significant increase in conflict. Moreover, Resolution II does not provide a solution to our urgent problem.

Let us always keep in mind the commercial insignificance of seabed mining for a long time to come. There is no need to fight to the death over completely theoretical possibilities clothed in the costumes of high principle when these conflicts get in the way of solving problems which, on time scales much shorter than the eventuality of seabed mining, can indeed threaten vital interests at stake. The fact is that the long term institutionalization of Resolution II will decrease the incentive for the U.S., U.K., and FRG to sign and ratify the Convention. Consequently, it will reinforce the lack of ratification by significant coastal States and, as a result, it will feed the growing divergence between State practice and the Convention on crucial items.

I think a solution lies in the combination of the remaining ideas. Certain issues have to be renegotiated in order to entice the U.S., U.K.

and the FRG to sign and ratify the Convention and to entice other advanced industrial States which have signed the Convention already to ratify it. Changed conditions affecting the seabed mining industry now create the possibility of doing so. But, given the differing perceptions of interest and even the reality of changed conditions between the advanced industrial countries and the Group of 77, this renegotiation must be approached carefully. The U.S. should therefore focus on a limited set of issues, not the "Green Book", allowing the PrepCom process to work over time to modify the details.

Let us be clear now on the criteria for a solution. We have to find a way to revise parts of Part XI and Annex III in order to make the treaty as a whole acceptable to advanced industrial countries without triggering a major confrontation with a distrustful Group of 77, who nevertheless show willingness to be flexible. The result of the modifications must be flexible enough to permit seabed mining when and if prospects improve sometime in the distant future but not so detailed so that the effort is quickly rendered nugatory by the harsh reality of changing conditions.

We appear, at the moment, to be stymied by a "catch-22" situation. Many in the Group of 77 are currently willing to solve both the U.S. participation and institutional design problems but they do not want to pay the significant political concessions that will be required unless they are sure that the U.S. and other advanced industrial countries will come in. Consequently, they want clear assurances ahead of time from the U.S. that this will occur. The U.S., on the other hand, wants clear assurance from the Group of 77 beforehand that they are willing to give up a lot as the price for U.S. accession. Not surprisingly, nothing happens.

What is required is leadership. I suggest that a new U.S. Administration take two immediate steps with respect to the Convention. The U.S. should declare its intention to participate in PrepCom as an observer and it should declare its bottom line for changes in Part XI and Annex III. Since the substance is not really significant but speed is essential for other reasons, I suggest that the U.S. bottom line be President Reagan's initial six points stated at the conclusion of the 1981 review. Since the issues are limited, they can be fixed but I will refrain from a detailed analysis of exactly how they should be fixed.

Once the United States takes the two steps I have suggested, these issues can be discussed informally outside PrepCom. Once a sufficient foundation has been made, they can then be moved into PrepCom. At that level, when agreement has been arrived at, states parties can discuss the means of adoption. The point here is to get agreement on substance first and then worry about the mechanism of adoption. From that vantage point, the latter will not seem to be such a large problem.

I think the game I have suggested is definitely worth the candle. What is at stake is universal acceptance of the Convention of 1982 which includes, for the first time, a highly innovative and comprehensive package of compulsory dispute settlement procedures. I do not think we can easily achieve this again and I am sure that the global marine community, and the United States, will be much worse off without it. Let us have the vision to seize the opportunity.

NOTES

1. By 1968 the U.S. was also concerned about the outer limit of the continental shelf.
2. Ironically, if the archipelagic regime is not customary international law, the U.S. could claim with justification that, absent the treaty entering into force, those waters are high seas.
3. Private communication, June 7, 1988.

REFERENCES

Alexander, Lewis. 1986. *Navigational Restrictions Within the New LOS Context: Geographical Implications for the United States*, (Peace Dale, R.I.: Offshore Consultants, Ltd.).

Beesley, J. Alan. 1988. "The Future of International Oceans Management," Banquet Speech to the Workshop on Canadian Oceans Policy, the University of British Columbia, Vancouver, Canada, March 18, 1988.

Hudson, Manley O. 1931. *International Legislation*, Vol. I, (New York: Carnegie Endowment for International Peace).

Knauss, John A. 1985. "Creeping Jurisdiction and Customary International Law," Banquet speech at the Eighteenth Annual Meeting of the Law of the Sea Institute, in Robert B. Krueger and Stefan A. Riesenfeld (eds.). *The Developing Order of the Oceans*, (Honolulu: University of Hawaii Press, 1985), pp. 735-742.

Liang, Yuen-li. 1947. "The Progressive Development of International Law and Its Codification Under the United Nations," *Proceedings* of the American Society of International Law.

Seagle, William. 1946. *The History of Law*, (New York: Tudor Publishing Co.).

LIST OF PARTICIPANTS

Bernhard Abrahamsson
U.S. Merchant Marine Academy
Kings Point, New York

Tundi Agardy
Marine Policy Center
Woods Hole Oceanographic Inst.

Alexanda Albuquerque
Marine Resources
Brazil

Don Aldous
Dept. of Fisheries & Oceans
Research Allocation Branch
Halifax, Nova Scotia

Lewis Alexander
Dept. of Geog. & Marine Affairs
University of Rhode Island

Scott Allen
Law of the Sea Institute
University of Hawaii
Honolulu, Hawaii

Lee G. Anderson
College of Marine Studies
University of Delaware
Newark, Delaware

Steinar Andresen
Institute of Marine Studies
University of Washington
Seattle, Washington

Valerie Andrianov
Ministry of Merchant Marine
Moscow, USSR

Bjorne Aune
London School of Economics
London, United Kingdom

Rawle Baddaldo
World Maritime University
Malmo, Sweden

Megan Bailiff
Sea Grant Intern
University of Hawaii

D. James Baker
Joint Oceanographic Institute
Washington, D.C.

John Bash
Marine Office
University of Rhode Island

Awni Behnam
Assistant to Secretary-General
UNCTAD
Geneva, Switzerland

Martin H. Belsky
Dean
Albany Law School
Albany, New York

F. Joseph Bersch III
University of Wisconsin
School of Law
Milwaukee, Wisconsin

Richard Bilder
University of Wisconsin
School of Law
Madison, Wisconsin

Cameron C. Bilger
Los Altos Hills, California

John Botzum
Nautilus Press, Inc.
Washington, D.C.

Raymond C. Bourgeois
Department of Fisheries & Oceans
Gatineau, Canada

William Brewer
Council on Ocean Law
Washington, D.C.

James Broadus
Marine Policy Center
Woods Hole Oceanographic Institute
Woods Hole, Massachusetts

Richard Burroughs
University of Rhode Island

Philippe Cahier
Geneva, Switzerland

Cynthia Carlson
Marine Policy Center
Woods Hole Oceanographic Institute
Woods Hole, Massachuestts

Ralph Chipman
Outer Space Affairs Division
United Nations Secretariat
New York, New York

Walter Clark
Sea Grant Program
University of North Carolina
Raleigh, North Carolina

Robert Corell
National Science Foundation
Washington, D.C.

Clifton Curtis
The Oceanic Society
Washington, D.C.

J. Armand Desroches
Dept. of National Defense
Ottawa, Ontario

Meinhard Doelle
Int'l Inst. for Transportation
and Ocean Policy Studies
Halifax, Nova Scotia

Alan Driscoll
Ocean Techical Systems
North Kingston, Rhode Island

Edward D. Eddy
University of Rhode Island
Kingston, Rhode Island

Judith Fenwick
Woods Hole Oceanographic Inst.
Woods Hole, Massachusetts

Frank Gable
Woods Hole Oceanographic Inst.
Woods Hole, Massachusetts

Edward Cannon
U.S. Coast Guard
Washington, D.C.

Daniel Cheever
Editor
Ocean Dev. & Int'l Law
Boston, Massachusetts

Aldo Chircop
Int'l Inst. for Transportation
and Ocean Policy Studies
Halifax, Nova Scotia

Thomas A. Clingan, Jr.
University of Miami
School of Law
Coral Gables, Florida

John P. Craven
Law of the Sea Institute
University of Hawaii
Honolulu, Hawaii

Ruguang Dai
State Oceanic Administration
Dept. of Marine Sci. & Tech.
Beijing, China

E. Dolly Dieter
University of Alaska
Seward Marine Center
Seward, Alaska

William Dolan
Dept. of Political Science
Salem State College
Salem, Massachusetts

Robert Duce
Graduate School of Oceanography
University of Rhode Island

Danny Elder
IUCN
Switzerland

Brit Floistad
The Fridtjof Nansen Institute
Oslo, Norway

Francalanci Giampiero
Italy

Martin Glassner
Southern Connecticut University
Department of Geography
New Haven, Connecticut

Ray Godin
CCCO
Paris, France

Edgar Gold
Int'l Inst. for Transportation
and Ocean Policy Studies
Halifax, Nova Scotia

Vladimir Golitsyn
U.N. Secretariat
New York, New York

Geoffrey Greiveldinger
OASD/ISA(PA)LOS
Washington, D.C.

James J. Griffin
NBC Technical Services Bldg.
Narragansett, Rhode Island

Jack Grunawalt
Naval War College
Newport, Rhode Island

Mark Gustafson
Tiverton, Rhode Island

George Haimbaugh, Jr.
University of South Carolina
School of Law
Columbia, South Carolina

Lynne Carter Hanson
Center for Ocean Management
University of Rhode Island

Jeremy Harrison
Richardson School of Law
University of Hawaii
Honolulu, Hawaii

Roger Herrera
BP America
Washington, D.C.

Ken Hinga
Graduate School of Oceanography
University of Rhode Island

Rick Hoos
Calgary, Alberta

Matsushiro Horiguchi
Ocean Division
Ministry of Foreign Affairs
Japan

Brian Hoyle
Oceans Law and Policy
Washington, D.C.

Tsu-Chang Hung
Academia Sinica
Law Sea Institute
Taipei, Taiwan

Carol Dryfoos Hunter
Center for Ocean Management
University of Rhode Island

Judge Robert Jennings
Cambridge, United Kingdom

M. Casey Jarman
Richardson School of Law
University of Hawaii
Honolulu, Hawaii

Lawrence Juda
University of Rhode Island
Dept. of Marine Affairs
Kingston, Rhode Island

Caroline Karp
Narragansett Bay Project
Providence, Rhode Island

Dana Kester
University of Rhode Island

Lee Kimball
Council on Ocean Law
Washington, D.C.

Viktor Kiselev
Moscow, USSR

John Kindt
University of Illinois
Mahomet, Illinois

John A. Knauss
Saunderstown, Rhode Island

Dale C. Krause
UNESCO
Division of Marine Science
Paris, France

Tadao Kuribayashi
Keio University
Japan

Maivan Clech Lam
Law of the Sea Institute
University of Hawaii
Honolulu, Hawaii

David Larson
University of New Hampshire
Dept. of Political Science
Durham, New Hampshire

James Lawless
National Oceans and Atmospheric Administration
Washington, D.C.

Moussa Bolar Ly
United Nations
New York, New York

F.R.J. Maes
State University of Ghent
Ghent, Belgium

Thomas Malone
St. Joseph's College
W. Hartford, Connecticut

Gerard Mangone
University of Delaware
W. Hartford, Connecticut

Jan Magne Markussen
The Fridtjof Nansen Institute
Lysaker, Norway

Juliao V. Mauele
World Maritime University
Malmo, Sweden

Alasdair D. McIntyre
Aberdeen Marine Laboratory
Aberdeen, Scotland

Richard McLaughlin
Sea Grant Legal Program
University, Mississippi

Evelyne Meltzer
Int'l Center for Ocean Development
Halifax, Nova Scotia

Thomas Mensah
International Maritime Organization
London, United Kingdom

Edward Miles
Institute for Marine Resources
University of Washington
Seattle, Washington

Joyce E. Miller
Seabeam
University of Rhode Island

Charles Morgan
Research Corporation
University of Hawaii
Honolulu, Hawaii

Joseph R. Morgan
Environ. and Policy Institute
University of Hawaii
Honolulu, Hawaii

Peter Mushkat
Int'l Inst. for Transportation and Ocean Policy Studies
Halifax, Nova Scotia

Satya Nandan
Ambassador
United Nations
New York, New York

Dolliver Nelson
U.N. Secretariat
New York, New York

Myron Nordquist
Attorney
Washington, D.C.

Anne Orcutt
Sea Grant Extension
University of Hawaii
Honolulu, Hawaii

Willy Ostreng
The Fridtjof Nansen Institute
Lysaker, Norway

Randall Prime
Int'l Inst. of Transportation
and Ocean Policy Studies
Halifax, Nova Scotia

Jean-Pierre Queneudec
Chatany Malabry
France

Alison Rieser
University of Maine
School of Law
Portland, Maine

Vernon Ross
Sea Grant Intern
University of Washington

R. Tucker Scully
OES/OPA
Department of State
Washington, D.C.

Sequoia Shannon
Environ. & Policy Institute
East-West Center
Honolulu, Hawaii

Leslie Shoales

E. Somers
State University Ghent
Ghent, Belgium

Jennifer Nicholson
Marine Policy
Guildford, United Kingdom

Stephen Olsen
Graduate School of Oceanography
University of Rhode Island

Francisco Orrego Vicuna
Inst. of International Studies
Santiago, Chile

Robert Pietrowski
Attorney
Washington, D.C.

Donald Pryor
Nat'l Oceans & Atmospheric
Administration
Rockville, Maryland

S.I. Rasool
NASA Headquarters
Washington, D.C.

David Ross
Dept. of Geology & Geophysics
Woods Hole Oceanographic Inst.
Woods Hole, Massachusetts

Frank Russo
U.S. Naval War College
Newport, Rhode Island

H. Segers
The Hague, The Netherlands

Kenneth Sherman
NMFS/NOAA
Narragansett, Rhode Island

Armand Silva
Department of Engineering
University of Rhode Island

Alfred H.A. Soons
Netherlands Institute for the
Law of the Sea
Utrecht, The Netherlands

Rafael Steer-Ruiz
General Secretary
Colombia Oceanographic Comm.
Bogata, Colombia

Howard Strauss
Dept. of External Affairs
Ottawa, Ontario, Canada

Judith Swan
South Pacific Forum
Solomon Islands

Martha Taylor
Seton Hall University
School of Law
Lawrenceville, New Jersey

Geir Ulfstein
Tromsoe, Norway

Jon Van Dyke
Richardson School of Law
University of Hawaii
Honolulu, Hawaii

Peter Varghese
First Secretary
Australian Embassy

Jonathan Waldron
U.S. Coast Guard
Washington, D.C.

Miranda Wecker
Council on Ocean Law
Washington, D.C.

Delores Wesson
Merchant Marine & Fisheries
Washington, D.C.

Edward E. Wolfe
Ambassador
Ocean & Fisheries Affairs
Washington, D.C.

Dana Yoeger
Woods Hole Oceanographic Inst.
Woods Hole, Massachusetts

Carol Stimson
Law of the Sea Institute
University of Hawaii
Honolulu, Hawaii

Jon G. Sutinen
Kingston, Rhode Island

Ian Townsend-Gault
Faculty of Law
Dalhousie University
Halifax, Nova Scotia

Tullio Treves
Permanent Mission of Italy
New York, New York

Stella Maris Vallejo
Ofc. for Ocean Aff. and LOS
United Nations
New York, New York

David Vanderzwaag
Dalhousie Law School
Halifax, Nova Scotia

Philomene Verlaan
Law of the Sea Institute
University of Hawaii
Honolulu, Hawaii

Ferris Webster
College of Marine Studies
University of Delaware
Lewes, Delaware

Conrad Welling
Ocean Minerals Company
Santa Clara, California

Greg Withee
NODC
Washington, D.C.

Jahara Yahaya
Faculty of Econ. & Admin.
University of Malaysia
Kuala Lumpur, Malaysia

Richard Young
Van Hornesville, New York

INDEX

Achille Lauro 205, 446
Africa, Law of the Sea Treaty 228
airships 166, 167
Alaska 71-76 71
  Arctic National Wildlife Refuge 75
  Beaufort Sea 71, 72, 78
  Bowhead whale 72
  causeways 73-75
  Inupiat Eskimos 71
  OCSL 71-73
  oil and gas development 71-76
  oil and gas development future 73-76
  oil decline 76
  Prudhoe Bay (decline) 75
Aldous, Don 153
Alexander, Lewis 3, 4, 411
Andrianov, Valery 405
Antarctic 101, 136-148, 194
  CCAMLR (Convention) 140-147
  fisheries 139
  Polar Convergence 136, 140
  Scientific Committee on Research 138, 139
  Treaty 139, 140
aquafarming 41
archipelagic states 443
Arctic National Wildlife Refuge 71, 75
Area 45, 46, 135, 498
  deep ocean mining 45
  ocean technology 46
Argo Jason 80-82
Army Corps of Engineers 74
artificial islands 42, 43, 67
  Canada 67
Aune, Bjorn 194, 430, 431
Australia 43, 151, 152, 160, 161, 169
  marine surveillance 151, 161
  Pacific Patrolboat Program 151, 160
  Royal Navy 151, 160
  surveillance training 169
Bailiff, Megan 25
Bascomb, Willard 36
Beaufort Sea 61, 62, 66, 67, 71, 72, 78
  Alaska 71, 72, 78
  Canada 61, 62, 66, 67, 78
Behnam, Awni 213, 214, 234, 235
Belgium 299, 300
Belsky, Martin 115, 148
Bering Sea 95
Berkner, Lloyd 17

Bilder, Richard 78, 431
biogeochemical cycling 20
biomass 97-100, 108, 139
  Georges Bank 108
  international programs 139
  yields 97, 98
Botzum, Jack 25, 34, 320
Britten, Burdick 234, 485
Brown, Harrison 17
Brundtland, Gro 19
Cahier, Philippe 412, 432, 435, 436
Canada 61-70, 72, 78, 89, 90
  artificial islands 67
  Beaufort Sea 61, 62, 66, 67, 78
  Berger Commission 65
  DEW Line 63
  floating drilling systems 68
  fur trade 62, 63
  MacKenzie Delta 61, 62, 66, 67
  Molikpaq 68
  oil and gas development 61, 62, 64-70
  oil transportation 70
  production facilities 69
  Tarsuit Island 67
  whaling 62
Carlson, Eric 360, 388, 400, 401
CCAMLR (Convention) see p. 515
Charney, Jule 17
Chile 425
China 342, 343, 344
  international research 344
  ocean data collection 342, 343
  State Oceanic Administration 342
Chipman, Ralph 242
Chircop, Aldo 435
chloroflurocarbons 29
Clingan, Thomas 441
coastal area management 368-383, 396, 397, 401
  difference between ocean management 376
  evolution of 368, 371
  exclusive economic zone 378
  initiatives 369, 370
  lessons learned 375, 376
  major issues 380, 381
  South Pacific islands 378
  state initiatives 382, 383
  United Nations 372-374
coastal planning 388
Coastal Resources Management 390-395
coastal states 37, 38, 44, 45, 207, 294, 305, 308
  Law of the Sea Convention 37, 38
  marine scientific research 294, 305
  ocean technology 45

coastal states (continued)
technology 38, 44
Committee on Climatic Change and Oceans 337
Committee on Earth Sciences 30
Committee on Geophysical Data 345-347, 352
federal coordination 347
principles 347
contiguous zone 39
technology 39
Convention for Registration of Ships 217-219
Convention on Conservation of Antarctic Marine Living Resources (CCAMLR) 101, 137-148, 194
ad hoc groups 145
conservation strategy 147
data collection 142-145
ecosystem monitoring 146
fish stock assessment 145, 146
implementation 144
krill research 145
Law of the Sea Convention 148
science and policy 138
Scientific Commission 143-147
Convention on the Continental Shelf 445
Convention on the High Seas 271
Cook Islands 158, 159
Corell, Robert 27, 34, 35
Couper, Alastair 199, 213, 235
Craven, John 36, 50, 51, 89, 321, 352, 433, 434
CSS Alabama 85
Cuba 313
Curtis, Clifton 271
Davis, J. G. 222
deep seabed minerals
manganese 59, 77
polymetallic 55
trends in exploitation 57
deep seabed mining 9-11, 45, 466-478, 497
Denmark 300
developing countries 219-226
shipping 219-222, 224-226
shipping modernization 225, 226
shipping policies 219-222
DEW Line 63
drug interdiction 39
Dryden, Hugh 17
Duce, Robert 15
Earth Observing System 20
Eckart, Carl 17
ecosystem 105, 109, 115-121, 141, 142, 146, 194, 277, 278
CCAMLR (Convention) 141, 142, 146
comprehensive approach to 117
international law 118, 120, 121
Law of the Sea Convention 119, 121

ecosystem (continued)
Northeast Continental Shelf 109
ocean commons 118
radioactive waste 278
U.S. (table) 105
El Nino 27
Elder, Daniel 92, 319, 397, 398
energy 201, 248, 250, 273, 469
environment, see: marine environment
environmental protection, international law 117
Europe 210, 305
European Space Agency 339
exclusive economic zone 8, 40-44, 50, 95, 97, 98, 142, 150, 151, 153, 154, 155, 161, 172, 173, 175, 182, 188, 191, 207, 378, 380, 443
artificial islands 43
coastal area management 378
large marine environment 97
law enforcement 150-152
Law of the Sea Convention 97, 98, 207, 443
living resources conservation 142
Malaysia 172, 173, 175, 182, 188
marine surveillance 153, 155, 161
municiple sovereignty 44
ocean technology 42-44
Okinotorishma 42
South Pacific islands 154
surveillance costs 191
surveillance over 151
technology 40, 41
U.S. 95, 98
extended jurisdiction 117, 191
claims 191
ecosystems 117
Fenwick, Judith 308
fiber optics, see: technology
floating drilling systems 68
Forum Fisheries Agency 151-157, 160-170, 192
airships 166, 167
Distant Water Fishing Nations 156
fisheries surveillance 192
formation of 154
information systems 165
INTELSAT 165
marine surveillance 151, 161, 162
multi-lateral treaties 157
observer program 162
regional telecom network 164, 165
structure of 155
surveillance capabilities 160
surveillance meeting 162
surveillance programs 167-170, 192
surveillance technology 163-166

Forum Fisheries Agency (continued)
surveillance training 163
vessel registration 156
France 85, 164, 300
SPOT 164
U.S. 85
freedom of navigation 204, 229, 232, 449, 451
freedom of overflight 229
Friedman, Herbert 17
Geographic Information Systems 388
Geophysical Data: Policy Issues 345-348
Georges Bank 100, 108
GESAMP Reports 398, 399
Global 2000 Report 97
global change 20, 27, 30-32, 100, 335, 352, 354
marine environment 100
Global Change Committee 20
Global Change Program 30-32, 335, 352, 354
United States 31
global climate change 333, 334, 337-341
lack of understanding 333, 334
predictions 337
programs 337-341 337
Global Positioning System 58
Godin, Raymond 337
Gold, Edgar 89, 90, 200, 234
Goody, Richard 18
Great Meteor East 251
Greece 301
greenhouse effect 27, 353
Greiveldinger, Geoffrey 442, 486
Griffin, James 285
Gros, Judge 413
Grunawalt, Richard 228, 229, 235, 236
Guinea-Guinea Bissau case 417, 421, 435
Gulf of Maine case 413, 416-418, 420, 421, 423-427
International Court of Justice 416, 417, 421, 427
equitable criteria 421
Hamilton, Douglas 322
Hawaii 329, 377, 379
Ke'ahole Point 41, 50
ocean management 377, 379
University of Hawaii 329
Herrera, Roger 26, 71, 78
Hinga, Kenneth 245
Hoos, R.A.W. 61, 78
Hoyle, Brian 84, 90-92, 481, 485, 486
induced polarization 58
INF Treaty 37
innocent passage 37, 38, 206, 449
INTELSAT 165
Intergovernmental Oceanographic Commission 28
International Biological Program 17

International Council of Scientific Unions 18, 19, 30, 333-336
international efforts 336
research priorities 334, 335
International Court of Justice 412-428, 430-436
Dubai-Sharjah Arbitration 415
French-English Arbitral Tribunal 415
Guinea-Guinea Bissau case 417, 421, 435
Gulf of Maine case 413, 416-418, 420, 421, 423-427
LOSC Article 83 414
Libya Malta case 415, 417-422, 424, 425
Libya Tunisia case 413, 424, 426
maritime delimitation 413, 415, 416, 417-420, 422, 424-428, 430-433, 435
North Sea Continental Shelf case 414, 418, 423, 424
International Decade of Ocean Exploration 15
International Geosphere-Biosphere Program 18, 19, 30, 239, 334
International Law Commission 430
international law 117, 118, 119, 120, 121, 231, 412-430
ecosystem management 120, 121
ecosystem model 118, 119
environmental protection 117
law of neutrality 231
maritime delimitation 412-420, 422, 424-428, 430
U.S. 120
International Marine Science Cooperation Program 315
International Maritime Bureau 214
International Maritime Organization 200, 208, 210, 234, 445
Law of the Sea Treaty 208
marine pollution 208, 210
MARPOL 73/78 210
ocean platforms 445
international shipping, see: shipping
International Union for Conservation of Nature 388
International Whaling Commission 149
Inupiat Eskimos 71
Iran Iraq war 203, 204, 230, 231-233
exclusion zones 233
Gulf attacks 231, 232
Ireland 301
Iselin, Columbus 17
Italy 301
Japan 41, 42
aquafarming 41
Okinotorishima 42
Jeanette Diana 157, 158
Johnson, Alastair 40
Ke'ahole Point 41, 50
Kimball, Lee 359, 395, 400, 401, 485, 486
Kiselev, Victor 405
Knauss, John 25, 149, 291, 321, 354, 398, 399
Krause, Dale 34, 320, 354, 397
landlocked states 304
large marine environment, see: marine environment

Larson, David 236
Law of the Sea Convention 6, 8-11, 33, 36-39, 47, 55, 79, 84, 86, 87, 88, 97, 98, 115, 119, 121, 135, 136, 141, 142, 148, 154, 200, 216, 272, 279, 293, 294, 303, 304, 359, 405-407, 414, 436, 441, 443-447, 449, 450, 454-456, 460, 461, 462-464, 469, 481-485, 491, 493-500
Africa 228
archaelogical artifacts 79, 87
archipelagic states 443
Article 17 209
Article 19 37
Article 21 206
Article 22 206
Article 26 207
Article 36 436
Article 41 207
Article 43 207
Article 53 207
Article 56 207
Article 61 142
Article 67 136
Article 83 414
Article 94 216
Article 33 39
Article 119 142
Article 123 135
Article 136 87
Article 149 87, 88
Article 157 87
Article 194 206, 208, 272
Article 197 136
Article 211 208
Article 217 209
Article 218 209, 210
Article 220 209
Article 246 47
Article 252 303
Article 303 86-88
CCAMLR (Convention) 148
coastal states 37
changing realities 441-500
coastal states 38
deep seabed minerals 55
dispute settlement 47, 456
distress assistance 232
disused platforms 445
ecosystem management 119, 121
exclusive economic zone 8, 97, 98, 207
expanded obligations 359
flags of convenience 216
international agreements 405
International Court of Justice 414
International Maritime Organization 208

Law of the Sea Convention (continued)
international shipping 200
large marine environment 136
living resources conservation 141
marine environment 359
marine pollution 208-210
marine scientific research 8, 293,
MARPOL 73/78 406, 407
navigation 443
overflight 443
Part XI 10, 279, 497-500
Part XII 272
radioactive waste 272
ratification urged 279, 496-498, 500
science policy 33
shipping 205-207
shipwrecks 84
South Pacific islands 154
technological anachronism 36
terrorism 446
United States 235, 494, 496, 498, 500
warships 37
Liberia (note) 227
Libya Malta case 415, 417-422, 424, 425
Libya Tunisia case 412, 413, 424, 426, 430
International Court of Justice 430
liquid natural gas 201
London Dumping Convention 273-276, 278
Lugo, Ariel 393
MacKenzie Delta 61, 62, 66, 67
Maitland, Guy 219
Malaysia 171-190, 192, 376
coastal area management 376
exclusive economic zone 172, 173, 175, 182, 188
fisheries legislation 171-174
fisheries zones 174, 175
fishery enforcement 176-181, 183, 184, 186-189, 192
foreign fishing vessels 173
GEWILLA 177, 178
Marine Police 176
MECC 176
NMCC 176, 177
Royal Navy 176, 179
surveillance activities 182, 183, 184
surveillance program 179-181
Thai fishermen 189
vessel apprehensions 185
Marshall Islands 159
Malone, Thomas 17, 25, 26
Mangone, Gerard 90
marine ecosystem 115-117, 119-121, 142, 194
marine ecosystem model 115-122
implementation 119-121

marine ecosystem model (continued)
Law of the Sea Convention 115
national sovereignty 116
sovereignty 117
marine environment 97-101, 135, 136, 137, 149, 361-366
anthropogenic impacts 361
coastal areas 363
eutrophication 364
future impact on 366
global change 100
habitat damage 365
hinterland areas 363
large marine environment 97, 98, 100, 101, 135, 136, 137, 149
living resources 363
non-living resources 362
oil exploitation 362
pollution 361, 362
present state of 365, 366
public health concerns 363, 364
transportation 361
waste disposal 361
marine fisheries, Malaysia 171
marine pollution 206-211
International Maritime Organization 208, 210
MARPOL 73/78 210
shipping 208
marine science 15, 22, 27, 315
global change 27
see also: oceanography
marine scientific research 8, 46, 47, 291-297, 299-305, 308-313, 315-317, 319, 321, 444
access 291
Belgium 299, 300
clearance requests 304
coastal states 294, 305
data stream 291, 292
definition of 302, 303
Denmark 300
DUMOND 46, 47
European experience 293
European state practice 305
France 300
Germany (FRG) 300
Greece 301
ICES 305
implied consent 303, 304
international organizations 305
Ireland 301
Italy 301
Law of the Sea Convention 294, 304, 444
Netherlands 295-297, 299
Portugal 301
Spain 302

marine scientific research (continued)
state practice 293
U.S. 308, 311-313, 315-317
United Kingdon 302
marine surveillance 151-153, 155, 161, 162
exclusive economic zone 151, 153, 155
technologies for 161
maritime delimitation 412-420, 422-428, 430-436
International Court of Justice 412, 413, 415, 416-420, 422, 424-428, 430-433, 435
international law 412-420, 422, 424-428, 430
maritime fraud 214, 226, 227
Maritime Fraud Prevention Exchange 226, 227
Maritime Security Convention 446
maritime states 207
maritime surveillance 150
maritime transit 203
MARPOL Convention 73/78 210, 225, 406, 407
Law of the Sea Convention 406, 407
Mauna Loa 15
McCarthy, James 19
McHamilton, Tom 82
McIntyre, Alasdair 360, 361, 398, 399
McLaughlin, Richard 320
Mero, John 36
Micronesia 157, 158
Miles, Edward 50, 51, 353, 354, 491
military intelligence 38
Morgan Joseph 135
Narragansett Bay 29, 391
NASA 339, 348, 352
data access 348
National Academy of Science 30
National Oceanic and Atmospheric Administration 28, 328, 349, 351, 352, 466-470, 473, 475, 477,
data programs 349
National Climate Data Center 350
National Oceanic Data Center 350
National Research Council 27, 345
National Science Foundation 15, 27, 34, 347
funding 34
ocean science 347
National Snow and Ice Data Center 350
Nauru Agreement 156
navigation 204, 229, 232, 443, 449, 451
Nelson, Dolliver 436
Netherlands 295-299, 377
marine scientific research 295-297, 299
MSR experience 295, 296
MSR notifications 297
MSR procedure 295
ocean management 377
New Zealand 152, 161, 377, 462

New Zealand (continued)
marine surveillance 161
ocean management 377
nickle 77
Nixon, Dennis 396
North Sea Continental Shelf case 412, 414, 418, 423, 424
Northeast Continental Shelf 99, 109
ecosystem 109
Norway 58, 59
Nuclear Energy Agency (OECD) 248
nuclear free zones 38
nuclear reactors (world listing) 246
nuclear vessels 38
nuclear waste disposal, see: radioactive waste
nuclear weapons 37, 38
ocean commons 118, 278
ocean dumping 46, 271-280
ocean exploration 57, 59
developments 57
technology 59
ocean management 368, 371-384, 396, 397, 401
coastal area management 397
difference between coastal area management 376
evolution of 368, 371, 372
exclusive economic zone 380
Hawaii 377, 379
lessons learned 375, 376
major issues 380, 381
Netherlands 377
New Zealand 377
OALOS 382
Ocean Economics Technology Branch 382
state initiatives 383, 384
United Nations 372-374
ocean planning 388
ocean space 199-211 199
ocean technology 42-46, 57, 58, 80, 81, 83, 161, 163, 164, 222, 223, 224, 287, 321-328, 339, 340, 466, 468
archaelogical artifacts 80
Area 45, 46
artificial islands 43
coastal states 44, 45
data base systems 325
data gathering systems 323
deep float arrays 340
exclusive economic zone 42-44
Global Positioning System 58
hydrographic surveying 321
moored current meters 339, 340
multi-beam sonar 287
networks 326, 327
NOAA systems 328
processing systems 324

ocean technology (continued)
sensors 322, 323
shipping 222-224
software applications 324
submersibles 80, 81, 83
surveillance 161, 163, 164, 466, 468
oceanography 292, 322-331, 333, 337, 342, 345, 347, 349-351
archival data 350
China's program 342-344
data, exchange 345
federal data policy 349-351
global projects 337-341
IGOSS 349, 350
international programs 333-336
NODC 350
see also: MSR, satellites, ocean technology
OECD, Nuclear Energy Agency 248
offshore oil, see: oil
offshore platforms 445
oil 44, 55, 61, 62, 64-70, 73-76, 201, 202, 362
crisis 201
exploitation 362
offshore 55, 202
see also: Alaska, Canada
Okamura, Kenji 40
Olsen, Stephen 360, 390, 395-397, 400, 401
Oregon 401
Orrego, Francisco 423, 431-435
overflight 229, 443
ozone hole 353
Palau 158
Papua New Guinea 159
Persian Gulf 204, 229-233
piracy 206
plate tectonics 58
population growth 19
port development 224, 225
Portugal 301
Press, Frank 25
Project DUMOND 46, 47
Queneudec, Jean-Pierre 418, 430, 432, 435-437
radioactive waste 245, 247-255, 257-259, 261, 262, 265, 266, 270, 271-279
background radiation compared 257
cancer risks 270
disposal feasibility 250
disposal research 247, 248
ecosystem 278
emplacement hazards 259, 261
engineering studies 251, 252
Great Meteor East 251
health risks 255, 257, 258
High Seas Convention 271

radioactive waste (continued)
International Commission on Radiological Protection 257
land repositories 245
Law of the Sea Convention 272
London Dumping Convention 274-276, 278
Pacific disposal sites 266
radiological assessment 252-255
risk assessment 276, 277
scientific uncertainty 277
seabed disposal regions 251
Seabed Working Group 249
site assessment 250, 251
Stockholm Conference 271, 272
subsea disposal 245, 247, 248
subsea repository 261
transport hazards 258, 259
U.N. South Pacific Regional Seas Convention 276
U.S. EPA 257
U.S. legislation 250, 273
U.S. regulatory agencies 258
UNCLOS III 272
Rasool, S. I. 333, 353, 354
remote sensing 19, 164, 237-240, 242-244, 287
economics of 242-244
future prospects 240
international coordination 242-244
International Geosphere-Biosphere Program 239
LANDSAT 242
ocean measurements 238
practical applications 239
satellites 237
space policy 244
technologies 238
U.N. 244
Revelle, Roger 17
Rhode Island 4, 390-392
Coastal Resources Center 390
oyster industry 392
Rorholm, Niels 395, 396
Ross, David 35, 77, 308, 319, 320
Rosswall, Thomas 19
Rugang, Dai 342
satellites 58, 59, 164, 237-239, 241-244, 322, 323, 339
international scope 237, 238
LANDSAT 242
mission periods 241
ocean observation 237, 239, 243, 244
remote sensing 237
see also: remote sensing
sensors 322, 323
SPOT 164
WOCE utilization 339
Saudia Arabia 388

science policy 30-33, 138, 285, 287
CCAMLR (Convention) 138
international 32
Law of the Sea Convention 33
priorities 31, 32
global climate change 333
international issues 22, 23
ocean science 347
policy making 285, 287, 288
radioactive waste uncertainty 277
renaissance 17
see also: marine scientific research, oceanography
Scully, Tucker 138, 148, 195
seabed mining 9-11, 45, 279, 466-478, 497
Sherman, Kenneth 97, 194
shipping 200-208, 211, 214-227, 234, 235, 450, 451
Achille Lauro 205
changes in 201, 202
Convention for Registration of Ships 217-219
cruise industry 202
developing countries 219-222, 224
fishing industry 202
flag states 215
flags of convenience 203, 214-216
future developments 211
genuine link 216, 217
industry 214
innocent passage 206
International Maritime Bureau 214
internationalization 203
Law of the Sea Treaty 205-207, 216
Liberia (note) 227
marine pollution 208, 211
maritime fraud 214, 226
Maritime Fraud Prevention Exchange 226
Maritime Safety Convention 206
MARPOL 73/78 225
neutrality 205
open registries 203, 214-216, 217, 218, 219
Persian Gulf attacks 204
piracy 206
port development 224, 225
slump in 200, 201
technological change 222-225
terrorism 205, 206, 211
UNCLOS III 205
shipwrecks 84-87
smuggling 39
Solomon Islands 158
Soons, Alfred 293, 319-321
South Pacific Forum 150, 152, 153
South Pacific Forum Fisheries Agency 152, 153
South Pacific islands 96, 150, 151, 153-160,

South Pacific islands (continued)
162-164, 166-168, 170, 378
Australia 151
exclusive economic zone surveillance 150, 151
Forum Fisheries Agency 154, 155, 160
geography of 153
Law of the Sea Convention 154
multi-lateral treaties 157
Nauru, Agreement 156
politics 154
regional cooperation 156
surveillance capabilities 157-160
surveillance programs 167, 168, 170
surveillance requirements 155
surveillance technology 163, 164, 166
tuna agreement 96, 157
U.S. 157, 162
South Pacific Regional Seas Convention 276
sovereignty 44, 116, 117
marine ecosystem model 116, 117
Soviet Union 95, 303
U.S. fisheries agreement 95
space science 22
Spain 302, 303
SPOT 164
Sri Lanka 431
Stockholm Conference (1972) 117, 118, 271, 272
Straits of Hormuz 229-232
straits passage 37
Strauss, Howard 77, 91, 319
Sturmey, S. G. 219
submarines 38
submersibles 39, 80-83, 466, 468
Alvin 82
Argo Jason 81, 82
IFREMER 81
Deepstar Miner 466, 468
Suez Canal 200
Sutinen, Jon 191
Tabago 316
technology 36, 38-47, 57-59, 80-83, 161, 163-166, 222-224, 237, 285, 287, 288, 321-328, 339, 340, 373, 382
coastal states 38, 44, 45
contiguous zone 39
data base systems 325
exclusive economic zone 40-44
fiber optics 47, 59
networks 326, 327
ocean exploration 59
ocean satellites 238
processing systems 324
remote sensing 287
satellites 237, 238

science policy 285, 287
see also: ocean technology
sensors 322, 323
side-scan sonar 57
software applications 324
territorial seas 37, 38
military intelligence 38
nuclear free zones 38
straits passage 37
terrorism 205, 206, 211, 446
shipping 205, 206
Titanic 55, 79-83, 85, 86, 90, 91
exploratory technology 81, 82
Memorial Act 86
Treves, Tullio 55, 79, 92, 432
Trinidad 316
Tropical Ocean-Global Atmosphere Program 28, 337
tuna 41, 96, 157, 463, 464
treaty 157
UNCLOS III 36, 205, 272
shipping 205
UNCTAD 213, 226, 227
maritime fraud 226, 227
underwater installations 44
UNEP 276, 374
UNESCO 34, 374
United Kingdom 302
United Nations 29, 34, 117, 217-219, 224, 227, 233, 244, 276, 372, 373, 374, 381
Article 51 233
Coastal Area Development Program 373
coastal area management 372-374
Convention for Registration of Ships 217-219
Convention on Multimodal Transport 224
Environment Program 29
General Assembly 117
OALOS 373, 381, 382
Ocean Economics Technology Branch 382
ocean management 372-374
training programs 373, 374
Outer Space Treaty 244
remote sensing 244
South Pacific Region Convention 276
UNESCO 34, 374
UNCTAD 213, 226, 227
UNEP 276, 374
World Maritime University 373
United States 31, 32, 39, 74, 85, 89, 95, 96, 98,105, 120, 157, 162, 204, 229, 230, 231-233, 235, 236, 247, 248, 250, 252, 257, 273, 287, 308-313, 315, 317, 339, 350, 392, 393, 466, 468, 482-484, 494, 496, 498, 500
Army Corps of Engineers 74
Coast Guard 39

United States (continued)
Coastal Zone Management Act 392, 393
Council on Environmental Quality 273
Cuba 313
Dept. of Energy 248, 250, 273
ecosystem (table) 105
EPA 257
exclusive economic zone 95, 98
France 85
freedom of navigation 232
Global Change Program 31, 32
Gulf policy questioned 236
Gulf reflagging 204
international law 120
Law of the Sea Treaty 235, 494, 496, 498, 500
marine scientific research 308, 309-313, 315, 317
NASA 339
National Climate Data Center 350
National Marine Fisheries Service 98
National Oceanic Data Center 350
National Snow and Ice Data Center 350
Navy 229, 230, 232, 233
Ocean Dumping Act 273
Palomares H-bomb 89
Persian Gulf 229-233
Presidency and 120
radioactive waste legislation 250, 273
radioactive waste program 247, 252
see also: Alaska
Small Business Innovative Research Program 287
South Pacific islands 157, 162
Soviet Union fisheries agreement 95
Straits of Hormuz 229, 230, 231, 232
tuna agreement 96
University of Hawaii 329
University of Rhode Island 4, 390
USS Samuel B. Roberts 229
USS Scorpion 89
USS Somers 85
USS Stark 229
USS Tecumseh 89
Vallejo, Stella 360, 368, 395, 400, 401
Verlaan, Philomene 148
Vernadsky, 17
Vorghese, Peter 150
warships 37, 87
waste disposal 46, 245, 361
Webster, Ferris 345, 352, 353
Weeker, Miranda 400
Welling, Conrad 57, 77
whales, Bowhead 72
whaling 62, 149
Withee, Gregory 322, 355

Wolfe, Edward 95, 148
Woods Hole Oceanographic Institution 46, 80, 83
World Bank 388
World Climate Research Program 28, 337
World Maritime University 373
World Meteorlogical Organization 29
World Ocean Circulation Experiment 28, 238, 337, 341
    1988 Conference 340, 341
    Core Projects 337, 338
    satellite utilization 339
Yahaya, Jahara 171
Yoerger, Dana 80
Zhizhong, Chen 37