Trends and Future Challenges for U.S. National Ocean and Coastal Policy

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Purpose

The purpose of the conference was to examine trends and future challenges (national and global) that are likely to affect U.S. national ocean and coastal policy in the next 25 years. Such trends include demographic pressures on the coast; trends related to resource scarcity; technological and industry-driven innovations; changes in social values and attitudes; changes in environmental and domestic governance frameworks; and changes in ocean industries. The meeting agenda is included in the Appendix.

Organizers

The workshop was organized by the National Ocean Service, NOAA; the Center for the Study of Marine Policy, University of Delaware; and the Ocean Governance Study Group. Funding support has come from the National Ocean Service, NOAA. The additional support of the Center for Marine Conservation, BOAT/US, and the Graduate College of Marine Studies, University of Delaware, is acknowledged with sincere thanks.

Editors' Note

The views expressed in the contributions making up this volume are those of the authors and not necessarily those of the organizers (National Ocean Service, NOAA; the Center for the Study of Marine Policy, University of Delaware; and the Ocean Governance Study Group).

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National Dialogues on Coastal Stewardship

The National Dialogues bring together the many partners who make up the coastal community to focus on the most important coastal and oceanic issues facing the United States. The Dialogues combine systematic approaches and interactive problem-solving, building partnerships and a sense of community among all stakeholders. Under the National Dialogues initiative, a number of national organizations have developed a comprehensive vision for the future of coastal stewardship; a national dialogue about the vision is being conducted over the Internet from July to October, 1999 (www.state-of-coast.noaa.gov/natdialog/). Major activities in 1998 included the Stratton Commission Roundtable; the organization of the Coastal Trends Conference, which resulted in this proceedings; and the development of a newsletter, *Ocean and Coastal Policy Network News*. These publications can be downloaded in PDF format from NOAA's National Dialogues Web site: http://state-of-coast.noaa.gov/natdialog/index.html

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1. Paper submitted after the workshop.

Introduction and Executive Summary

LOOKING AHEAD: FUTURE CHALLENGES FOR U.S. OCEAN AND COASTAL POLICY

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The Changing Context of National Ocean and Coastal Policy

We see a changing context for U.S. ocean and coastal policy in the late 1990s. Some of these changes are physical—the warming climate and the associated effects at the shoreline including accelerated sea level rise and coastal erosion, the possibility of increased storm frequency and perhaps intensity; some are social and demographic—the increasing flow of people and activities to coastal areas and the consequent changes in coastal environments; some are related to technology—the need for deeper navigational channels and harbors to accommodate larger and faster vessels and the need to respond to the challenges of new technologies such as marine biotechnology; and some represent changes in public policy—a recognition that many environmental and resource problems are effectively addressed only by partnerships, between levels of government and between the public and private sectors.

Population growth will continue to be a driving force in the 21st century. It is expected that populations—both globally and in the United States—will continue to concentrate in coastal areas. World megacities (defined as cities larger than 8 million) which numbered 20 in 1990 will increase to 30 in 2010. Twenty of these 30 megacities will be coastal megacities (Nicholls 1995). In the United States, coastal populations are expected to rise from 141 million in 1996 to 166 million in 2015 (Bookman, Culliton and Warren, 1999, in this volume). By 2010, for example, two coastal states—California and Texas—will lead the nation in population, while Florida's expected population of 16 million will rank fourth in the nation, up from tenth in 1960 (Culliton et al, 1990). Population density in coastal areas—in 1988 it was 341 persons per square mile, more than 4 times the U.S. average—is expected to increase more than 10% between 1988 and 2010 (Culliton et al, 1990).

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Population pressures will typically lead to increased user conflicts and competition for scarce ocean and coastal resources, result in loss of access to the ocean commons, and raise a variety of public health issues. Concomitantly, coastal ocean degradation is likely to continue in the form of declining water quality and coastal fisheries and destruction of important habitats. Controlling nonpoint (or land-based) sources of marine pollution—such as rain-caused run-off from urban surfaces containing grease and oil, plastics, salt, and other substances, storm water run-off, and run-off from agricultural activities containing fertilizers, pesticides, and other chemicals used in farming practices—will pose one of the most significant challenges to decision-makers since land-based sources such as these account for more than 75% of the pollutants entering the oceans (YOTO 1998, C-19). Changes in the global climate, as they materialize, are expected to result in rising sea levels, increased damage by storms and floods, and changes in rainfall and freshwater flow to estuaries.

In the marine realm, we are likely to see increased growth in coastal and marine tourism as travel and tourism, the world's largest industry, continues to rise.

In the marine realm, we are likely to see increased growth in coastal and marine tourism as travel and tourism, the world's largest industry, continues to rise. In 1995, the industry employed 211.7 million

people, produced 10.9% of world gross domestic product, invested $693.9 billion in new facilities / equipment, and contributed more than $637 billion to global tax revenues (WTTC, no date). Hopefully, pressures for maintaining the health and attractiveness of coastal areas for tourism will provide the needed political will to push for such programs as clean water protection and beach restoration and maintenance. Global trade, most of it by ship, will continue to grow in importance and the marine transportation industry will demand refurbished and modernized port facilities, including deeper channels, to accommodate the deeper-draft, larger, and faster ships now coming on line. Given the decline of fisheries worldwide (60 percent of commercial stocks are either overfished or fully harvested (FAO 1996)), the focus in this area will likely be on conservation and on rebuilding stocks rather than on fisheries development.

Regaining U.S. leadership in international ocean matters thus looms as one of the major challenges in national ocean policy in the next decade.

Aquaculture currently accounts for about 25% of world food fish supplies, with China, India, Taiwan, and Thailand among the leaders in this field (YOTO 1998, C-28). Aquaculture is likely to grow as a substitute to wild fisheries but ways will need to be found to avoid the environmental problems that have plagued aquaculture operations in some Asian and Latin American countries. Marine areas, too, will increasingly be used for the "bioprospecting" of novel marine organisms and marine organisms with unique properties (such as the heat-tolerant hyperthermophiles found in deep-ocean hydrothermal vents). Policy frameworks that establish standards for allowing access to and exploitation of such resources will need to be developed, given the lack of any policy guidance at present. In offshore oil development, new challenges will be faced in at least two areas: the dismantling of offshore oil platforms, in an environmentally sound manner, in oil fields that have been depleted (approximately 4,000 platforms will need decommissioning around the world, and 1,000 in the Gulf of Mexico in the coming decade), and, as industry develops oil resources in deeper and deeper areas of the Gulf of Mexico (Coy et al. 1997), new policy issues related to marine safety, environmental impact, and relations with neighboring Mexico are likely to arise.

From an economic and political perspective, the globalization of the economy will continue and world economic and political interdependence will be even more apparent than it is today. New factors which have become manifest in the last several years such as the emergence of regional economic blocs and growing international terrorism are likely to continue. In the period to 2025, we will see more, rather than fewer, demands for United States international leadership. In this regard, the United States was once the acknowledged leader in ocean affairs internationally. Now the United States finds itself outside the ambit of some of the most important international agreements ever concluded on oceans, particularly the Law of the Sea Convention and the 1993 Convention on Biological Diversity and will increasingly find it difficult to influence the course of actions decided by international bodies set up under these Conventions. Regaining U.S. leadership in international ocean matters thus looms as one of the major challenges in national ocean policy in the next decade (Cicin-Sain and Knecht, 1999).

Meeting these challenges is not going to be easy and will require the kind of advance planning and concerted, integrated, and sustained action that we have not recently demonstrated. Solving the fisheries problem, for example, will require more than simply closing fisheries and allowing sufficient time for the stocks to recover. To achieve improved abundance on a sustainable basis, we will also have to address such problems as continuing loss of essential fish habitat, problems of bycatch, and problems associated with land-based sources of marine pollution. Restoring and managing the nation's recreational beaches will require much closer cooperation and collaboration among organizations such as the U.S. Army Corps of Engineers, the Federal Emergency Management Agency and its National Flood Insurance Program, the coastal management programs in place in each of the coastal states, and local governments and their coastal communities which are clearly on the front line with regard to this problem. Modernizing the nation's port system to meet the needs of the 21st century, for another example, will require a significant effort at all levels from the local port community itself, to the host coastal state, and to the national level where a more coherent national port policy is needed. All in all, a more integrated system of ocean governance will be needed, one that looks at the ocean and its resources as a whole and not only at its discrete parts.

Discussions at the 1999 Workshop on Trends and Future Challenges

This volume contains the papers presented at the Trends and Future Challenges for U. S. National Ocean and Coastal Policy workshop held in Washington, D. C. on January 22, 1999. The workshop, part of the series of Dialogues on National Ocean and Coastal Policy, sought to raise awareness of trends and emerging challenges in national ocean and coastal policy and to set the stage for continuing national dialogues on these important issues. The workshop was organized by the National Ocean Service, NOAA; the Center for the Study of Marine Policy, University of Delaware; and the Ocean Governance Study Group. Funding support came from the National Ocean Service, NOAA, the Center for Marine Conservation, BOAT/US, and the Graduate College of Marine Studies of the University of Delaware. The support of these organizations is gratefully acknowledged.

The main points presented in each of the papers contained in this volume are outlined below.

In ***Ocean and Coastal Futures: The Global Context,*** **Allen Hammond of the World Resources Institute** asks two questions: (1) What forces are shaping the world, and where would we like to go; and (2) Can we envision some development trajectories that will get us to the type of world that we would like to leave for the future? In seeking to answer these questions, Hammond focuses on environmental trends but also presents an overview of a number of other interacting factors, including population trends, economic trends, sociopolitical trends and security trends. The discussion of key trends is organized via an exploration of three scenarios—*Market World, Fortress World, and Transformed World.*

Market World is a scenario where markets and the private sector play a major role in the future. It also envisions the continuing technological revolution, the spread of democracy around the world, widespread improvements in literacy, and even environmental improvements in many industrialized countries. The problem with a *Market World* future is that markets do not automatically solve environmental problems, and they often exacerbate, rather than ameliorate problems of equity and other social problems.

Fortress World is a vision of what might result if unattended environmental and social problems undermine *Market World.* Trends such as increasing population growth, urbanization, and consumption coupled with widening disparities in wealth may lead to the demise of *Market World. Fortress World* envisions islands of luxury and privilege surrounded by oceans of poverty, despair, and environmental degradation.

The final scenario is *Transformed World,* which recognizes that fundamental social and political reform is necessary to solve some of the problems that exist in *Market World* and *Fortress World.* In order to achieve *Transformed World*, changes in attitude and a new sociopolitical consensus are needed. While Hammond concludes that this scenario may require a bit of a leap of faith, he argues that many transforming trends are already underway. Such transforming trends include changes in political consensus and social attitudes, the rise of civil society, and the greening of corporations.

In ***Global Trends in Fisheries and Aquaculture,*** **Richard Grainger of the FAO Fisheries Department** describes past trends in capture fishery and aquaculture production and compares the current production with fisheries potential. Grainger focuses particularly on the contribution of fisheries to food supply and the economy; capture fisheries development and the need for management; improving fisheries management; aquaculture development; and information needs.

With regard to the contribution of fisheries to food supply and the economy, both global fish production and consumption have increased markedly since the 1950s. Growing numbers of people have found employment in world fisheries and aquaculture, and trade in fishery commodities has also significantly increased since 1970.

The section on capture fisheries development and the need for management discusses fishing fleets, fishery landings, and tracking fishery development. A preliminary FAO assessment on industrial fishing vessels of over 100 GT indicates a significant decrease in fleet size, with very little change in tonnage per vessel between 1991 and 1997. Capture fishery production has leveled off in the last decade, and the increase in food fish production in recent years has been due entirely to aquaculture. With regard to fishery development, a transition from largely undeveloped fisheries to mainly senescent and mature fisheries is clear.

In the realm of fisheries management, Grainger concludes that management has generally failed to protect resources from overexploitation. However, recent developments such as the UN Straddling Fish

Stocks Agreement and the FAO Code of Conduct for Responsible Fishing should allow an unprecedented opportunity for improving fisheries management. If this opportunity is lost and management does not improve, there could be a shortfall of 10 to 40 million tons between demand and supply for human consumption by 2010, despite increased aquaculture production.

Aquaculture has been the world's fastest growing food production system for over a decade. Grainger concludes that the rapid growth in aquaculture seems set to continue in the near future. With regard to information needs, Grainger notes that fishery managers and policy makers will need to draw more on fisheries research programs that encompass economics, sociology, and anthropology as well as biology. There will be a major need for development and use of sustainability indicators to synthesize the very broad range of information.

In ***The Coastal Population Explosion,*** **United Nations consultant and author Don Hinrichsen** emphasizes the increasingly skewed nature of population distribution. Recent studies have shown that the overwhelming majority of people are concentrated along or near coasts on just 10 percent of the earth's land surface. In 1998, more than half of the world's population (3.2 billion people) lived and worked in a coastal strip 200 kilometers (120 miles) wide. Two-thirds of the global population live within 400 kilometers of a coast.

Hinrichsen reviews population density through comparative regional analyses. The bulk of Asia's population, with the exception of India, is coastal or near-coastal. Of the region's collective population of 3.5 billion, 60 percent (2.1 billion) live within 300 kilometers of a coast. Latin American and Caribbean coastal states have a collective population of approximately 610 million. Three-quarters of this population lives within 200 kilometers of a coast. The majority of the Caribbean Basin's 200 million permanent residents live on or near the seashore. Of all the continents except the Antarctic, only Africa has more people living in the interior than along or near coastlines and major river valleys. Even in Africa, demographic patterns are shifting. Over the past two decades, Africa's coastal cities have been growing by 4 percent a year or more. In the Mediterranean Basin, the resident population might become as large as 555 million people by 2025. According to Blue Plan projections, the urban population of coastal Mediterranean administrative regions could reach 176 million—30 million more people than the coastal population in 1990. In the United States, 55 to 60 percent of Americans now live in the 772 counties adjacent to the Atlantic and Pacific Oceans, the Gulf of Mexico, and the Great Lakes. In 1990, the most crowded coastline in the United States, stretching from Boston to Washington, D.C., had over 2,500 people per square kilometer. Another 101 coastal counties had population densities exceeding 1,250 per square kilometer.

Hinrichsen concludes that now is the time to develop and introduce management plans that protect vital coastal ecosystems, while permitting economic growth and ensuing a better quality of life for all coastal dwellers. Continued denial of the problems will only make solutions harder to achieve in the coming decades.

In ***Trends in U.S. Coastal Regions, 1970-1998,*** **Charles Bookman, Thomas Culliton and Maureen Warren of the National Ocean Service, NOAA** examine emerging trends and underlying issues that are shaping the coast, coastal resources and uses, and coastal management and policy. Present and projected trends are discussed in terms of populations and settlement; social values; economic activity; resources; environmental quality; hazards; and governance and management.

The authors' examination of coastal population and settlement trends finds that the coastal population of the United States is projected to increase from 141 million to 166 million between 1996 and 2015. In order to counter the deleterious impacts of increasing population pressure, states and localities have begun to channel public investment for infrastructure into areas that are best equipped to accommodate growth. An analysis of social trends finds that over the last thirty years, public attitudes toward the environment have changed markedly. In addition to the evolution of public attitudes that favor ocean protection, nongovernmental organizations have emerged to work towards conservation and management of the environment. The authors found the marine-related economic activities in the coastal zone and coastal ocean account for up to two percent of the U.S. GNP. Recreation and tourism, waterborne commerce, energy and mineral production, and fisheries account for most economic activities along the coast. In their discussion of environmental quality, the authors note that coastal oceans and estuaries are extremely valuable and productive natural systems. However, these systems are threatened by a number of environmental stresses including nutrient over-enrichment, bacterial contamination, chemical pollution, oxygen

depletion, oil spills and unplanned habitat alterations. Concerning coastal hazards, the authors found that while a greater potential for loss exists now than in the past, relatively fewer actual losses occur. This paradox has been attributed to improvements in forecasting and storm predictions and stricter building codes.

The authors conclude by noting that three important trends are occurring to address the fragmented nature of ocean governance and management. These trends are: (1) the move towards greater enclosure of the oceans, as codified in the 1982 LOS Convention; (2) the establishment of special management areas and expansion of national capacities to plan for and manage the coastal zone; and (3) the increased adoption and utilization of integrated management approaches.

In ***New Approaches to Environmental Management: Lessons From the Chesapeake Bay*, Donald Boesch of the University of Maryland** begins by noting that the Chesapeake Bay Program represents perhaps the most ambitious and costly effort to restore a major coastal ecosystem. The Chesapeake Bay Program aims not only to restore the Bay, but also to manage activities in the coastal zone and a catchment area of 64,000 square miles. Boesch seeks to answer two fundamental questions about the 20-year old Program: (1) What can we learn from this experience; and (2) Where does this experiment in ecosystem management need to go in the 21st century? Boesch examines the Program's commitments and goals, as well as its science, model monitoring, sustainable resource use; growth management; and climate change activities in order to answer these questions.

In answering the first question, Boesch finds that the Chesapeake Bay Program owes its longevity and successes to the high and sustained level of social commitment it has enjoyed. The Program has been goal-oriented, even though setting appropriate goals has often been clouded by uncertainty. The goal-oriented nature of the Program has lent it strength by focusing bureaucratic attention and providing a framework and currency for debates. The Program prides itself in being science-based, and Boesch explores its emphasis on the development and application of sophisticated computer models of the Bay and its watershed. These models have tremendous power in tracking progress, identifying significant problems, and determining the effects of management alternatives. Finally, the Chesapeake Bay Program operates the largest and most extensive monitoring programs of any coastal ecosystem in the world. This is another strength of the program because environmental monitoring is essential for the practice of adaptive environmental management.

With regard to the second question, Boesch notes that the first generation of Chesapeake restoration goals was based on nutrient inputs. The next generation of restoration goals will be based on living resources. Rates of land development are too fast to meet and hold Bay restoration goals, and they are also unsustainable in terms of infrastructure demands and quality of life considerations. As a result, the Chesapeake Bay watershed has become a focal point of the Smart Growth movement. Finally, Boesch notes that the Program needs to begin to take heed of the possible changes and implications associated with climate change.

In ***Perspectives on Marine Water Quality*, Tim Eichenberg of the Center for Marine Conservation and the Clean Water Network** reviews the historical state of water quality in the United States, conditions that led to the adoption of the Clean Water Act in 1972, progress that has been made since the enactment of the CWA, and areas that remain unaddressed.
Eichenberg begins by noting that until 1972, the United States had no national program for regulating the discharge of sewage and industrial pollutants. By 1972, more than 60 percent of assessed rivers, lakes, and estuaries were not fishable or swimmable, and over 50 percent of the wetlands in the continental United States had been destroyed. Thus, conditions were ripe for the adoption of national clean water legislation. In 1972, the Clean Water Act was overwhelmingly passed over President Nixon's veto. The Act had three primary goals: (1) to eliminate the discharge of pollutants by 1985; (2) wherever attainable, to provide for the protection and propagation of fish, shellfish and wildlife, and recreation in and on the water by 1983; and (3) to prohibit the discharge of toxic pollutants in toxic amounts.

Eichenberg maintains that while significant progress has been made in addressing water quality problems since 1972, a great deal of work remains to be done in order to meet the goals of the CWA. The Clean Water Act has not been reauthorized since 1987, and Eichenberg contends that new approaches are needed to address remaining clean water challenges. Many such challenges have been identified. For example, the EPA estimates that 60 percent of water quality impairment now comes from nonpoint sources of pollution. Less than three percent of the State Revolving Fund (SRF) has been devoted to

nonpoint source pollution. Section 319 of the CWA provides no mandatory controls on the major sources of nonpoint source pollution. NOAA's Coastal Nonpoint Pollution Control Program is currently moribund. There are no enforceable national standards for monitoring and posting swimming beaches. There are no enforceable national standards for fish consumption advisories. These problems represent only some of the challenges that need to be addressed in the future. Eichenberg suggests a number of potential approaches for managing continuing water quality problems.

In ***Conserving Ocean Biodiversity: Trends and Challenges,*** **Thomas Hourigan of the National Marine Fisheries Service, NOAA** discusses trends in the health of marine biodiversity, specifically mentioning fisheries, protected marine species, and key ecosystems. Hourigan also identifies five critical elements of action for addressing the threats to living marine resources. The new Aquatic Restoration and Conservation Partnership for Marine, Estuarine and Freshwater Living Resources is also described.

Hourigan begins by noting that the primary threats to marine biodiversity are fisheries operations, chemical pollution and eutrophication, physical alteration of coastal and marine habitats, invasions of exotic species, and ultraviolet-B radiation damage to phytoplankton and zooplankton resulting from stratospheric ozone depletion. With regard to trends in the health of marine biodiversity, trends for oceanic resources have revealed that anthropocentric activities are meeting and often exceeding the productive and recuperative limits of the ocean.

Hourigan describes how the U.S. government, in partnership with public and private stakeholders domestically and internationally, is working to address the threats to living marine resources and to ensure the promise of these resources for future generations. The core of this new strategic vision is comprised of five critical elements: (1) investing in science in the interest of stewardship; (2) applying the precautionary approach; (3) applying new technologies to ensure the environmental sustainability of marine aquaculture; (4) building partnerships; and (5) exploiting the full potential of an ecosystem-based approach to resource management.

Hourigan also discusses the Aquatic Restoration and Conservation (ARC) Partnership for Marine, Estuarine and Freshwater Living Resources. Members of the partnership include NOAA, the U.S. Geological Survey and other federal agencies, states, NGOs, and professional organizations. The goal of the ARC partnership is to ensure the conservation of the nation's freshwater, estuarine, and marine living resources by creating a common information base and options for preserving the ecological and economic integrity of these resources.

Hourigan concludes that it is important to make full use of new approaches to management on scales that are meaningful to ocean living resources. Such approaches can then be placed in watershed and integrated marine and coastal area management regimes that involve all stakeholders. Hourigan maintains that, together, these offer the promise of better conserving marine biodiversity.

In ***Global Trends in Marine Protected Areas,*** **Tundi Agardy of Conservation International** notes that marine protected areas are increasingly being used to protect biologically rich habitats, resolve user conflicts, and help restore overexploited stocks and degraded areas. Agardy maintains that the increase in the designation and management of marine protected areas is occurring on two tracks: (1) the establishment of reserves to safeguard representative habitats or particularly rich and diverse areas, and (2) the use of protected areas to complement both fisheries and coastal management.

Agardy notes that protected area placement, design, and operation all relate to the scope and nature of the goals being targeted—i.e. the specific objectives the protected area is meant to achieve. She contends that what is most necessary, and what is most often overlooked when the process of establishing a marine protected area is initiated, is information on what the protected area is being established to achieve. Goal-setting or objective elaboration is critical in order to determine expectations, effectively design the reserve, and have in place targets and benchmarks against which progress towards the objectives can be measured. Thus, Agardy concludes that the identification of these objectives is ultimately societal, not scientific, and that the human element in marine protected areas cannot be overlooked. The success of any protected area is closely related to how well user groups and stakeholders are identified and brought into the planning and management processes for the protected area.

Agardy also presents a summary of published literature and anecdotal evidence that demonstrates that marine protected areas have produced certain quantifiable benefits: (1) increases in abundance of reef fish and invertebrates; (2) increases in individual

size / age; (3) increases in reproductive output; (4) increases in species diversity; (5) increases in spillover; (6) increases in replenishment; (7) increases in preservation of genetic and demographic diversity; and (8) increases in habitat quality and diversity.

Agardy concludes that despite incomplete knowledge and imprecise science, steps must be taken to establish protected areas now, and to use the additional information gained as time goes on to alter these reserves, remove superfluous ones, and add new reserves. She maintains that by clearly defining objectives and using science to design the best possible plans for meeting those objectives, the management of marine activities can be improved.

In ***Changing Ship Technology and Port Infrastructure Implications,*** **Rod Vulovic of Sea-Land Service, Inc**. addresses a number of topics including the changing face of world trade and its effects upon ship size, environmental impacts of mega-carriers, intermodalism, safe navigation, the ideal container port, and ballast-water exchange. Vulovic begins by noting that fully 90 percent of international trade is carried by sea. He notes that while container ships are the linchpin of cargo transportation, the total system includes sophisticated shoreside terminals, intermodal extensions to inland points by rail and highway, and automated information systems that track a shipment throughout its journey.

With regard to future trends in ship size, Vulovic contends that the practicable upper limit of container ship size has not been reached by the 7,000-TEU plus vessels now in existence. He proposes that an eventual ceiling might be found around levels of 10,000 to 12,000 TEU, and that market forces will continue to influence the evolution of the system as long as it moves in a way that continues to provide improvements in cost, reliability, speed, and customer satisfaction.

Concerning environmental impacts of mega-carriers, Vulovic states that these ships display an increasingly important characteristic that may directly affect air quality. In an operational environment in which the contribution to atmospheric pollution by marine sources is being increasingly scrutinized, the operation of a mega-carrier will result in a measurably lower release of pollutant gases than from an equivalent transportation capacity in smaller ships.

Vulovic concludes that an ongoing dialogue between port users, operating authorities, support and regulatory organizations, and government will facilitate the provision of solutions to the many problems and challenges that currently exist for shipowners and port operators. Vulovic maintains that while the goal of seamless intermodalism is a difficult one to reach, it will eventually be achieved.

In ***Deepwater Offshore Oil Development: Opportunities and Future Challenges,*** **Paul Kelly of Rowan Companies, Inc**. begins by noting that the extraction of petroleum resources from beneath the seabed is a key maritime activity in the Gulf of Mexico, offshore southern California, and in some regions of Alaska. Kelly points out that petroleum production from offshore federal lands presently comprises 20 percent of domestic oil production and 27 percent of domestic natural gas production. Currently, the offshore oil and gas industry and its attendant support services sector provide 85,000 jobs. Kelly notes that it is probable that the number of jobs provided by the industry will more than double over the next 20 years, and that oil production in the Gulf of Mexico is expected to double by 2002. He also indicates that revenues from OCS oil and gas development generate between $3 and $4 billion a year in federal receipts and contribute to the Land and Water Conservation Fund and the National Historic Preservation Fund.

Kelly discusses the successful development of technology in offshore petroleum production and relates how new exploration, drilling, and production-related technologies have resulted in unprecedented production in 3,000 to 5,000 feet of water in the Gulf of Mexico. Not only have technological advances led to increased offshore production, but such advances have also improved the OCS safety and environmental record. For example, less than 0.001 percent of the oil produced from the OCS has been spilled from production facilities during the last two decades.

Kelly also addresses the efforts of the Minerals Management Service to resolve conflicts and build consensus among stakeholders with regard to OCS oil and gas development. Kelly notes that such an approach is being used in the current five year OCS leasing program, and that coastal state administrations appear to be more satisfied with the increase in communication and consideration between the federal government and the states regarding OCS oil and gas policy. For these reasons, among other things, Kelly maintains that President Clinton's extension of the OCS moratorium beyond the year 2000 was premature.

Kelly also touches upon the benefits of offshore oil technology for ocean research and other activities and the future challenges for deep water oil exploration and production. He closes his paper by emphasizing that, as petroleum exploration advances into ever-deeper waters, it is critical that the United States ratify the 1982 Law of the Sea Convention in order to assure 200 nautical miles of U. S. OCS jurisdiction.

In ***Challenges Facing the U.S. Commercial Fishing Industry*, Pietro Parravano of the Pacific Coast Federation of Fishermen's Associations** maintains that the Fishery Conservation and Management Act of 1976 was the most significant piece of fisheries legislation passed in this century. The FCMA established: (1) U.S. control of fisheries in waters offshore out to 200 miles in a Fishery Conservation Zone (FCZ); (2) U.S. policy to "Americanize" U.S. fisheries by phasing out foreign fishing offshore and developing a domestic fleet fully capable of harvesting the fishery resources in the FCZ; and (3) federal management of U.S. fisheries in the FCZ through eight regional fishery management councils and the Department of Commerce.

Parravano contends that the "Americanization" policy, with its emphasis on fleet construction rather than research, has led to a vast overcapitalization of the U.S. fleet with far more harvesting capacity than there are resources to support that capacity. The author also maintains that the policy has led to overfishing of many species and the collapse of the New England groundfish fisheries. Additionally, Parravano argues that the "Americanization" policy had caused the Department of Commerce to ignore the plight of smaller and more traditional fisheries, and to fail to act in a timely manner to prevent the near extinction of some Pacific salmon species.

After reviewing the effects of several pieces of fisheries-related legislation over the past 25 years, Parravano proposes seven focal points for fishery planning for the next 25 years: (1) full implementation of the Sustainable Fisheries Act; (2) greater fostering and support of small-boat and fishing family (owner-operator) operations; (3) encouraging fishery management decisions to be made at regional, state, and local levels, provided that they are consistent with overall federal objectives; (4) increased funding for research purposes, gear development, and provision of autonomy for regional fishery councils; (5) greater emphasis on value-added fisheries and low-impact/high-value fisheries; (6) fostering of aquaculture operations only where they are nonpolluting, nondamaging and have high conservation ratios; and (7) making fishing men and women with first-hand knowledge of the marine environment an integral component of fishery research, management, and decision making.

In ***Coastal Tourism and Recreation: The Driver of Coastal Development*, Biliana Cicin-Sain and Robert W. Knecht, University of Delaware,** note that while there is general recognition that coastal tourism and recreation are important in the coastal zone, that their impact is systematically undervalued both economically and as the most important driver of coastal development in many U.S. coastal areas. Travel and tourism are estimated to have provided $746 billion to the U.S. domestic product, about 10% of U.S. output, making travel and tourism the second largest contributor to GDP, just behind combined wholesale and retail trade (Houston 1995). Although there are no precise estimates of the magnitude of coastal travel and tourism in the U.S., studies have shown that beaches are America's leading tourist destination, ahead of national parks and historic sites. Approximately 180 million people visit the coast for recreational purposes, with 85% of tourist-related revenues generated by coastal states (Houston 1996, 3).

Given these figures, it is significant to note that there is no federal agency with a mandate to manage coastal travel and tourism, and that there is no overall national policy in place to plan for, and achieve, sustainable tourism in the U.S. A major reason for the lack of a formal program at the national level is that travel and tourism is viewed as a sector that requires relatively little formal management and is primarily a private sector endeavor. The benefits of tourism on coastal areas are great, yet its adverse effects are often not immediately visible, which leads to a sort of "management apathy." Also, most aspects of coastal travel and tourism that need managing are already dealt with at one governmental level or another, but in separate programs and run by different agencies, rather than as a coordinated, interconnected whole.

Cicin-Sain and Knecht discuss the major federal programs most relevant to coastal travel and tourism—including coastal management and planning, management of clean water and healthy ecosystems, management of the impacts of coastal hazards, waterways safety— and set forth a number of policy challenges that need to be addressed to promote sustainable and environmentally friendly tourism development in American coastal areas.

In ***Assessing the Economic Benefits of America's Coastal Regions*, Howard Marlowe of the American**

Coastal Coalition raises a number of issues related to increasing growth in and development of coastal areas. Environmental challenges posed by coastal development include increasing pressure upon drinking water supplies and sewage systems, greater disruption of natural sand systems and subsequent erosion, more pollution, and increasing tensions and conflicts among various resource users. Marlowe notes that each of these issues is important, but the political process at every level frequently adopts a piecemeal approach to these problems, focusing on one issue at a time rather than working in an integrated manner.

To illustrate his points, Marlowe discusses two issues: (1) whether the Federal government should support beach nourishment; and (2) whether the Federal government should subsidize coastal flood insurance policies. Marlowe uses these issues to demonstrate the somewhat myopic nature of public policy making. He points out, for example, that while the Army Corps of Engineers conducts a benefit-cost analysis of every potential shore protection project, the analysis places its greatest emphasis on the value of private property immediately adjacent to the shoreline. Marlowe contends that such an approach to analysis misses the benefits that accrue to homes and businesses in the area located elsewhere than adjacent to the shoreline as well as other environmental benefits.

Marlowe emphasizes the economic benefits of a number of beaches throughout the United States, including those in California, Florida, Delaware, and Texas. Marlowe concludes his partial review of the economic impact of coastal regions in the United States with data from the EPA. He notes that America's coastal waters support 28.3 million jobs and generate $54 billion in goods and services annually. The coastal recreation and tourism industry is the second largest employer in the nation, serving the 180 million Americans who visit domestic coasts each year.

Marlowe concludes by maintaining that the development of a comprehensive set of data on all of the benefits derived from America's coastal regions is critical. He notes that major steps need to be taken to improve coastal management practices and policies. Such steps include restoring and maintaining eroding beaches, improving water quality, protecting and enhancing coastal wildlife, promoting policies that mitigate coastal hazards, and generally improving the quality of the coastal environment.

In ***A Profile of Recreational Boating in the United States,*** **Ryck Lydecker and Margaret Podlich of the Boat Owners Association of the United States (BOAT/U.S.)** discuss the relative importance of recreational boating. They note that 75 million Americans were directly involved in on-the-water activities last year. Recreational vessels comprise America's largest fleet with 16.8 million boats in use nationwide.

Lydecker and Podlich also address the "yachting misnomer," which has led some to believe that recreational boating is largely the domain of wealthy "fat cats." The authors note that recreational boating is a social activity and family sport, and that boaters contribute to the Aquatic Resources Trust Fund through motorboat fuel taxes and fishing gear excise taxes. Lydecker and Podlich point out that the Fund puts approximately $350 million a year into boating safety education, law enforcement, environmental protection, public access, and fishery restoration.

Lydecker and Podlich identify three major issues that currently are and will continue to be of great importance to recreational boaters in the future: (1) access, (2) natural resources, and (3) opportunity. With regard to access, the authors note that in order to allow the general public the ability to get to the water, ramps, access points, marinas and transient dockage, moorings, anchorage, and dry and winter storage must be available. Lydecker and Podlich also maintain that in order to make exploration of waterways a legacy of recreational boaters, they must work towards making citizens coastal stewards interested in preserving the areas they explore. Regarding natural resources, the authors note that the enjoyment of recreational boating is heavily dependent upon clean water. The authors contend that new methods of reducing both point and nonpoint source pollution are necessary. Lydecker and Podlich also discuss the necessity of commercial and recreational interests working together to achieve flexible, timely management of fish and wildlife. Considering the issue of opportunity, the authors point to costs, fees, government regulations, and maintenance as the most often cited reasons preventing the average citizen from engaging in recreational boating. They mention a number of possible solutions to these impediments, including improved infrastructure and timeshare boat owning arrangements. Lydecker and Podlich conclude by reiterating that much of the nation is heading for the coast, and recreational boaters should be considered a major component in the quest to create coastal stewards.

In ***Marine Aquaculture in the United States: Current and Future Policy and Management Challenges*, M. Richard DeVoe of the South Carolina Sea Grant Consortium** provides an overview of domestic marine aquaculture, addressing such issues as the current status of the industry, the nature of the industry, coastal and ocean use conflicts, aquaculture and the environment, legal and regulatory structures, marine aquaculture and federal policy, and the future of marine aquaculture in the United States. DeVoe begins by noting that while domestic aquaculture production has not grown rapidly enough to balance the consumer demand for seafood, the development of the industry is considered to be critical to the future of the United States because it has the potential to produce: (1) high quality seafood to replace declining wild harvests; (2) products for export to aid in the reduction of the nation's foreign trade deficit; (3) stock enhancement of important commercial and recreational fisheries species; (4) economic development opportunities; and (5) new employment opportunities.

Regarding problems confronting marine aquaculture, DeVoe notes that a number of issues have constrained the development of marine aquaculture in the United States These issues include the complex and diverse nature of the industry, conflicts with other, more traditional uses of the nation's coastal and ocean waters, environmental concerns, and the existing legal and regulatory climate, all of which DeVoe discusses in some detail.

In conclusion, DeVoe maintains that the United States must return to the fundamental issues in order to address the lack of development in the marine aquaculture industry. He specifically suggests: (1) reevaluation and reaffirmation of the nation's aquaculture policy; (2) increased support of sustainable marine aquaculture; and (3) strengthened policy development through improved coordination. DeVoe summarizes that the key to the future of marine aquaculture in the United States is the creation of technological and political systems that provide for sustainable marine aquaculture. He contends that sustainable aquaculture necessitates that all aspects of the industry, including production and technology, economics and marketing, business and financing, natural resource needs and protections, and administrative and legal institutions are addressed comprehensively and simultaneously.

In ***Offshore Marine Aquaculture in the U.S. Exclusive Economic Zone: Legal and Regulatory Concerns*, Alison Rieser of the University of Maine School of Law and Susan Bunsick of the University of Delaware** begin by noting that the future development of marine aquaculture in the U.S. EEZ is constrained by legal and regulatory concerns that need to be addressed in order for the industry to become both financially viable and internationally competitive. The authors describe the current federal regulatory framework, identify important elements that need to be included in an improved government framework, review the major obstacles to offshore aquaculture, and present an overview of recent U.S. government planning initiatives.

Among the legal obstacles to consider in any revision of the current regulatory framework, the authors identify five issues: (1) limited availability of property rights or other interests that can secure a producer's investment; (2) poorly defined standards that fail to reduce conflicts among competing users of public resources; (3) poorly defined agency jurisdictions leading to delays in defining applicable standards or regulations; (4) redundant regulations due to overlapping agency responsibilities; and (5) inappropriate restrictions designed to protect wild stocks.

After reviewing the current status of U.S. government planning efforts, the authors note that a window of opportunity for addressing the issues associated with the development of marine aquaculture was missed in the most recent reauthorization of the National Aquaculture Act, which left the current federal approach unaltered. However, funding for marine aquaculture has been included in the Clinton Administration's National Oceans Initiative, which was announced in June 1998. The authors conclude that adoption of the draft National Aquaculture Development Plan could facilitate the changes in the legal and regulatory framework that are necessary to promote the development of marine aquaculture in the EEZ.

In ***The Potential for the Marine Biotechnology Industry*, Shirley Pomponi of the Harbor Branch Oceanographic Institution** begins by noting that the marine environment is a rich source of both biological and chemical diversity, and the oceans represent a virtually untapped resource for discovery of novel and useful compounds. Pomponi focuses on the current status and future potential of marine biotechnology related to the discovery, development, and sustainable use of marine-derived compounds with biomedical applications. She also identifies four of the challenges facing the marine biotechnology industry in the next millennium: (1) identifying new

sources of marine bioproducts; (2) developing novel screening technologies; (3) providing a sustainable source of supply; and (4) optimizing production and recovery of bioproducts.

With regard to the first challenge, the identification of new sources of marine bioproducts, Pomponi notes that federal agency support for deep ocean exploration for biotechnology is limited, and that manned and unmanned submersibles are underfunded and restricted. Pomponi contends that there is a need for the development of versatile bioreactors that can be deployed and operated in extreme environments. She also notes that another approach to the identification of new products is the incorporation of miniaturized biosensors into both collecting tools and bioreactors for rapid, in situ analysis of both wild and cultivated marine organisms for target molecules. Concerning the second challenge, Pomponi states that none of the assays used in major pharmaceutical drug discovery programs considers the role of marine-derived compounds in nature, and that the development of in situ biosensors would facilitate the ability to explore the expression of secondary metabolites, lead to a greater understanding of the role of secondary metabolites in nature, and provide insight into the potential biomedical utility of such compounds.

With regard to the third challenge, the author notes that some options for sustainable use of marine resources are chemical synthesis, controlled harvesting, aquaculture of the source organism, in vitro production through cell culture of the microorganism or its source, and transgenic production. Considering the fourth challenge, Pomponi points out that the area in which marine bioprocess engineering has the greatest potential is in the design and optimization of bioreactors for marine metabolite production. To summarize, Pomponi states that the marine biotechnology industry faces a unique challenge: inventing a new generation of tools and processes to discover new bioproducts and designing methods for their sustainable development.

In *Emerging Challenges for U.S. Marine Biotechnology*, Robert Knecht, Biliana Cicin-Sain, and Dosoo Jang discuss the policy challenges that the U.S. marine biotechnology industry will face in the near future-challenges related to the evolving international framework affecting marine biotechnology operations. The first policy challenge is defining an appropriate regime for governing access to marine resources / organisms under the jurisdiction of coastal nations as well as to genetic resources found in deep-sea areas; this will require harmonization between the Law of the Sea Convention and the Convention on Biological Diversity. The second major policy challenge is the issue of safety in biotechnology, or "biosafety," as this issue has become known. While there are not yet any binding agreements to address the transboundary movement of living modified organisms, there has been a major effort underway to develop an international agreement on safety in biotechnology, under the aegis of the Convention on Biological Diversity. Such a legally-binding agreement will greatly affect an individual nation's behavior and its domestic policies on biotechnology in the next century. Finally, the issue of intellectual property rights represents a major policy challenge for the U.S. marine biotechnology industry at the international level—countries in the "North" (developed nations, the U.S. included) want stricter intellectual property controls on new biotech discoveries (to guarantee the biotech industry the recovery of their investments and costs); while, in contrast, the "South" (the developing nations) are concerned about inequitable sharing of benefits arising from the utilization of their genetic resources.

In ***Building Capacity for Ocean Management: Recent Developments in U.S. West Coast States,*** **Marc Hershman of the School of Marine Affairs at the University of Washington** begins by noting that in a previous paper, he had concluded that there was a trend toward increased state-level participation in ocean management within the United States, and that this trend was likely to continue because the states' role in these issues had become institutionalized. In this paper, Hershman reports on recent developments in the West Coast states of California, Oregon, and Hawaii to determine how their role in ocean affairs has progressed since 1996.

After reviewing developments in California, Oregon, and Hawaii, Hershman concludes that all three states have continued to advance an ocean program. He notes that political and leadership changes can influence progress in a new subject area like ocean management. Organizational change and revision of policy documents have hindered progress in the past, and Hershman states that with the exception of Oregon, this pattern may continue to dominate. Hershman finds that there appear to have been substantive shifts in at least three areas. The first issue is fisheries policy. While fisheries-related issues were previously unaddressed in the three states' ocean management programs because of existing fisheries management agencies, in the past two years all three states have adopted new laws or policies

dealing with fisheries management. The second policy shift has been in the area of increased local government involvement in ocean affairs. The third policy shift is in the area of maritime policy, particularly in establishing state maritime policy and designating responsible agencies.

Hershman concludes that the experiences of California, Oregon, and Hawaii suggest that the scope of ocean issues of concern to coastal states is broadening. He notes that these states' capacity for ocean management has improved since new laws and governmental responsibilities have been identified and added to the states' suite of management tools. However, Hershman cautions that there is still considerable flux in defining responsibility for ocean issues in the states.

In ***Coastal States' Challenges,*** **Sarah Cooksey of the Delaware Department of Natural Resources and Environmental Conservation and the Coastal States Organization** describes the importance of the Coastal Zone Management Act (CZMA). Cooksey notes that the CZMA is the only federal statute that puts forth a comprehensive, voluntary, federal-state partnership based on the goal of maximizing sustainable economic and environmental objectives. Cooksey maintains that it is time for a major commitment through the CZMA to provide for new and improved planning and management tools for local communities so that they might better understand and address complex economic and ecological dynamics of coastal systems and communities.

After providing background on the CZMA, Cooksey presents a summary of the Coastal States Organization's proposals for reauthorization of the CZMA in 1999: (1) provide increased support for the development of new tools which will build capacity at the state and local level through technical assistance and targeted support to states and communities to implement place-based management in critical coastal areas; (2) provide for increased support for state coastal programs to address the cumulative and secondary impacts of development and land-based sources of polluted runoff; (3) provide funding under the Coastal Zone Management Fund for regionally significant projects, international projects, emergency response to coastal hazards, and innovative demonstration projects addressed at local communities; (4) clarify the role of and provide increased support for the National Estuarine Research Reserves and seek to build closer links to coastal programs; and (5) enhance federal support for base programs under the CZMA consistent with increased challenges and responsibilities, particularly in the nation's largest states where base grants have been capped for the past seven years despite substantial increases in state and local needs.

In ***Development of a Comprehensive Ocean Policy for Florida,*** **James Murley and Laura Cantral of the Florida Governor's Ocean Committee** discuss Florida's efforts to develop an ocean management approach that is coordinated and comprehensive, and that can account for a wide variety of uses and activities. The authors include a brief history of the current ocean planning initiative, describe the preliminary projects that laid the groundwork for the creation of the Florida Governor's Ocean Committee, and summarize the Committee's work to date.

Murley and Cantral note that the impetus for developing an ocean management strategy for Florida began with the Florida Coastal Management Program (FCMP), located in the state's Department of Community Affairs. The FCMP serves as the coordinating agency for nine state agencies that regulate coastal activities, and over time it became clear that an integrated framework was needed to manage offshore ocean resources and to eliminate inconsistencies between different agency responsibilities.

In order to provide shape and direction to the ocean management effort, the FCMP funded a series of preliminary projects that, among other things, were designed to generate support for ocean planning and ultimately to justify the creation of a high-level group that would be charged with developing coordinated ocean governance strategies for the state. The projects included a comprehensive analysis of the status of marine law and policy in Florida; a Statewide Ocean Resource Inventory (SORI); and the Florida Ocean Policy Roundtable. Once these projects were complete, the next step toward the development of a comprehensive ocean management strategy was the formation of a formal policy committee, known as the Florida Governor's Ocean Committee (FGOC).

Murley and Cantral note that the FGOC developed a number of ocean management strategies, contained in the Committee's draft final report. The strategies are organized into five broad categories: (1) improving information on and understanding of ocean resources; (2) creating an improved ocean management framework that is more coordinated and comprehensive; (3) achieving and sustaining diverse marine ecosystems that are capable of supporting multiple uses; (4) raising awareness, promoting

education, and fostering stewardship of the ocean; and (5) facilitating greater financial support for ocean research, education, and management.

Taken together, the suite of papers presented in this volume provide, we think, a wide-ranging picture of current trends, issues, and emerging challenges in a variety of areas of national ocean and coastal policy. We expect that future National Dialogues will further define and expand on these themes.

Acknowledgments

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1. The Next 25 Years: Global Issues

The development of human society is coupled to the health of the planet. Speakers in the first session of the conference addressed fundamental transformations and trends, which require societal responses. These include changes in the distribution of wealth and the organization of society; the implications of unchecked population growth for coastal regions; and global trends in fisheries and aquaculture. For the United States, this session included a comprehensive examination of underlying and emerging trends that are shaping the coast, coastal resources and uses, and coastal management and policy.

Ocean and Coastal Futures: The Global Context
Allen Hammond, World Resources Institute

Global Trends in Fisheries and Aquaculture
Richard Grainger, Fisheries Department,
UN Food and Agriculture Organization

The Coastal Population Explosion
Don Hinrichsen, UN consultant and author

Trends in U.S. Coastal Regions, 1970-1998
Charles Bookman, Thomas Culliton, and Maureen Warren,
National Ocean Service, NOAA

OCEAN AND COASTAL FUTURES: THE GLOBAL CONTEXT

Allen Hammond
World Resources Institute

The interaction of human society and the planet is a coupled nonlinear complex system. If you take complex systems apart and just study the parts, you miss some of the important phenomena; you have to look at the whole. So it is important to try to take an overview of how many factors interact—population trends, economic trends, social and political trends, environmental trends, security trends. I will emphasize environmental trends in these remarks, but will touch on others too, to answer two questions: What are the forces that are shaping our world in coming decades, and where would we like to end up? Can we envision some trajectories that will get us to the kind of world that we would like to pass on to our grandchildren?

As a society, we're not very good about looking ahead. Much of our economic decision-making is governed by the quarterly profit statement, and our political horizons rarely go much beyond the next election.

As a society, we're not very good about looking ahead. Much of our economic decision-making is governed by the quarterly profit statement, and our political horizons rarely go much beyond the next election. Yet we're making choices, consciously or unconsciously, that are going to have generational implications: our use of energy and its implications for future climates, for example, or our loss of species and the implications for a more biologically impoverished planet.

Analysis of persistent trends can tell us a lot about the future—about constraints or plausible ranges of important variables. But trends are not destiny, and many important factors that govern the future cannot readily be quantified. So I also use scenarios to explore different trajectories into the future, scenarios that reflect radically different assumptions or world views about the future. Scenarios are not predictions, but they are powerful tools for thinking about the future precisely because we respond to them emotionally as well as cognitively. And that helps generate a process of making choices—it highlights and changes the way you think about the present in ways that might influence your actions.

I will discuss three scenarios—*Market World*, *Fortress World*, and *Transformed World*. They also turn out to be a good way to organize a discussion of key trends.

Market World is the vision of the future that points to the extended U.S. boom and the free market policies that have engendered it as a model for the world. It also points to the continuing technological revolution, to the spread of democracy around the world, to widespread and rapid improvements in literacy, even to environmental improvements in many industrialized countries. It is a scenario that calls for downsizing government by privatizing and deregulating and asserts that free markets and the genius of the private sector will solve our problems and bring widespread prosperity. This world view is broadly held in corporate boardrooms and among high-tech entrepreneurs, and it is supported by many politicians. And markets do have the upper hand at the moment—they often dictate to governments, as Southeast Asia has recently found. Furthermore, economic reform and governmental downsizing have enormous momentum in many parts of the world. Market World is a powerful vision, because we suspect that at least parts of it are right—markets and the private sector will play a major role in the future. On the other hand, we also know that markets don't automatically solve environmental problems, and they don't solve equity or other social problems. In fact, they often make them worse.

Could unattended environmental and social problems undermine Market World? Populations are still growing rapidly, especially in the poorest parts of the world. Urbanization is occurring even more rapidly, with a million new urban residents a week worldwide. In China, for example, experts expect 300 million people to move from rural to urban areas between 1995 and 2010—the equivalent of all of North America moving to the city in 15 years. Can developing societies build the necessary housing and

other infrastructure rapidly enough? Will there be enough jobs in urban areas? And what about the environmental impact of hundreds of new megacities, many of them located in coastal areas and most of them with inadequate pollution control?

If we look at environmental trends more systematically, it is useful to focus first on those associated with industrial activity. Consumption of natural resources to produce the goods and services that our economies provide also produces pollution and waste. It turns out that it now requires annually about 80 metric tons of natural resources per person to support the U.S. lifestyle and the U.S. GDP, and a comparable amount in other industrial countries. As industrialization spreads around the world, how will natural resource consumption rise? The conventional wisdom is that world energy consumption is likely to grow by a factor of 2.5, and manufacturing activity by a factor of 3, over the next half century. But with much of that growth concentrated in developing regions, the potential for increased pollution in those regions—especially air pollution and toxic pollu-tion—is much higher. And globally, if fossil fuels continue to be the primary source of energy, the impact of this consumption pattern will be rapidly rising atmospheric concentrations of greenhouse gases, suggesting that we may well find out what global warming and a changing climate are all about.

...the trends suggest that soil loss is accelerating, that forests everywhere are at high risk of degradation, that many of the most biologically rich coral reefs are even now at high risk, and a majority of the world's marine fisheries are overfished and in danger of severe degradation.

A second set of environmental trends are those associated with the degradation of Earth's biological systems. And these may have an even greater and more direct impact on human welfare, because as much as a third of the earth's population still depends directly on local environmental resources—what can be grown or gathered or caught—for most of their sustenance and livelihoods. Yet the trends suggest that soil loss is accelerating, that forests everywhere are at high risk of degradation, that many of the most biologically rich coral reefs are even now at high risk, and a majority of the world's marine fisheries are overfished and in danger of severe degradation. And as populations rise, a finite amount of such renewable resources as fertile soil or water must serve more and more people. So the risk is for growing biological impoverishment, and for human impoverishment as well, not to mention the potential for growing resource conflicts.

In addition, if Market World fails to spread the wealth and improved welfare it generates to all of Earth's people, might we also have quite a large number of people who know more and more about how the rich live but who know that they don't have any chance to participate in such wealth or even to meet their basic needs? And might such people, in their frustration and even anger, become a vast recruiting ground for terrorism and fuel growing illegal migration? If there aren't enough jobs in the swelling cities of the developing world, might the result be growing crime and instability and the potential for violence? Might emergent diseases—some 30 in the past 20 years, most arising from the degraded ecosystems in developing countries—become an even greater global health threat? In short, might there be new security threats to cope with as well?

If you put all of these adverse trends together, the result is a different vision of the future, which I call *Fortress World*. The fortress imagery comes from thinking of islands of luxury and privilege surrounded by oceans of poverty and despair and environmental degradation. Whether on a small scale—like the high-rises on the beach at Rio surrounded by the shanty towns on the hills, or the gated communities that you see spreading in this country—or on a larger scale—the whole United States as an island of prosperity in an ocean of countries that are suffering, like Central America—the image is a powerful one.

Fortress World is a dark vision. It's certainly not a world that anybody wants to live in. But neither is it possible to dismiss it. Private security forces now outnumber the police by four to one globally, and by ten to one in places like South Africa and Russia. Think of how many places now where businessmen have to have bodyguards and send their kids to school in armored limousines—in Moscow, Mexico City, Hong Kong. Even the middle class in Colombia worry about kidnaping.

Fortress World is a symbol of what's plausible but which we hope will not come to pass. What other options are there?

That leads me to what I call *Transformed World*. That's a vision that says we know we're going to need fundamental social and political reform to solve some of these problems. We need some new forms of governance, because we can't run a global economy without some form of regulation—the last year showed that all too clearly. And quite apart from such things as regulation, we need new ways of making decisions. We need to reform some of our institutions. We need some changes in values and behaviors. Transformed World is a scenario in which these things actually occur.

To some degree, such a scenario requires a leap of faith. But to a surprising degree, many of these transforming trends are already underway, at least in a preliminary form. And that offers both cause for optimism and an agenda for action.

Think about the remarkable change in attitudes towards smoking in the United States in the last ten years. Such changes in attitudes and behaviors are a source of great hope for the future. For instance, if the world decided that climate was important, we could find ways to solve the climate problem. Partly what is required is policy reform, but more fundamentally what is needed are changes of attitude, a new social and political consensus about where we want to go. Then the policies will follow.

Places like Poland and the Czech Republic have been essentially reborn with much more optimism and hope and progress, even though their physical problems haven't at all gone away. And such changes illustrate that political consensus and social attitudes can change very quickly and are absolutely important in determining what's going to happen.

Technology is also creating new options, new tools that can help, if we have the wit to use them creatively.

Still another hopeful trend is the rise of civil society: church groups, environmental groups, citizens organizations, nonprofit aid agencies, university students and faculty, and many others. Such nongovernmental organizations (NGOs) already play an important role locally and nationally, and they are beginning to emerge as a force at an international level—delivering services, setting political and social agendas, brokering new forms of collaboration with the private sector. A good example is the treaty to ban land mines that was passed last year, largely driven by a group of more than 700 NGOs around the world.
The Internet is empowering civil society in a unique way because it lets groups link together in coalitions. And civil society groups far outnumber both governments and major corporations, and their numbers are growing rapidly. In effect, civil society is forging a new form of governance, a new mode of social decision-making and consensus-building that may prove crucial in the decades ahead.

Finally, I want to point to the greening of corporations as a still preliminary but potentially very important transforming trend. Look at what happened on the climate front just in the last few months. Some 15 or 20 major global companies came out actively endorsing the need for a climate treaty: GM, BP, Monsanto, Dupont, and a host of others. In almost every case they had worked with a group of environmental NGOs, including my organization. The result is that these companies decided: (a) they could live with a climate treaty, (b) it was socially responsible to start acting as though that was going to happen, and (c) there was a tremendous business opportunity if they got out in front.

We're beginning to see corporations going beyond narrow compliance to take a leadership role, but that may accelerate. The larger the corporation, the more vulnerable it is to social expectations, and as companies understand that, they're increasingly going to realize that they can't afford not to be perceived as part of the solution, not part of the problem. And global corporations do have very unique capabilities, if they could be harnessed to help solve environmental and developmental problems.

So there are a number of reasons to have some faith in a Transformed World vision. And thinking about Market World, Fortress World, and Transformed World poses the question of what choices we need to make. What would shift us from one trajectory, one scenario, to another?

If we think about how these trends and these scenarios might play out focused on our coastal and ocean areas, I think you'll see that while there are some issues unique to the coastal zone, it is not possible to isolate oceans and coasts from the trajectory of the larger society. So if we want to understand the forces shaping these regions, we have to look very broadly, as I have tried to do here.

GLOBAL TRENDS IN FISHERIES AND AQUACULTURE

Richard Grainger
FAO Fisheries Department

Introduction

This paper aims to describe past trends in capture fishery and aquaculture production, particularly concerning the development of marine capture fisheries, and to compare the current production with fisheries potential. Food fish supply prospects will depend to a large extent on the effectiveness of fisheries management and the responsible development of aquaculture, both of which will be tested in facing the sustainability challenge. An essential requirement for ensuring sustainable fisheries and aquaculture through good policies and management will be the provision of objective information on the state of fisheries and aquaculture.

The number of fishers and fish farmers more than doubled in the last 25 years, increasing from 13 million in 1970 to 30 million in 1995...

Contribution of Fisheries to Food Supply and the Economy

Global fish production has grown impressively, almost doubling average per capita food fish supply from 8 kilograms in 1950 to almost 16 kilograms in 1997 (Figure 1). The average consumption of fish protein has risen from 2.7 grams per capita per day in 1960 to 4.0 grams today, now representing 16% of all animal protein consumed by the world's 6 billion inhabitants. Of the 30 countries most dependent on fish as a protein source, all but 4 are in the developing world. In addition to human food, fisheries have provided a major source of high quality feeds for livestock and, increasingly, for aquaculture.

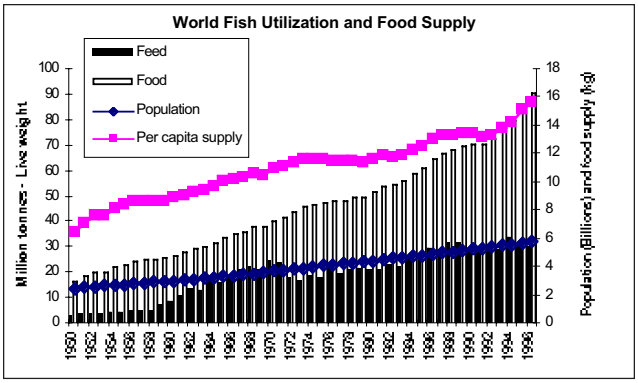

Figure 1. Trends in global utilization of fish for human food and animal feeds and average per capita food fish supply.

World fishers and fish farmers by continent

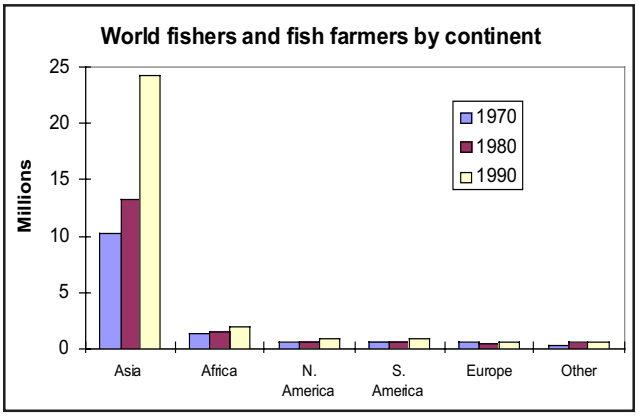

Figure 2. Number of people employed in the fisheries primary sector as fishers or fish farmers in 1970, 1980 and 1990 by continent.

World fishers and fish farmers by continent

2). The number of people dependent on fisheries for a livelihood has been estimated at 200 million worldwide.

First sale value of capture fishery production was worth an estimated $83 billion in 1995. Aquaculture production was worth a further $42 billion. Exports of fishery products worldwide were worth $52 billion in 1995. Since 1970, trade in fishery commodities has increased by a factor of 16, compared to 6 for agricultural commodities and 13 for all merchandise.

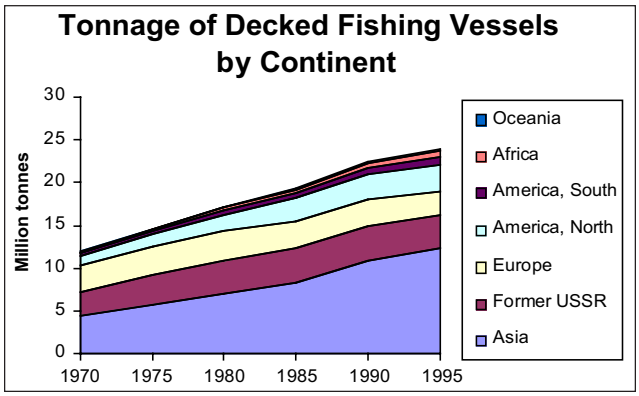

Figure 3. Trend in the total tonnage of the world's decked fishing vessels broken down by continent according to FAO statistics.

The Development of Capture Fisheries and the Need for Management

Fishing Fleets

According to FAO statistics, growth in the number of decked fishing vessels has been much slower since 1990, following two decades of rapid growth, particularly in Asia (Figure 3). Average tonnage of decked vessels has also increased slightly over this period.

Most of the increase in Asian fishing vessels since 1980 is attributable to the Chinese fleet, which increased rapidly up to 1990. Since 1990, the increase has been slower in terms of number but not much slower in terms of tonnage, probably because vessel size has been increasing in line with the policy of developing offshore fisheries. China's fishing fleet totaling about 5.5 million GT is now by far the largest in the world, followed by the fleet of the Russian Federation with a tonnage of about 3 million.

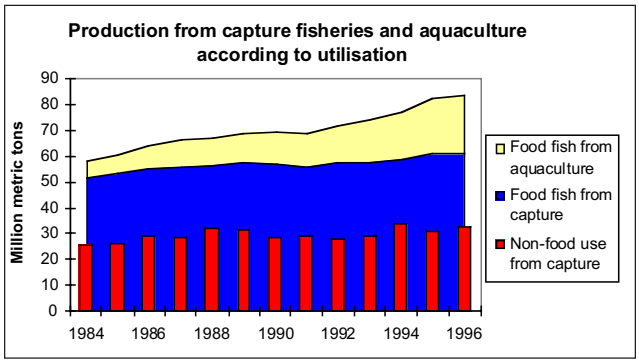

Figure 4. Fish production from capture fisheries and aquaculture destined for food and capture fishery production for non-food use (e.g. feeds).

A recent, and still preliminary, FAO assessment of industrial fishing vessels of over 100 GT (which account for a large proportion of total landings), has been undertaken based on data in the Lloyd's Register database. Lloyd's data show a significant decrease in fleet size from about 26,000 fishing vessels in 1991 to less than 23,000 in 1997, and with very little change in the tonnage per vessel. As with the FAO statistics, this contrasts with the growth in the fleet observed up to 1990.

Fishery Landings

Capture fishery production for both food and non-food utilization has leveled off in the last decade. The increase in food fish production in recent years has been entirely due to aquaculture (Figure 4). Per capita food fish supply from capture fisheries has actually declined during the last decade.

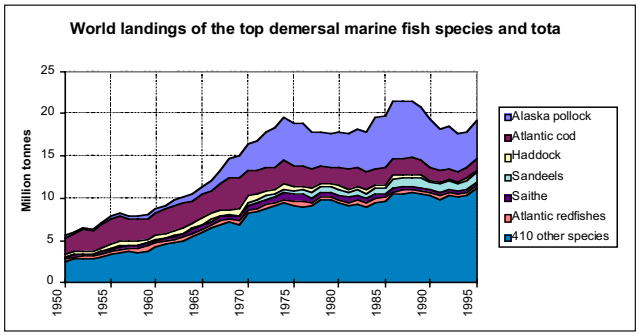

Figure 5. World landings of demersal fish species.

Total harvests of over 400 demersal fish species leveled off in the early 1970s (Figure 5). In contrast, pelagic fish catches, despite large fluctuations, have shown an underlying trend of increasing catches. There are signs that the increasing trend may now be coming to an end.

Tracking Fishery Development

Fisheries development started in the Northeast Atlantic, spread throughout the Atlantic, then to the Pacific and finally to the Indian Ocean. The marine fishery harvest potential of 100 million tonnes estimated by Gulland[1] in 1970 is now being approached.

A study undertaken by FAO[2] used a simple fisheries development model to track the state of fishery development of the world's top 200 marine fish resources based on trends in catches (Figure 6). A transition from mainly "undeveloped" fisheries to mainly "senescent" and "mature" is clear. About

60% of the resources are now categorized as "senescent" or "mature." These require urgent management action to halt the increase in fishing effort or rehabilitate overfished resources.

FAO analyses indicate that the Atlantic and Pacific Oceans are "fully fished," but that further fisheries expansion may be possible in the Indian Ocean. There are very few underexploited resources left, and some (e.g. krill and meso-pelagic fish) may not be commercially viable.

- Larger fish can often be fished more selectively, reducing discards and wastage.

Discards from marine fisheries have been estimated at 27 million tonnes per year. More recent estimates are about 22 million tonnes, still very significant. More selective gears and fishing practices can reduce the capture of unwanted bycatch. Utilization of unwanted bycatch can be increased. This is already happening in tropical shrimp trawl fisheries where

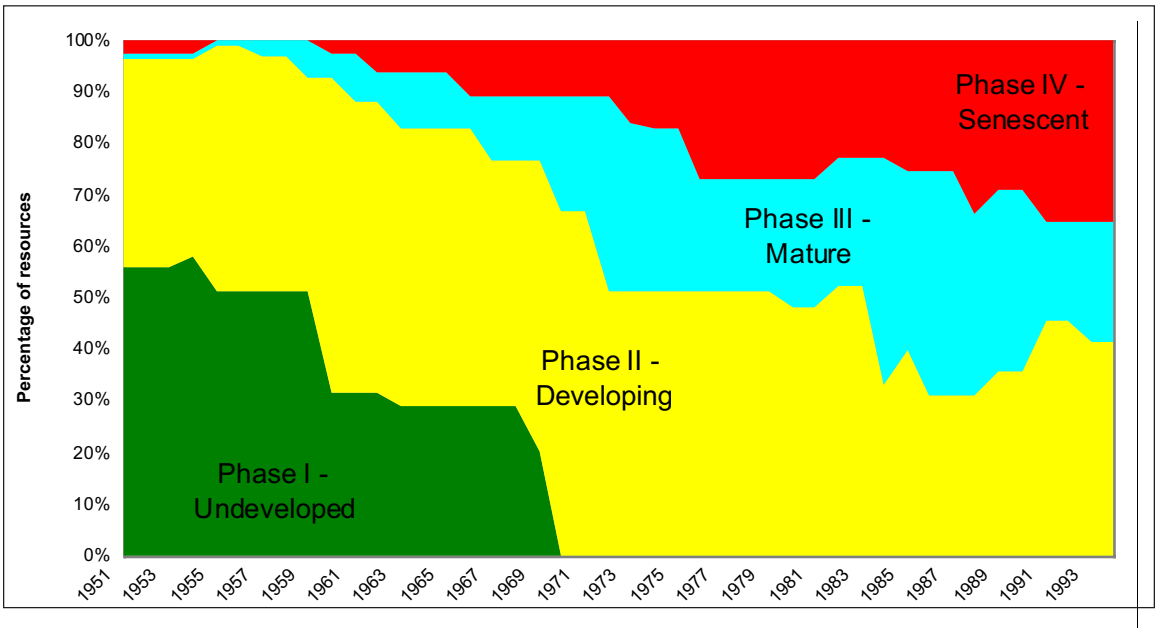

Figure 6. Percentage of major marine fish stocks in various phases of fishery development.

FAO analyses[3] provide estimates of marine fishery potential. The most reliable of these is 93 million tonnes, a gain of about 10 million tonnes from the present comprising 4 million tonnes from improved management in each of the Atlantic and Pacific Oceans and 2 million tonnes from further development in the Indian Ocean. Less reliable estimates imply higher gains derived almost entirely from new fisheries.

The benefits of effective management could be high, of the order of 10-20% of the present landed value of over US$80 billion. Apart from increased yield in quantity and revenue, there are other benefits to be derived from improved fisheries management, such as the following:

- Less fluctuation in yields from year to year as fish live longer, providing more stability to the industry.

- Fish grow larger and larger fish are often more valuable, increasing earnings per tonne.

fish previously discarded are increasingly used for food and aquaculture feed.

Fisheries Management: Turning Failure into Success

Fisheries management up to now has generally failed to protect resources from being overexploited. There are many reasons for this, including the following :

- Lack of political resolution to make difficult adjustments

- Persistence of direct and indirect subsidies
- Lack of control on fleets by flag states

- Ineffectiveness of fishery commissions to which member countries are reluctant to delegate necessary powers

- Lack of consideration of rights and potential contribution of traditional communities

- Success of industry lobbies in resisting change
- Lack of capacity for implementation of management in developing countries.

However, some recent developments have provided conditions which should allow an unprecedented opportunity for improving fisheries management, the most important of which are as follows:

- Widespread recognition of the problems of fishery management, with readiness to change expressed at highest levels of governance
- New concerns for the environment, people's participation, and empowerment
- Consensus on the institutional origin of the failure, with all other factors, including scientific uncertainty, being secondary
- Availability of international instruments and initiatives (e.g. UNCLOS, UN Fish Stocks Agreement, FAO Code of Conduct), often embracing the precautionary approach.

If this opportunity is lost and management does not improve, there could be a shortfall of 10-40 million tonnes between demand and supply for human consumption by 2010, despite increased aquaculture production. If domestic supplies of major importing developed countries are not improved, already expanding trade for human consumption will be further promoted, possibly leading to increased depletion of resources exploited by the major exporting developing countries.

There are other risks associated with not improving management. Abrupt resource declines with rapid corrective measures causing major socio-economic damage (e.g. Canadian cod fishery) will continue to occur. If the situation deteriorates, there may be slow changes in species dominance and trophic relationships and environmental degradation. There may be a loss of traditional fishing rights to other sectors such as conservation, tourism, oil industry, and coastal activities.

Aquaculture Development

Aquaculture, the farming of aquatic plants and animals, has been the world's fastest growing food production system for over a decade, with global per capita "food fish" supply from aquaculture (i.e. the production of farmed aquatic finfish and shellfish on a whole live weight basis, and excluding farmed aquatic plants) increasing at an average rate of 10.9% per year from 1.5 kilograms in 1984 to 4.6 kilograms in 1996.[4] By contrast, per capita food fish supply from capture fisheries has remained relatively static, increasing from 10.8 kilograms in 1984 to 11.0 kilograms in 1996 at an average rate of 1.8% per year or equivalent to the growth of the human population (1.75%) over the same period. On the basis of the above data, one quarter of fish consumed by humans in 1996, from a total average per capita food fish supply of 15.6 kilograms, is currently being supplied by aquaculture.

About 60% of the resources are now categorized as "senescent" or "mature." These require urgent management action to halt the increase in fishing effort or rehabilitate overfished resources.

Of particular importance was the fact that 28 million tonnes or 82% of total world aquaculture production in 1996 was produced within Low-Income Food Deficit Countries.[5] Moreover, aquaculture production within LIFDC's has been growing over 6 times faster (15% per year since 1984) than within developed countries (2.4% per year since 1984).

China alone produced two-thirds of total world aquaculture production, corresponding to 23 million tonnes, in 1997. Aquaculture provided about 55% of total Chinese fisheries production of 35 million tonnes in 1997. Moreover, in terms of meat production, total Chinese fisheries landings produced the equivalent of 22 million tonnes of aquatic meat products for human consumption in 1997, as compared with 55 million tonnes for total terrestrial meat products.

The rapid growth in aquaculture seems set to continue in the near term. Indicators pointing to good growth potential include increasing demand for fish, emergence of aquaculture as a sector for investment,

and recognition of its potential for expansion, and growing awareness of sustainability needs.[6] Sustainable development is the overriding strategic issue and challenge and, although most aquaculture is conducted with significant nutritional and social benefits and little environmental cost, actual and perceived negative impacts of some types of aquaculture have already constrained development, mainly in coastal zones.[7]

Information Needs

Fishery managers and policy makers will need to draw more on fisheries research programs which encompass economics, sociology, and anthropology, as well as biology. There will be a major need for development and use sustainability indicators to synthesize the very broad range of information. Above all, there will be a major need for comprehensive, reliable, and objective information on fisheries and aquaculture, including reviews, expert interpretation and analysis, the provision of scenarios and prognoses with associated benefits, losses and risks. FAO for its part plans to contribute to this.

Notes

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4 Tacon, A. and R. Grainger. Contribution of aquaculture to food security. In prep.

5 LIFDCs have an average per capita income <US$ 1505/annum in 1996 and are net importers of food in terms of calories.

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THE COASTAL POPULATION EXPLOSION

Don Hinrichsen
United Nations consultant and author

Humankind is in the process of annihilating coastal and ocean ecosystems. At the root of the problem are burgeoning human numbers and their ever-growing needs. Population distribution is increasingly skewed. Recent studies have shown that the overwhelming bulk of humanity is concentrated along or near coasts on just 10% of the earth's land surface. As of 1998, over half the population of the planet — about 3.2 billion people — lives and works in a coastal strip just 200 kilometers wide (120 miles), while a full two-thirds, 4 billion, are found within 400 kilometers of a coast.

Recent studies have shown that the overwhelming bulk of humanity is concentrated along or near coasts on just 10% of the earth's land surface.

Take the example of China, the world's most populous nation. Of China's 1.2 billion people, close to 60% live in 12 coastal provinces, along the Yangtze River valley, and in two coastal municipalities — Shanghai and Tianjin. Along China's 18,000 kilometers of continental coastline, population densities average between 110 and 1,600 per square kilometer. In some coastal cities such as Shanghai, China's largest with 17 million inhabitants, population densities average over 2,000 per square kilometer.

In general, with the exception of India the bulk of Asia's population is coastal or near coastal. Of the region's collective population of 3.5 billion, 60% — 2.1 billion — live within 400 kilometers of a coast.

Indonesia and Vietnam are two typical examples of Asia's population shift from the hinterlands to coastal areas. Of Indonesia's population of 200 million, 130 million live on the main island of Java, on just 7% of the country's land area, most of them in rapidly growing towns and cities. Similarly, Vietnam's population is almost all coastal. And coastal populations are growing two-tenths of a percentage point faster than the rest of the country. Population densities along the country's coastline average between 500 and 2,000 people per square kilometer. In parts of Hanoi, population densities average 35,000 per square kilometer.

Japan's population is also overwhelmingly coastal. Japan transformed itself from a largely rural and noncoastal nation into an overwhelmingly urban and coastal country within two decades. In 1950, Japan's 83 million inhabitants were dispersed throughout the country, with nearly half living in farming households. By 1970, most Japanese were living in urban areas, the majority of them in the Pacific Coastal Belt, which extends from Tokyo southwest through the Seto Inland Sea to the northern part of the island of Kyushu. As early as 1970, the national census revealed that over 53% of the population lived in densely inhabited districts that occupy 1.7% of the country's land area. Population densities in this crowded region average over 11,500 per square kilometer.

In 1997, Japan's total population amounted to 126 million. Of this, nearly 80% or 100 million, are considered coastal. But no one in Japan lives more than 120 kilometers from the sea. Furthermore, 77% of all Japanese live in urban areas along or near the coast. The dramatic shift has left much of the interior drained of workers. Nearly 47% of Japan's land area, mostly in the interior, is now designated as "depopulated" and eligible for special funding.

The population of Latin America and the Caribbean is even more littoral. The region's coastal states have a collective population of around 610 million, a full three-quarters of whom live within 200 kilometers of a coast.

The majority of the Caribbean Basin's 200 million permanent residents (including over 20 million people living in 99 coastal counties along the U.S. Gulf Coast) live on or near the seashore. The resident population is swelled every year by the influx of some 100 million tourists, nearly all of whom end up on the region's beaches.

Consider the following trends:

- On South America's crowded west coast, some 40 million people crowd along thin coastal strips. In Chile, three-quarters of the population live and work along a 500-kilometer stretch of coastline between Valparaiso and Concepcion, on 15% of the country's land area.

- The east coast is even more crowded. Some 15 million people live in the Buenos Aires-La Plata-Montevideo region.

- The largest and most crowded coastal area by far is the highly urbanized region stretching from Sao Paulo to Rio de Janeiro, Brazil. This area already bulges with 30 million people. If trends continue, it is expected to hold 40 million or more inhabitants by 2010.

Of all the continents except the Antarctic, only Africa has more people living in the interior than along or near coastlines and major river valleys. But even here, demographic patterns are shifting. Over the past two decades, Africa's coastal cities — centers of trade and commerce —have been growing by 4% a year or more, drawing people inexorably out of the countryside. Cities such as Lagos, Mombasa, Dar es Salaam, Accra, Abidjan and Dakar have seen their populations explode from in-migration.

Europe and North America

The forces at work in the developing world also account, in large measure, for the explosion of coastal towns and cities in the industrialized countries of Europe and North America. Historic patterns of economic development that fueled the first industrial revolution and transformed coastal cities into international centers of trade and commerce have been augmented since the end of the Second World War by a massive population shift from the hinterlands to coastal areas. Millions of middle class families now have significantly more disposable income and more leisure time to enjoy the fruits of their labors. Seacoasts, with their boundless economic opportunities and better quality of life, increasingly are viewed as preferred places to live, work, play, and retire.

One of the most celebrated and threatened coastlines in the world is the Mediterranean. Here, north and south meet, with all the tensions such a confluence cultivates. According to demographic projections worked out by the Mediterranean Blue Plan, the socioeconomic part of the Mediterranean Action Plan that links the protection of the environment with various levels of development, the Mediterranean Basin's resident population could go as high as 555 million by 2025. Also, according to Blue Plan projections, the urban population of coastal Mediterranean administrative regions could reach 176 million — 30 million more people than the entire coastal population in 1990. Furthermore, depending on how tourism is developed in the future, the Mediterranean could be hosting up to 350 million seasonal tourists every year by 2025. At the same time, the number of the automobiles in the region's is expected to triple, causing serious air pollution problems in many urban areas.

Michel Batisse, president and chief architect of the Blue Plan and former assistant director-general for science at UNESCO, is convinced that the future of the region is in jeopardy. "While northern populations with declining fertility rates will become progressively older, the southern and eastern regions will be dominated by young people," points out Batisse. "The numbers arriving on the labor market will largely exceed those leaving it, with a maximum gap around 2020, creating considerable unemployment and probably spawning waves of migrants heading to Europe in search of work."

Batisse argues that these trends are likely to generate serious conflicts over dwindling resources in an increasingly polluted environment. This will be especially true for water availability, as well as mounting land use conflicts, traffic congestion, destruction of wetlands, soil erosion, and continued pollution of coastal waters.

"In all the scenarios we developed for the southern and eastern rim countries, their development problems are aggravated by rapid, pell-mell urbanization," notes Batisse. "The greatest concentration of people will continue to be in the narrow, mountain-lined coastal strips characteristic of the region."

In the United States, 55-60% of Americans now live in 772 counties adjacent to the Atlantic and Pacific Oceans, the Gulf of Mexico, and the Great Lakes. The Washington D.C.-based Population Reference Bureau reports that between 1960 and 1990 coastal population density in the United States increased from an average of 275 to nearly 400 people per square kilometer. In 1990, the most crowded coastline in the United States, stretching from Boston south through New York and Philadelphia to Baltimore and Washington D.C., had over 2,500 people per square

kilometer. Another 101 coastal counties had population densities exceeding 1,250 per square kilometer.

Florida, which is almost entirely coastal, is projected to have more than 16 million residents by 2010, an increase of over 200% from its 1960 level of 5 million. South Florida, which had a 1990 population of 6.3 million, is expected to have 15 to 30 million people by 2050. Similar dramatic increases are projected for California and Texas.

The five states with the greatest rise in population are all coastal: California, Texas, Florida, Georgia, and Virginia. By the year 2025, nearly 75% of Americans are expected to live in coastal counties. These counties already contain 14 of the country's 20 largest conurbations.

Implications for Planning

What these demographic trends portend for the urban landscape and resource management are disturbing, to say the least. Most of the developing world lacks the capacity to manage current coastal population growth in any equitable fashion. Nor do most developing countries have the political motivation, expertise, or money to introduce comprehensive coastal management plans. At the same time, the developed world has not come to grips with the implications of these demographic and resource trends.

Now is the time to develop and introduce management plans that protect vital coastal ecosystems, while permitting economic growth and ensuring a better quality of life for all coastal dwellers. Continued denial of the problems will only make solutions harder to achieve.

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TRENDS IN U.S. COASTAL REGIONS, 1970-1988 [1]

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Coastal areas are invaluable for their economic vitality and biological diversity. At the same time, the coasts are under considerable pressure. This paper examines underlying and emerging trends that are shaping the coast, coastal resources and uses, and coastal management and policy. Present and projected trends are discussed in population and settlement; social values; economic activity; resources; environmental quality; hazards; and governance and management.

Population growth and its associated impacts may be the most critical issue confronting coastal managers and decision-makers.

Coastal population and settlement

Population growth and its associated impacts may be the most critical issue confronting coastal managers and decision-makers. Coastal areas are crowded and becoming more so. About half the nation's population presently resides in the narrow fringe of coastal counties. From 1996-2015, the coastal population is projected to increase from 141 million to 166 million. Population growth and consequent increases in settlement densities bring jobs, create economic prosperity, add new industry, improve regional infrastructures, enhance educational opportunities, and increase tax revenues—but they also burden local environments. As coastal populations swell, the natural features that may have attracted people to the coast are lost or diminished. Population pressures lead to increased solid-waste production, higher volumes of urban runoff, losses of green space and wildlife habitat, declines in ambient water quality, and increased demands on wastewater treatment, potable water, and energy supplies. To control these kinds of impacts, states and localities have begun to channel public investment for infrastructure into areas that are best able to accommodate growth without deleterious environmental impacts.

Social trends

Thirty years ago, most Americans believed that resources were essentially infinite and could be exploited forever. Today, in contrast, marine and coastal resources are known to be finite, and capable of being harmed or lost by human activities. As shown by national polling data, the transition of the environment from an issue of limited concern to one of universal concern occurred years ago. Moreover, the public understands the ocean's importance to human health, and demonstrates a sense of responsibility to protect the ocean for present and future generations. Coincident with the evolution of public attitudes that favor ocean protection, nongovernmental organizations have risen to work with both landowners and government agencies to conserve and manage the environment, and they have considerable technical and managerial capabilities and resources.

Economic and resource trends

Marine-related economic activities in the coastal zone and coastal ocean account for up to two percent of the U.S. Gross National Product and are comparable in scope to other important sectors of the economy, such as agriculture. Recreation and tourism, waterborne commerce, energy and mineral production, and fisheries account for most economic activities along the coast.

Table 1. The environment as a voting issue: Exit polls, 1982-1992

Year	Exit Pollster	Most Important Issues	Percentage
1982	CBS / NY Times	Unemployment	38
		Environment	*3*
1984	LA Times	Government Spending	22
		Environment	*4*
1988	CBS / NY Times	Helping Middle Class	25
		Environment	*10*
1990	Voter Research and Surveys	Education	26
		Environment	*21*
1992	Voter News Service	Economy / Jobs	12
		Environment	*5*

Source: Adapted from Ladd and Bowman, 1996

- **Recreation and tourism**. Outdoor recreation and tourism are the most significant economic activities in the coastal zone, accounting for half or more of total ocean-related economic activity. Despite the diversity and scope of recreational activities—from birdwatching, to boating-based sports, to second-home developments—little information is available on coastal and marine recreation and tourism, its scope, importance, and impacts. Interestingly, the government plays an important role in providing the underlying conditions for marine recreation and tourism. These include (1) ensuring a clean environment, (2) assuring coastal access, and (3) promoting a safe operating environment. Given the economic importance of marine recreation and tourism, and the importance of the government role in providing the basic underlying conditions for these activities, much more could be done to understand, document, manage, and promote marine recreation.

- **Waterborne commerce.** U.S. waterborne foreign trade is projected to continue to grow at an average annual rate of 3.7 percent. Domestic waterborne trade is also growing, and becoming more diverse—the shifting of freight cargoes from ships to barges, and the growth in passenger traffic, especially ferries and day boats, are prominent domestic trends. The focus of all this activity is the major ports (about 145 of them), each of which handles more than 9 million metric tons of cargo annually. These ports need to keep pace with the growth in trade, and other changes in ships and shipping. U.S ports are affected by important changes in two areas: (1) the rapidly changing intermodal freight transportation market, which moves increasing amounts of cargo on ever more demanding schedules, and (2) the increasing number and complexity of environmental regulations that pertain to ports. The U.S. Department of transportation and other agencies have initiated a coordinated national effort to highlight trends, promote coordination at the national level, and encourage local solutions. This will help ensure adequate port infrastructure, including appropriate channel and berth depths, real-time navigation information, modern port facilities, and efficient intermodal connections.

- **Energy and minerals resources and production**. About 19 percent of the nation's produced oil comes from federal offshore lands. Moreover, revenues and royalties earned on this production are a significant source of revenue for the federal government. Heightening the importance of the oceans to the U.S. energy supply is the fact that about 50 percent of oil consumed is imported by ship, and the reliance on imported petroleum is slated to grow to 60 percent by 2010. An increasing fraction of domestic offshore oil and gas is being discovered and produced from wells drilled in deep water, especially in the Gulf of Mexico. Rapid and dramatic technology advances, coupled recently with relief from paying royalties on deepwater production, have combined to encourage the trend toward deep water production. Current models suggest that federal offshore lands contain 50 percent of the nation's remaining undiscovered oil and gas resources; offshore oil production rates are projected to increase by at least 10 percent between 1995 and 2000.

- **Fishery resources and food supply**. U.S. fishery landings have increased over the past 50 years, but have now reached the maximum capacity of our oceans and coastal waters to produce fish. While landings in Alaska have increased dramatically, they have declined in other regions for many species. In addition, for some marine species, recreational landings represent a significant and growing proportion of the catch. The challenge in fisheries management is to achieve sustainable fisheries over the long-term. To accomplish this, it is necessary to end overfishing and allow depleted stocks to rebuild.

  The acreage of designated shellfishing waters is at an all-time high. At the same time, health restrictions on these waters are at their lowest levels since 1980. Overall, the condition of shellfish harvest waters is improving.

  The degradation and loss of coastal habitats, with other factors such as overfishing, are constraining the contribution of fisheries to world dietary needs at a time when population growth and rising affluence are increasing the demand for food. Aquaculture holds some promise as an alternative to wild harvest, but has environmental problems of its own.

Environmental quality

Coastal oceans and estuaries are among the most productive and valuable natural systems. They are also among the most threatened. Environmental stressors include nutrient overenrichment, bacterial

contamination, chemical pollution, oxygen depletion, oil and grease spills and contamination, and planned and unplanned habitat alterations. The importance and severity of these stressors varies from region to region and often is a consequence of human activity.

- **Point sources.** Point sources of pollution include discharges of municipal and industrial wastewater and dumping of materials into ocean waters. In general, the nation has made a massive and partially successful investment over the last generation to control point sources, and the environment has benefited as a result. Two of the outstanding successes include (1) more widespread wastewater treatment, and higher levels of treatment, across the nation, and (2) the elimination of most ocean dumping and greater control over the one major dumping activity that remains—the disposition of materials dredged from navigable waterways. The developments in wastewater treatment are mirrored and confirmed in environmental measurements that show long-term reduction of heavy metal and organic chemical pollution in the marine environment near urban areas, as well as improvements in other indicators of environmental quality. Ocean dumping of dredged material now is confined to clean materials placed in designated dump sites that are carefully monitored.

In general, the nation has made a massive and partially successful investment over the last generation to control point sources, and the environment has benefited as a result.

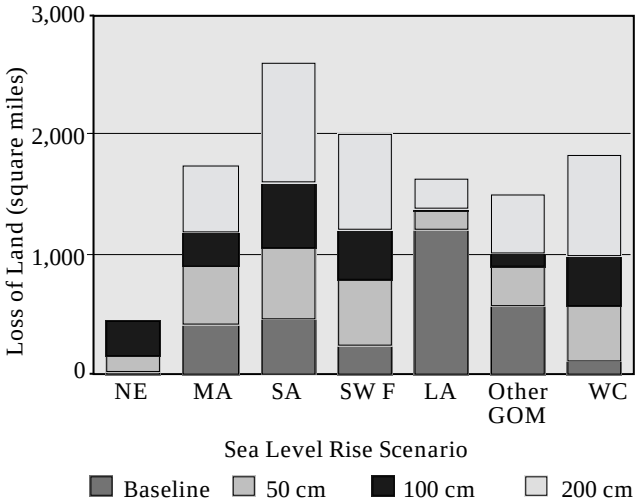
- **Nonpoint sources.** The remaining one- to two-thirds of pollutants contributing to the degradation of coastal and marine waters are from nonpoint sources, which include runoff and seepage from agricultural and urban areas, and air deposition onto land and into water. Seasonal eutrophication (oxygen depletion) of water bodies is an important manifestation of nonpoint pollution. The problem varies by region. The aggregate picture indicates an increase in the severity and extent of eutrophication in the future, with greater than 60 percent of the monitored estuaries expected to show worsening eutrophication symptoms. This is largely a consequence of the anticipated population growth in estuarine watersheds. Because of projected population increases, the need to limit nutrient inputs to estuaries must be emphasized further as we move into the next century.

- **Habitats.** Human activities have changed, degraded or destroyed coastal habitats, threatening many important species. Until recently, many coastal habitat resources were undervalued or not fully appreciated in terms of our dependence on them. Efforts have recently begun on every coast to identify the habitats essential for every life stage of every managed fish species. Once these essential habitats have been identified, measures can then be taken to protect them from direct damage, and from degradations such as nonpoint source pollution, eutrophication, and physical habitat loss resulting from coastal development.

Coastal hazards

Coastal storms damage property, take lives, and disrupt ecosystems as a result of high winds, storm surge, flooding, and shoreline erosion. The theory that global warming will make storms stronger and more frequent is under intense study; the data are

Figure 2. Dry land loss by 2100 without shore protection



Note: NE-Northeast; MA-Middle Atlantic; SA-South Atlantic; SWF-Southwest Florida; LA-Louisiana; Other GOM-Other Gulf of Mexico; WC-West Coast.

Source: Titus et al., 1991

incomplete about whether global warming will lead to more destructive coastal storms. It is known, however, that sea level is rising in many regions, and that global warming may speed this process. Global sea level is projected to rise on average about 5 mm / yr. A rise in sea level and increased storm frequencies could accelerate erosion and associated habitat loss, increase salinity, alter tidal ranges, change sediment and nutrient transport patterns, and increase coastal flooding.

The societal cost of coastal hazards is determined not only by the annual variability in their occurrence, but also by the increasing population at risk, the growing numbers and value of structures and businesses, and other manifestations of economic activity. Both population and wealth have increased greatly, and these changes have increased the exposure of the U.S. population to damages from coastal hazards.

When the losses from coastal storms are normalized to account for these changes, the extent of damages actually has decreased (on average) over the years. The explanation for this conundrum of greater potential for loss, but relatively fewer actual losses, lies in the success of major and long-term efforts to prepare and plan for coastal hazards, and to mitigate their effects. These efforts include (1) better predictions, forecasts and warnings that enable timely and targeted preparations and evacuations of high hazard areas, and (2) building codes that incorporate hazard-resistant construction standards, as well as guidelines for appropriate siting of structures in areas where they are less likely to suffer wind or water damage.

Governance and management

The great number of activities that occur in the coastal zone and in, on, and under the coastal ocean are governed by a complex and often fragmented framework of laws, regulations, and practices. Three fundamental trends are occurring to address this situation. First, on an international scale since 1973, the idea of the oceans as a "commons" has been supplanted by principles, codified in the Law of the Sea Convention, which
(1) recognize the rights of nation-states to establish 200-mile exclusive economic zones over ocean resources and uses, and (2) authorize regional management arrangements for ocean uses. This trend has led to increases in resource utilization, such as fisheries development and offshore energy production. Second, federal environmental mandates have established special ocean and coastal management areas, and expanded the national capacity to plan for and manage the coastal zone. Third, integrated management approaches are coming into use that bring together diverse stakeholders to address the economic, environmental, and social demands placed on finite ocean and coastal resources.

Notes

1. This is an Executive Summary of the NOAA report entitled, "*Trends in U.S. Coastal Regions, 1970-1998: Addendum to the Proceedings of the Workshop on Trends and Future Challenges for U.S. National Ocean and Coastal Policy*."

2. Trends in Managing the Environment

Integrated management approaches are increasingly being employed to address environmental problems. The second session of the meeting reviewed trends in non-point source pollution, habitat and biodiversity. Lessons from the Chesapeake Bay are examined for their management implications. National progress in attaining the goals of the 1972 Clean Water Act are reviewed, and remaining challenges are highlighted, especially those concerning non-point sources of pollution and integrated management of watersheds and the coastal ocean. Trends and challenges in biodiversity are addressed, as are trends in the identification, designation and management of marine protected areas.

New Approaches to Environmental Management: Lessons from the Chesapeake Bay
Donald F. Boesch, Center for Environmental Studies, University of Maryland

Perspectives on Marine Water Quality
Tim Eichenberg, Center for Marine Conservation

Conserving Ocean Biodiversity: Trends and Challenges
Thomas Hourigan, National Marine Fisheries Service, NOAA

Global Trends in Marine Protected Areas
Tundi Agardy, Conservation International

NEW APPROACHES TO ENVIRONMENTAL MANAGEMENT: LESSONS FROM THE CHESAPEAKE BAY

Donald F. Boesch
University of Maryland

Ecosystem Management

Coastal management is evolving from a limited, compartmentalized endeavor that seeks to manage land uses and human activities in the narrow coastal zone to an expansive, integrated activity that reaches far inland, addresses water and air quality, incorporates fisheries and other living resource management, and engages society's future life style choices. This requires an ecosystem approach that broadly embraces the physical environment and the biota, including the humans that dominate these ecosystems. Furthermore, an ecosystem approach must be place-based, thus restricting the efficacy of uniformly applied solutions. Everyone seems to embrace this concept, but how do we actually employ ecosystem management, particularly on the large, regional scales necessary for major estuaries and bay.

The Chesapeake Bay Program represents perhaps the most ambitious and costly effort to restore a major coastal ecosystem and manage activities not only in the coastal zone but also in a vast catchment area—64,000 square miles in this case. It has been going on, in one way or another, for about 20 years and is the conceptual parent of the National Estuary Program in which some 28 estuaries are enrolled. What can we learn from this experience? Where does this experiment in ecosystem management need to go in the 21st Century?

Commitments

The Chesapeake Bay Program owes its longevity and successes to the high and sustained level of societal commitment it has enjoyed. It is directed by an Executive Council that includes the Governors of Pennsylvania, Maryland, and Virginia, the Mayor of the District of Columbia, the Administrator of the U.S. Environmental Protection Agency (EPA) and the Chair of the Chesapeake Bay Commission, an organization of the state legislatures of the region. They are actually involved, they show up at the annual meetings, and they know that their constituents support this effort. They bring the weight and force of the agencies in their jurisdictions to participate. Furthermore, the glue which has held this together has been a sustained federal appropriation for administration, assessment, public outreach, and implementation. But this federal investment is multiplied multi-fold by investments of states and local communities. The commitments are high level, sustained, significant, and popularly based.

Goals

The Chesapeake Bay Program has set goals, even when it was not crystal clear what those goals should be. The major focusing goal has been to reduce controllable sources of nutrients by 40% by the year 2000, but there have been other numerical goals as well. These goals serve to focus bureaucratic attention and provide a framework and currency for debates. Goals have a dimension that assists public understanding and stimulates political commitments. For example, the recalcitrant former Governor of Virginia finally surrendered to the pressure of the other members of the Executive Council for a riparian restoration goal of 2000 miles by 2010, but because of his political genius suggested that the goal of 2010 miles by 2010 sounds better!

Science

The Chesapeake Bay Program prides itself in being science-based. The initial directions and goals were established following a 5 year study phase. There is a remarkable level of "science literacy" among the operatives, assisted by the remarkable and widely distributed Bay Journal. There is a heavy reliance on computer modeling and environmental modeling. There is perhaps the largest aggregation of coastal science in the nation in the region. However, as we move past the year 2000 milestone, it is clear that scientific activities need to be more strategic and forward-looking. Furthermore, because so many key uncertainties now reside on the land, in the watershed, there is a need to boost and link the science of landscape changes, hydrological dynamics, and social choices into the Program.

Models

Great emphasis has been placed on the development and application of sophisticated computer models of the Bay and its watershed. These models are linked so that one can examine the effects of changes in future land uses or agricultural practices or even the effects of the Clean Air Act on delivery of nutrients to the Bay and their effects on dissolved oxygen, food chains, and seagrasses. Although these models may sometimes seduce managers in believing that they represent the real world rather than a virtual world, they have tremendous power in tracking progress, identifying more significant problems, and determining the effects of management alternatives.

Monitoring

The Chesapeake Bay Program, in conjunction with the State agencies, operates the largest and most extensive monitoring program of any coastal ecosystem in the world. It has been going on for over 13 years now. The monitoring program is the plowhorse in contrast to the flashy show horse that is the modeling program. To managers, models provide firm results and can make predictions, while monitoring results are subject to natural and stochastic variability and are inherently retrospective. The monitoring program costs lots of money, money that can be spent to implement programs, hire more office staff, or hold meetings. They are hard to sustain. Yet, environmental monitoring is absolutely essential if we are to practice adaptive environmental management, i.e. management that recognizes that it's hard to predict anything about a complex ecosystem, particularly about the future, and approaches its task with humility and an interest in observing and learning.

Sustainable Resource Use

Why are we trying to reduce nutrient inputs and improve water quality if not for the fish, shellfish, and birds we enjoy and use? Furthermore, does it make much sense for us to restore this ecosystem and overfish or otherwise abuse these resources? Moreover, it has become increasingly clear that steps taken to manage one species, striped bass, for example, may have consequences to other resources, menhaden and blue crabs, for example.

The first generation of Chesapeake Restoration goals was based on something we could measure and count—nutrient inputs. The next generation of restoration goals will be living resource-based. But what kind of meaningful goals can we set and measure? And how do we develop strategies for multi-species management in an ecosystem context? This is one of the major challenges for the future of Chesapeake Bay restoration and management.

The Chesapeake Bay Program, in conjunction with the State agencies, operates the largest and most extensive monitoring program of any coastal ecosystem in the world.

Managing Growth

The commitments and goals for Chesapeake Bay restoration include a "cap," by which once the nutrient input goals are met they will not be exceeded in the future. This means that the effects of all future population growth and land development must be offset by gains in efficiency. With conversion of forested and agricultural land taking place at rates three times greater that the rate of population growth in some areas, for example in the greater Washington, D.C. area, this is a daunting proposition. The rates of land development are clearly unsustainable, not only to meet and hold Bay restoration goals but also in terms of infrastructure demands and quality of life considerations. As a result, the Chesapeake Bay watershed, and the Washington-Baltimore region in particular, has become the hotbed of the Smart Growth movement. The recently announced Clinton-Gore initiative in this area provides opportunities for other coastal regions to begin to address the problems of their future landscapes.

Climate Change

We live in a changing world. Not only is the Chesapeake Bay of today not John Smith's Bay of the 17th Century, the Bay of 100 years from now will be different from either of these. Not only will the outcome be related to how well we have met restoration goals and held gains in the face of population growth and social change, but it is becoming increasingly clear that our climate will change in non-trivial ways, both on global and regional scales. The Chesapeake Bay Program needs now to begin to take heed of these possible changes, both in terms of its scientific investigations and management alterna-

tives. Much has been written about accelerated sea level rise in the warmer world we face. This will have consequences for the Chesapeake Bay as well as other coastal areas. An additional, and perhaps more significant, challenge that we face in the Chesapeake is the prospect for increased freshwater runoff that climate models indicate are likely. These would not only affect the salinity distribution in the estuary, but would deliver more nutrients and result in greater density stratification, thus worsening the effects of eutrophication. The hill we are climbing to restore this great ecosystem may become even steeper.

PERSPECTIVES ON MARINE WATER QUALITY

Tim Eichenberg
Center for Marine Conservation and Clean Water Network

Editors' Note: *This is an outline of Mr. Eichenberg's talk.*

Until 1972, the United States had no national program for regulating the discharge of sewage and industrial pollutants

- For 200 years, the only remedies for pollution were legal actions under common law nuisance and riparian rights.
- The 1899 Refuse Act (§13 of the Rivers and Harbors Act) provided criminal liability for the discharge of refuse, but it was minimally enforced and rarely used to control water pollution.
- Federal clean water laws enacted in 1948, 1956, 1965, and 1966 provided funding to states for the construction of sewage treatment plants, and developed requirements for state water quality standards.
- However, ambient water quality standards, or WQS (i.e., instream uses and water quality criteria to protect those uses) were largely ineffective due to inadequate implementation and enforcement, inadequate means to identify polluters, and no national permitting program or effluent standards.
- By 1972, more than 60% of assessed rivers, lakes, and estuaries were not fishable/swimmable, and over 50% of the wetlands in the continental United States had been destroyed.

In 1972, conditions were ripe for the adoption of national clean water legislation.

- The Clean Water Act (CWA) was overwhelmingly passed over President Nixon's veto (52-12/Senate, 247-23/House).
- Objective of the CWA: "To restore and maintain the chemical, physical and biological integrity of the Nation's waters" [§101(a)]
- Goals of the CWA [§101(a)(1-3)]:
  - Eliminate the discharge of pollutants by 1985.
  - Wherever attainable, provide for the protection and propagation of fish, shellfish and wildlife, and recreation in and on the water by 1983.
  - Prohibit the discharge of toxic pollutants in toxic amounts.
- Basic provisions of the CWA:
  - §301 makes illegal the discharge of pollutants without a permit .
  - §402 requires National Pollutant Discharge Elimination System (NPDES) permits for sewage and industrial point source discharges; administered by the Environmental protection Agency (EPA) and assumable by the states.
  - §304 requires technology-based, national effluent limits for toxic and conventional pollutants.
    - BPT for existing sources of pollution.
    - BCT (economically achievable) for conventional pollutants (pH, ss, BOD, secondary treatment).
    - BAT economically achievable for toxics .
    - BADT for new sources.
- §404 establishes a national permitting program for the discharge of dredged or fill material into navigable waters administered by the Corps and EPA, and assumable by the states.
- §303 requires states to establish water quality standards to:
  - Provide additional controls where technology-based controls are inadequate to protect water quality.
  - Keep clean waters clean (antidegradation).
  - Restore impaired waters [§303(d)].

We have made significant progress in addressing water quality problems since 1972.

- Federal, state and local governments and industry have spent more than $200 billion on reducing the discharge of sewage and industrial pollutants.
- The number of people served by secondary and advanced wastewater treatment has doubled (to about 180 million), and pollutant loads from POTWs have decreased by 40%.
- Over 100,000 tons of toxic metals and organic material are removed from discharges annually.

EPA estimates that 60% of water quality impairment now comes from nonpoint sources (NPS) of pollution.

But we still have a long way to go to meet the goals of the CWA

- 40% of rivers, lakes, and estuaries "assessed" still are not fishable/swimmable, and only 16% of major watersheds have good water quality.
- We know very little about the condition of our waters; few are adequately surveyed (less than 20% of rivers, 10% of ocean waters, 40% of lakes, and 72% of estuaries).
- We still lose about 120,000 acres of wetlands per year which protect water quality, prevent flooding, and provide habitat and recreational opportunities.
- More than 4,000 beaches were closed or posted due to contamination in 1997.
- More than 2,100 fish consumption advisories were posted in 1996.
- More than 30% of our shellfish beds are harvest-restricted.
- More than 50% of all estuaries have low or no oxygen levels at some point during the year; the Gulf of Mexico has a 7,000 square mile dead zone that appears each summer.
- Between 1972 and 1998, the number of HABs doubled (pfiesteria, red and brown tides).
- The General Accounting Office (GAO) reports that 20-25% of major facilities are in significant noncompliance with the CWA.
- We still have major infrastructure needs: $137 billion is needed for secondary and advanced treatment, combined and sanitary sewer overflows.

The CWA has not been reauthorized since 1987; new approaches are needed to address remaining clean water challenges

- EPA estimates that 60% of water quality impairment now comes from nonpoint sources (NPS) of pollution.
- The leading source of NPS pollution is agriculture which causes 60% of the river, 50% of the lake, and 54% of the estuary impairment.
  - About 130 times more animal waste than human waste is produced, but there are no federal regulations for the handling, storage, use or disposal of animal waste.
  - Most large CAFOs are unregulated despite CWA §502(14) permitting requirements (about 2,000 of the 450,000 feedlots are permitted).
- Less than 3% of the SRF has been devoted to NPS pollution.
- §319 of the CWA provides no mandatory controls on the major sources of NPS pollution.
- NOAA's Coastal Nonpoint Pollution Control Program is moribund:
  - Established under §6217 of the 1990 amendments to CZAMA, it still has not produced an approved state plan
  - It has received only $1M in federal funding since 1995 (although $8M was appropriated in FY 1999, and $12 million is requested in FY2000 budget).
- Therefore, an enforceable national program to prevent polluted runoff should be established to

reduce the major cause of water quality impairment that:

- Identifies and targets significant sources of NPS.
- Applies enforceable measures with milestones and deadlines to meet WQS in 10 years .
- Requires immediate mandatory controls for significant new sources of NPS.
- Provides adequate EPA backup authority and WQ monitoring.
- Requires NPS controls / monitoring on federal lands.
- Provides adequate federal funding (up to $500 million / year) as provided in the President's 1998 Clean Water Action Plan.
- Requires permits for large factory farms with minimum standards for manure storage structures, setbacks from water bodies, manure application requirements, advanced treatment for large operations (7,000 = city of 45,000), and provides bonding and public notice for permits.
- Regulates stormwater discharges from small municipalities, industries, and construction sites.

- There are no enforceable national standards for monitoring and posting swimming beaches
  - There have been more than 20,000 beach closures and advisories since 1988 from polluted runoff, stormwater, sewage spills, and overflows
  - Only 8 states comprehensively monitor their beaches and notify the public (NJ, NH, NC, DE, IL, CT, IN, OH).
  - Five states lack any regular monitoring of beach water quality (AL, GA, LA, OR, WA).
  - Most states have not adopted EPA's suggested criteria, and still use fecal and total coliform indicators.
  - Therefore, national standards should be established for beach water quality, monitoring beaches and for posting waters that pose a public health threat.
- There are no enforceable national standards for fish consumption advisories.
- Fish consumption advisories rose by 26% in 1996 to 2193, including advisories in 100% of the Great Lakes and their connecting waters and a large portion of the nation's coastal waters.
- Most of the advisories were for mercury (76%); PCBs, chlordane, dioxins and DDT were also frequently cited.
- differences among state programs are vast.
- Therefore, federal standards are needed to provide consistency, additional training and enforceable mandates for testing and posting fishing areas to ensure that the public health is protected adequately.
- State water quality standards are not protecting adequately existing and designated uses, nor do they address adequately excess nutrients, sediment contamination, and the loss of habitat. Therefore, EPA should strengthen its rules governing water quality standards by:
- Adopting water quality criteria for nutrients (nitrogen and phosphorous), sediments, physical and biological resources, and requiring the adoption and implementation of such criteria by states.
- Strengthening the implementation of state antidegradation policies to protect waters that meet or exceed minimum fishable / swimmable standards.
- Prohibiting the use of mixing zones, especially for toxic pollutants and pollutants that persist or bioaccumulate in the environment.
- Bringing impaired waters into compliance with CWA standards within 8-10 years by ensuring that states identify and list waters that do not meet WQS, and develop TMDLs and WLAs to reduce pollutants from point and nonpoint sources.

CONSERVING OCEAN BIODIVERSITY: TRENDS AND CHALLENGES

Thomas F. Hourigan
National Marine Fisheries Service, NOAA

Introduction

The ocean's biological diversity—its genetic resources, species, and ecosystems—provides immense benefits to the United States and to all of human society. Knowledge about these resources is still rudimentary; however, trends in the best studied species and ecosystems—commercially exploited fishes, protected marine mammals and turtles, and certain coastal ecosystems, such as coral reefs—indicate that these resources and their benefits are threatened by human activities both in the United States and globally. The U.S. government is already taking steps to address the threats, and actions are paying dividends in healthier resources. Recent initiatives, such as the President's Executive Order on Coral Reef Protection, signal a commitment to continue to improve the state of the marine environment. The key to further progress will depend on strengthening scientific research; applying a precautionary approach to resource use; strengthening partnerships with all stakeholders; and managing marine resources on an ecosystem basis. This paper highlights the ecosystem approach and the new Aquatic Restoration and Conservation (ARC) Partnership for Marine, Estuarine and Freshwater Living Resources as parts of a conceptual framework for organizing future actions to protect marine biodiversity.[1]

The ocean's biological diversity—the living resources that compose it and the ecological processes that sustain it—forms a foundation for the quality of human life as well as the raw materials to enrich it.

The Living Ocean Treasure

The ocean's biological diversity—the living resources that compose it and the ecological processes that sustain it—forms a foundation for the quality of human life as well as the raw materials to enrich it. Biological diversity, or biodiversity, refers to the variety and variability among living organisms, and among the ecological complexes of which they are a part. Marine living resources provide essential economic, environmental, aesthetic, and cultural benefits to humanity. Sixteen percent of all animal protein consumed worldwide comes from the ocean. The United Nations Food and Agriculture Organization (FAO) estimates the total value to fishers of the world's commercial marine catch at $80 billion per year. The comparable value of fishes landed in the United States is $3.5 billion, and commercial fisheries contribute $21 billion to the U.S. economy. Besides food, marine living resources provide myriad products including fertilizers, animal feed, medicines, and aquarium fishes.

The value of marine biodiversity extends far beyond fisheries and other products. Marine ecosystems also provide natural goods and services such as carbon storage, atmospheric gas regulation, nutrient cycling, and waste treatment. Coral reefs, mangroves, and kelp forests protect coastal areas from storm damage. Marine algae contribute nearly 40 percent of global photosynthesis. The values of these marine ecosystem services greatly exceed direct use values, yet they generally are not incorporated into economic or policy calculations. Globally, the value of marine ecosystem services has been estimated at $8.4 trillion per annum for open ocean ecosystems, and $12.6 trillion for coastal ecosystems (Costanza et al. 1997). These services depend on marine biodiversity, even though the processes that underlie this dependence are still unclear.

As human populations increase, demands have accelerated for food, products, and services from the ocean, as well as for living and recreational space on its shores. The primary threats to marine biodiversity are fisheries operations (both direct overfishing and indirect fishing impacts—e.g., bycatch of non-target and protected species, habitat destruction by trawls and other gear or techniques, and other ecosystem effects that may accompany fishing activities), chemical pollution and eutrophication, physical alteration of coastal and marine habitats, invasions of exotic species, and ultraviolet-B radiation damage to phytoplankton and zooplankton resulting from stratospheric ozone depletion (NRC

1995). Looming on the horizon is the threat of human-caused climate change with potentially major negative effects on tourism, freshwater supplies, fisheries, and biodiversity. These factors also have been identified by the Parties to the Convention on Biological Diversity2 as key threats (UNEP / CBD 1995).

Trends in the Health of Marine Biodiversity

Knowledge about marine species and ecosystems lags far behind that of terrestrial systems. We cannot even characterize the health of many common marine species and ecosystems. What relatively little is known about the state and trends of living marine resources is based on species exploited commercially for fisheries; protected marine mammals, turtles, and fishes; and certain commercially significant and accessible coastal ecosystems such as wetlands and coral reefs. Until recently, the oceans were thought to be a limitless source of food and natural resources, and a limitless sink for human pollution. Trends for these resources during the last few decades, however, have shown that human activities are reaching and often exceeding the productive limits and recuperative potential of the ocean.

A. Fisheries

Many commercial fish stocks reveal a pattern of declining populations. Recent trends indicate that about one-third of the resources on which fishers depend are overfished in the United States and worldwide (Fig. 1). Without major changes in fishery management, FAO estimates that global landings will not be able to exceed current levels despite increased demand from growing populations, and could be reduced by as much as 25 percent (FAO 1996a). Despite the collapse of certain fisheries, U.S. management actions have contributed to several successes, including Alaska groundfish, king and Spanish mackerel, striped bass, and surf and ocean quahogs.

Beyond the impacts of overfishing, fishery operations also have tremendous impacts on marine ecosys-

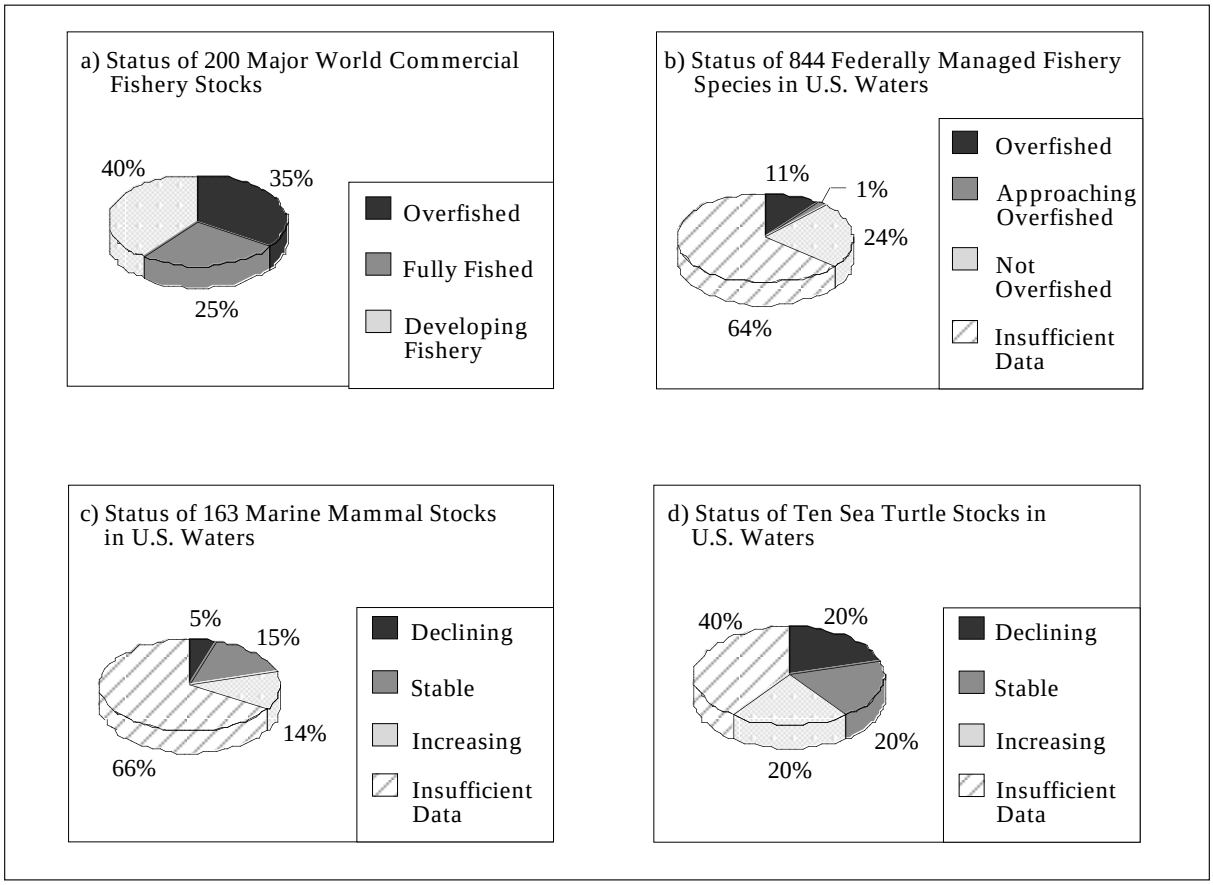


Figure 1. Status of selected marine living resources. a) World fisheries (FAO 1996a); b) U.S. Federally managed fisheries (NMFS 1998); c) & d) Marine mammals and sea turtles sea turtles (NMFS 1996).

tems. Globally, about 60 billion pounds of sea life are destroyed as discarded bycatch each year (FAO 1996b). Additionally, it has recently been estimated that bottom trawls and similar fishing gear scrape 14.8 million square kilometers of sea bottom annually, an area equivalent to over half the world's continental shelves (Watling and Elliot, 1998). Although the impact of this destruction on biodiversity and productivity is unknown, its magnitude must give us pause.

Recent trends indicate that about one-third of the resources on which fishers depend are overfished in the United States and worldwide.

B. Protected Marine Species

Protected marine species in the United States include marine mammals and species listed under the Endangered Species Act (ESA). In the past, the exploitation or incidental capture of marine species, along with a lack of adequate natural resource management policies, led to the decline and even extinction of many species. Protection under the ESA, Marine Mammal Protection Act, and the International Whaling Commission has led to increasing populations of certain marine mammals (e.g., gray whales) and at least two sea turtle species in U.S. waters. Still, habitat destruction and human activities continue to place other species in jeopardy. For example, 23 salmonid populations have been listed or proposed for listing as endangered or threatened since 1991, while populations of the northern right whale and Hawaiian monk seal continue to decline. Meanwhile, less well—studied marine organisms are being lost before ever being identified, much less protected.

C. Key Ecosystems - the Coral Reef Example

As the world's most biologically diverse marine ecosystems, coral reefs are home to one-third of all marine fish species and tens of thousands of other species. Coral reef areas under U.S. jurisdiction cover approximately 16,879 square kilometers (NOAA 1998b). Despite their importance, shallow water coral health and cover have declined worldwide over the last two decades. It is estimated that 58 percent of the earth's coral reefs are at high or moderate risk from overexploitation, coastal development, and pollution (Bryant et al. 1998). In the United States, coral reefs appear threatened wherever they are close to large concentrations of people; however, data are available to evaluate the status and trends of U.S. coral reefs in only a few sites (NOAA 1998b). The International Year of the Reef, 1997, and President Clinton's 1998 Executive Order on Coral Reef Protection are providing impetus to new reef monitoring programs that should greatly increase our understanding of the status and outlook for coral reefs worldwide.

A Challenge for the Future: The Ecosystem Approach to Conserving Marine Biodiversity

The U.S. government, in partnership with public and private stakeholders at home and internationally, is taking action to address the threats to living marine resources and to ensure the promise of these resources for future generations. Hourigan et al. (1998) outlined five critical elements at the heart of this new strategic vision:

1. Investing in science in the interest of stewardship. Basic assessment and monitoring of the status and trends of resources, as well as economic and social information, are the fundamental tools of natural resource managers.

2. Applying the precautionary approach. Even the best science cannot ensure adequate management, since marine systems are characterized by a great deal of natural variability. The precautionary approach states that in the face of uncertainty, managers and decision makers must err on the side of conservation of living marine resources and protection of the environment. The precautionary approach has been conceptually best developed in the fishery sector (e.g., the FAO Code of Conduct for Responsible Fisheries and the United Nations Straddling Stocks Agreement) and is being integrated into U.S. fishery policy and practice. The challenge will be to implement the precautionary approach in fisheries and to broaden its application to other arenas of ocean resource management.

3. Applying new technologies to ensure the environmental sustainability of marine aquaculture. World population is expected to increase by one billion people during the next decade, yet future seafood harvests from the wild are not expected to increase. As humans once moved from hunting to agriculture on land, they must soon move from reliance on wild fish stocks to marine aquaculture in the oceans. The success of this move depends upon employing new

technologies to address the environmental problems that have plagued aquaculture in the past.

4. Building Partnerships. Successful management of ocean living resources is often less a question of science and technology than one of human behavior and balancing legitimate short- and long-term social needs and aspirations. U.S. federal programs and policies are reaching out to involve stakeholders in decision-making and implementation.

5. Exploiting the full potential of an ecosystem-based approach to resource management. Each individual organism has a habitat, which it needs to live and reproduce, and depends on a community of other species for food and survival. This interconnected community of living things, including humans—their dynamic interactions with each other and the physical environment, and their overlapping mosaic of habitats—together constitute an ecosystem.

As the world's most biologically diverse marine ecosystems, coral reefs are home to one-third of all marine fish species and tens of thousands of other species.

Increasingly, the United States is adopting an ecosystem approach to management designed to sustain or restore natural systems and their functions and values (Interagency Ecosystem Management Task Force 1995). The ecosystem approach has also become a major touchstone advocated by the Convention on Biological Diversity for the conservation and sustainable use of marine biodiversity (UNEP / CBD 1995). An ecosystem approach to management is applied within a geographic framework defined primarily by ecological boundaries. The ecological boundaries of ocean ecosystems and the services they provide reach across traditional state and international boundaries, and they are linked to water and soil systems in watersheds and to each other through ocean currents. Thus, effective management will require expanding both interstate and international cooperation.

Applying this ecosystem approach represents the greatest challenge of the coming decades. Current management still generally deals with fish or endangered species as isolated stocks, and with threats as individual rather than cumulative insults to ocean systems. The ecosystem approach requires integrating the current patchwork of management tools that address endangered species, fisheries, pollution, watersheds, and coastal zones into a coherent whole. Federal and state integrated coastal zone management programs and watershed management plans that address non-point source pollution are important pieces of the puzzle. So also are the new "Essential Fish Habitat" provisions of the 1996 Sustainable Fisheries Act and increasing use of habitat conservation agreements with states, tribes, and private land owners to address endangered species management. To date, however, these have not been placed in a context that recognizes the scale and interconnectedness of ocean living systems.

Marine and coastal protected areas in the National Marine Sanctuary Program, the National Estuarine Research Reserve System, the National Estuary Program, and other national and state parks can provide important refuges for marine biodiversity. However, these areas currently provide only limited protection from fishing impacts. Twenty-two percent of U.S. federal lands are "no-take" wilderness areas. In contrast, the federal government has jurisdiction over marine areas eight times larger than the federal land areas, but only 0.002% of these are currently "no-take" marine wilderness areas (Brailovskaya, 1998).

Management of terrestrial systems has been revolutionized by the application of watershed management and coastal zone management approaches. The challenge over the next century will be to expand these zoning approaches to the nearshore waters and beyond. We must:

1. Identify areas of important biological diversity and productivity, habitats for endangered species and commercial and recreational fisheries species, and coastal and marine areas that provide key ecosystem functions;

2. Map sources of pollution and other human impacts on these areas; and

3. Conserve representative productive and pristine areas and restore priority habitats that are degraded.

The National Oceanic and Atmospheric Administration has recently formed a partnership with the U.S. Geological Survey and other federal agencies, states, NGOs, and professional organizations to take the

first analytical steps in this direction on a nationwide basis. We have begun the Aquatic Restoration and Conservation (ARC) Partnership for Marine, Estuarine and Freshwater Living Resources. The goal of the ARC Partnership is to ensure the conservation of our nation's freshwater, estuarine and marine living resources by creating a common information base and options for preserving the ecological and economic integrity of these resources into the 21st Century.

ARC builds on the successful Terrestrial Gap Analysis Program. Gap analysis is a science-based program for identifying the degree to which native animal species and natural communities are represented in our present—day mix of conservation areas. Those species and communities not adequately represented in the existing network of conservation areas constitute conservation "gaps." The Gap Analysis Program provides broad geographic information on the status of species and their terrestrial habitats in order to provide managers, planners, and policy makers with the information they need to make better—informed decisions.

Making full use of new approaches—analytic tools such as ARC and management tools such as fishery "no-take" zones that protect fishes, their habitat, and biodiversity—will allow management on scales that are meaningful to ocean living resources. They can then be placed in watershed and integrated marine and coastal area management regimes that involve all stakeholders. Together, these offer the promise of better conserving marine biodiversity, our ocean's living treasure.

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Notes

1 The trends in marine living resources described in this paper draw on the recent review developed for the *Year of the Ocean Discussion Papers* (NOAA 1998a; and Hourigan et al. 1998). The conclusions derived from these trends, and suggested options for future action, are the author's and do not necessarily reflect the policies of the U.S. Government.

2 The United States has signed, but not yet ratified, the Convention on Biological Diversity.

GLOBAL TRENDS IN MARINE PROTECTED AREAS

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Introduction

Marine protected areas are increasingly being used to protect biologically rich habitats, resolve user conflicts, and help restore over-exploited stocks and degraded areas. The upsurge in the use of the tool is in part due to the fact that fisheries managers are now looking to reserves to complement conventional fisheries management techniques. In the United States, the legislative requirement to identify and protect essential fish habitat for managed fisheries species has contributed to the debate over and use of marine protected areas in all their various forms. Similarly, fisheries managers and government agencies abroad are now realizing that marine protected areas can serve to enhance sustainable resource utilization in addition to promoting conservation. We are thus witnessing an increase in the designation and management of marine protected areas that is occurring on two tracks: 1) the establishment of reserves to safeguard representative habitats or particularly rich and diverse areas, and 2) the use of protected areas to complement both fisheries and coastal management. Many will claim the new wave of marine protected areas is characterized by a strong reliance on marine sciences—scientific knowledge that has at long last matured to the point that it has become useful to marine resource managers. It should be noted, however, that protected area placement, design, and operation all relate to the scope and nature of the goals being targeted—i.e. the specific objectives the protected area is meant to achieve. The identification of these objectives is ultimately societal, not scientific. Subsequent to the elaboration of specific objectives, conservation biology and other sciences can be harnessed to help identify what needs to be protected and in what manner, leading to optimally effective marine protected areas. A few good examples of such well-planned protected areas have now emerged around the world, but unfortunately this number is small compared to the vast number of ill-designed "paper parks" around the world.

Global Trends in Marine Protected Areas

The designation "marine protected area" encompasses everything from small marine parks established to protect an endangered or threatened species, a unique habitat, or a site of historical or cultural interest, to vast reserves that target a range of conservation, economic, and social objectives and encompass different types of protection. The use of marine protected areas has enjoyed a sudden upsurge in popularity as marine reserves are being invoked to complement and strengthen traditional fisheries management. In the United States this has been driven by the revision of the Magnuson-Stevens Fishery Conservation and Management Act, now mandating fisheries managers to identify and protect essential fish habitat. Paralleling this new push for the use of protected areas in fisheries management regimes has been an upsurge in multiple objective protected areas. Indeed, many of the newest marine protected areas are more ambitious than conventional marine protected areas, resulting in multiple use reserves that try to accommodate many different users groups, each with their own needs and objectives. Administrators are finding different uses can indeed be fostered without adverse impacts on ecosystem function, as long as planning is based on ecological realities, relies on specific objectives from the outset, and balances established objectives (Agardy, 1993). These protected areas can provide a footing for integrated coastal management and better ocean governance

We are thus witnessing an increase in the designation and management of marine protected areas that is occurring on two tracks: (1) the establishment of reserves to safeguard representative habitats or particularly rich and diverse areas, and (2) the use of protected areas to complement both fisheries and coastal management.

overall. Whatever the scope of the protected area, the science of conservation biology has contributed important theories, perspectives, and tools, many of which await critical testing (Allison et al., 1998).

The terms marine protected area, marine reserve, closed area, harvest refugium, marine park, and sanctuary may cause semantic difficulty since they are often used interchangeably and without definition. The spectrum in size, design, and management objectives that comprise marine protected areas is vast—ranging from the small and focused harvest refugium (a place where harvest of one or more species, usually of fish or shellfish, is restricted) to the large and ambitious sanctuary. Closed area and harvest refugium are sometimes synonymous, but closed areas can also be closed to entry in general, or can be used to restrict non-living resource extraction such as oil and gas. Reserve is the term that most closely approximates a synonym of marine protected area in some countries though "reserve" can refer to a particular type of protected area such as a biosphere reserve, or, as in Britain, to an area closed to all fishing (in other words, a harvest refugium) (Gubbay, 1995). Lastly, there is that problematic term "marine park," which outlived its usefulness when protected areas shifted away from being places of recreation. The term "marine protected area, " and only that term, encompasses all of the other terms, and is thus the term used herein.

Arguments abound about the nature of marine protected areas and how they relate to conventional land parks; the fact remains that marine protected areas do significantly differ from protected areas on land. The greatest single factor underlying this difference is the nebulous nature of boundaries in the fluid environment of the sea (Steele, 1974). It is notoriously difficult to attach boundary conditions to marine ecological processes, just as it is difficult to bound the impacts that affect those processes. While this is also true for inland freshwater systems, these ecosystems usually have distinct horizontal layers and outer bounds. In essence, it is impossible to "fence in" living marine resources or the critical ecological processes that support them, just as it is impossible to "fence out" the degradation of ocean environments caused by land-based sources of pollution, changes in hydrology, or ecological disruptions occurring in areas adjacent or linked to a protected area. This holds true not only for open ocean pelagic environments but for the coastal zones as well, where functional linkages between habitats are so geographically widespread. The vastness of linkages between species and between critical habitats in a coastal area requires comprehensive management of all its parts (Caddy and Sharp, 1986).

The open nature of coastal and ocean areas exists as a spectrum ranging from relatively fixed and "land-like" systems to highly dynamic and complex systems. Coral reef ecosystems, for instance, harbor organisms that are largely confined in their movements to the specific habitats of reef, surrounding soft or hard benthos, and coastal wetlands. The structural framework for reef systems is fixed in place and can be mapped, much like a tropical forest provides a relatively fixed framework for the interactions of the forest community. The functional links between the water column in reef areas and the benthos are strong, so one can treat the ocean space together with reef structures themselves. In contrast, temperate open ocean systems such as estuarine/gulf/banks complexes are highly dynamic and in no way "fixed." Here, living marine resources move in space and time according to physically dominated, largely non-deterministic patterns. The ecology of the benthos is not strongly linked to that of the water column, and physical reference points for the system cannot easily be mapped. This wide array of system types thus presents a challenge to conservationists and resource managers, requiring that protected area measures be appropriate to the system in question. The random application of terrestrial models to the marine environment will not result in a viable means of protecting resources and the underlying ecology that gives rise to them. New paradigms are needed—and the newest generation of marine protected areas reflects this new way of thinking.

Modern marine protected areas serve a wide variety of functions. However, there is no single "model" marine protected area. The size, shape, and means of implementation in any single marine protected area will be a function of the primary objectives that protected area sets out to achieve. If the goal of a protected area is, for instance, the protection of a single vulnerable habitat type from a specific type of use (e.g. protection of a fringing reef system from prospective shipping accidents), the resulting protected area can be simple in both design and management. If, however, the conservation goal targets a wide range of habitats/resources, the protected area will have to be necessarily more complex. Where a functional approach is adopted, in other words where the object of conservation is not a single stock of resources or a single species but the ecosystem and its processes, marine protected areas will tend to be large and encompass many types of linked habitats (Lauck et al., 1998). These large, multiple-use

protected areas can be thought of as demonstrating the concept of ecosystem-based management, where the limits of protection in a geographical sense are based on the extent to which movements of organisms and physically-linked processes (Hatcher et al., 1989; Dayton et al., 1995). The underlying ecology thus defines the outer boundaries for the area of protection, or management unit. In recognizing these linkages, marine protected area planners can work towards conserving ecosystem integrity, not just individual resources or ecosystem structures.

Globally, marine protected areas are being designated according to at least two major approaches: 1) preservation of ocean or coastal "wilderness" areas (the term wilderness is in quotation marks because no part of the world's oceans, inland seas, or coastlines is pristine) and 2) resolution of conflicts among users (current or in the future). Most existing national marine protected area networks follow the first strategy. For instance, Parks Canada is currently designing a network of Marine National Conservation Areas to represent each of the 29 distinct ecoregions (based on large-scale biophysical units) of Canada's Atlantic, Great Lakes, Pacific, and Arctic coasts. The long-term goal of this program is to establish a protected area in each region. Similarly, the federal government of Australia is developing a strategy for establishing a National Representative System within Australian Coastal and Marine Environments. In designing such a system, site selection will be guided by representativeness, opportunity, and redundancy (meaning that the government's policy is to designate more than one protected area per representative habitat type). Other national efforts are currently underway. In fact, the 1995 publication of the Great Barrier Reef Marine Park Authority, the World Bank, and IUCN, which is the most comprehensive overview of existing marine protected areas and gaps in coverage, strongly urges all countries to establish such representative networks (Kelleher et al., 1995).

Conflict resolution is the other major driving force behind the establishment of networks or systems of reserves or protected areas. Virtually all the world's coasts and nearshore areas are characterized by conflict between and among user groups or jurisdictional agencies, or at a minimum a serious lack of communication between these factions. Shipping and mineral extraction, for instance, often conflict with recreational use of coastal areas. Fishing, both commercial and subsistence, conflicts with skin and scuba diving and nature-based tourism. In such cases of conflict, zoning can be used to accommodate a wide variety of user groups in relative harmony, and can be a tool for dispute resolution where conflicting uses clash (Reynard, 1994; Valdez-Pizzini 1995).

The human element in marine protected areas cannot be understated. The success of any protected area is closely related to how well user groups and stakeholders are identified and brought into the planning and management processes for the protected area. Marine protected areas cannot afford to be elitist, nor can they be exclusionary—again underscoring the difference between terrestrial and marine protected areas. Wilderness is not a concept easily applied to ocean areas—nor does it provide a particularly useful perspective for marine conservation. Humans and their needs are the driving force for marine protected area work, and humans stand most to benefit from their effective implementation. The designation of a marine protected area can provide local communities, decision-makers, and other stakeholders with a defined arena in which to promote effective management—a sense of place, as it were.

Table 1. Relationship between marine protected area objectives, size, and design complexity.

Specific MPA Objective	Relative Size	Complexity
Protecting an Endangered Species	Small to Medium	Simple
Protecting a Migratory Species	Large (or Network)	Simple to Complex
Protecting Habitat from Single Threat	Medium	Simple
Protecting Habitat from Multiple Threats	Medium to Large	Complex
Preventing Overfishing	Small	Simple
Enhancing Stocks	Small to Medium	Simple
Protecting an Area of Historic or Cultural Interest	Small	Simple
Providing a CZM Model or Empowering Local People	Small to Medium	Somewhat Complex
Promoting Marine Ecotourism	Small	Simple
Providing Site(s) for Scientific Research	Small	Simple
Conserving Biodiversity	Large (or Network)	Simple to Complex

Scientific information on biomass, dispersal patterns, recruitment dynamics, trophic interactions, and critical habitat are all needed for designing the size, shape, and management of marine protected areas. But what is needed first and foremost, and what is most often overlooked when the process of establishing a marine protected area is initiated, is information on what the protected area is being established to achieve. This goal-setting or objective elaboration

is critical in order to determine expectations, effectively design the reserve, and have in place targets and benchmarks against which progress towards the objectives can be measured. Thus, the most crucial information for protected areas is inherently societal, and not scientific. Table 1 suggests how reserve design and management can be a function of the specific objectives that the protected area is trying to target.

We now know that marine protected areas can be designed to help make fisheries and coastal management more effective. In the last 5 years, new, rigorous, and defensible evidence has emerged to show that marine protected areas do indeed improve fish yields while conserving biological diversity more generally. These benefits have included increased fish stock size inside the reserve as well as spillover effects in which fish populations have also increased outside the reserve (Roberts, 1995). One of the most cited examples of this spillover effect has been the work of Russ and Alcala (1996; 1997) in the Philippines, where a small protected area in Apo Island was shown to increase fish yields well outside the boundaries of the reserve less than a decade after its establishment. Other marine protected areas that appear successful in helping manage fisheries include Kenyan refuges (McClanahan and Kaunda-Arara, 1996; McClanahan and Shafir, 1990); New Zealand fishery reserves (Ballantine, 1991,1995; McCormick and Choat, 1987); several Mediterranean reserves (Dugan and Davis, 1993); invertebrate reserves in Chile (Castilla and Duran, 1985); coral reef reserves throughout the Caribbean (Rakitin and Kramer, 1996; Reynard, 1994; Roberts and Polunin, 1991); Red Sea reserves (Roberts and Polunin, 1992); and fisheries zones in Florida (Bohnsack, 1996a, 1996b), inter alia.

A summary of published literature and anecdotal information shows that marine protected areas have yielded the following quantifiable benefits (Ruckelhaus, in Florida Forum Report #1, 1997): 1) increase in abundance of reef fish and invertebrates; 2)increase in individual size / age; 3) increase in reproductive output; 4) increase in species diversity; 5) increase in spillover; 6) increase in replenishment; 7) increase in preservation of genetic and demographic diversity; and 8) increase in habitat quality and diversity. All of these factors increase the potential for fisheries production and yields (Roberts and Polunin, 1993). There are even more examples of successful marine protected areas that have enhanced fish stocks through broader conservation measures aimed at protecting habitat and biological diversity more generally (e.g. Agardy, 1997). An ideal situation seems to be the establishment of harvest refugia within the context of a larger multiple-use protected area such as a coastal biosphere reserve, marine sanctuary, or other large-scale marine protected area.

Fishers, nations, and indeed the entire biosphere can benefit from the establishment of marine protected areas at all scales and in all coastal environments. As noted above, the rationale for marine protected area establishment is no longer lacking —but the courage to go forward is often hard to summon. Despite incomplete knowledge and imprecise science, steps must be taken to establish protected areas now—and use the additional information we gain as time goes on to alter these reserves, remove superfluous ones, and add new reserves. By clearly defining objectives and using science to design the best possible plans for meeting those objectives, we can improve our management of marine activities before the health of the seas is compromised and with it the ability of marine systems to provide us with the resources and services upon which we increasingly depend.

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3. Industry-Driven Changes and Policy Responses

Panel Three focused on recent trends in coastal and ocean industries and the responses to these trends. One key trend has been an increase in the size of ships involved in the rapidly growing maritime industry. Another trend has been the exploration and development of oil and natural gas from deeper waters in coastal and ocean areas. Overfishing is yet another important development in coastal areas during the past 25 years. As coastal industries grow and expand, an assessment of the economic importance of coastal areas is also required, including the importance of beach and boating activities. Recent trends in marine aquaculture show that it has the potential to become a major growth industry in the United States. However, the industry is still very young, and is constrained by legal and regulatory concerns. The marine environment is also a rich source of unique chemical compounds with the potential for industrial development as pharmaceuticals, cosmetics, nutritional supplements, molecular probes, enzymes, fine chemicals, and agrichemicals.

Changing Ship Technology and Port Infrastructure Implications
Rod Vulovic, Sea-Land Service, Inc.

Deepwater Offshore Oil Development: Opportunities and Future Challenges
Paul L. Kelly, Rowan Companies, Inc.

Challenges Facing the U.S. Commercial Fishing Industry
Pietro Parravano, Pacific Coast Federation of Fishermen's Associations

Assessing the Economic Benefits of America's Coastal Regions
Howard Marlowe, American Coastal Coalition

A Profile of Recreational Boating in the United States
Rick Lydecker and Margaret Podlich, Boat Owners Association of the United States (BOAT/US)

Marine Aquaculture in the United States: Current and Future Policy and Management Challenges
M. Richard DeVoe, South Carolina Sea Grant Consortium

Offshore Marine Aquaculture in the U.S. Exclusive Economic Zone (EEZ): Legal and Regulatory Concerns
Alison Rieser and Susan Bunsick***
**University of Maine School of Law, **University of Delaware*

The Potential for the Marine Biotechnology Industry
Shirley A. Pomponi, Harbor Branch Oceanographic Institution, Florida

CHANGING SHIP TECHNOLOGY AND PORT INFRASTRUCTURE IMPLICATIONS

Rod Vulovic
Sea-Land Service, Inc.

The Changing Face of World Trade

An anonymous seer once stated that world trade is the engine that drives civilization. How right he was! The closing 100 years of the second millennium have seen world trade grow astonishingly. With this growth, not only have trade patterns and the types of cargoes changed radically, but the ships that carry the goods have changed almost beyond recognition. Today's cargo-handling methods bear not the slightest resemblance to what had been there before. The key to the change? Containerization, intermodalism and globalization–interlocked concepts that are much more than fashionable epithets.

Before the advent of the container, world trade was a piecemeal undertaking, with the land and sea segments accomplished in isolation, with little coordination between the various independent operations. The shipowner accepted the cargo when it arrived at the pier. Shipper and recipient alike did not expect, nor could they even envision, so-called "just-in-time" service. That luxury was simply not available, and the en-route delays, which were a part of the transport system, were an unavoidable part of doing business internationally.

All of this has changed. Sea-Land's initial voyages over 40 years ago proved the feasibility of container transport, revolutionizing the movement of goods by allowing the land and sea portions to function as a system. Within these four decades, this technological and commercial breakthrough has resulted in the near demise throughout the world of the break-bulk ship, in which cargo was stowed virtually by hand, a practice which had existed almost without change for hundreds of years.

Today's container ship is the linch-pin of cargo transportation, but it is only a part of the total system which includes sophisticated shoreside terminals, intermodal extensions to inland points by rail and highway, and automated information systems that track a shipment throughout its journey.

The importance of this to the people of the world is that fully 90 percent of international trade is carried by sea. To and from the United States alone, the yearly waterborne foreign trade amounts to over 1 billion tons, having a value of more than $ 625 billion. Tankers, bulk carriers, container ships, and other vessels all share the enormous tonnage, using the same waterways, the same navigational aids, the same ports.

...fully 90 percent of international trade is carried by sea.

Of the port users, the container vessel is the most time-sensitive. High value cargoes demand expedited handling, which requires coordinated actions by ship operators, port authorities, landside transport organizations, and regulatory and support agencies. Nearly 15 million TEU of container cargo is handled through American ports per year, over half of which moves through the five largest ports. The mandate of the American people to keep this cargo flowing is clear.

Trade and its Effect upon Ship Size

In addition to the radical change in the way cargo is handled, there is another evolutionary force that has significantly affected international trade over the past five decades since the end of World War II. World trade has escalated as the population of the world has risen.

The net effect of the market forces has been to challenge technology in the development of increasingly economic methods of moving cargo. In respect to this, engineers have responded by devising entirely new vessel types and expanding the frontiers of deadweight tonnage and speed. The result has been an ocean transportation system, that is able to carry the vastly increased amount of cargo swiftly and safely.

The pioneering container ships could carry only 59 containers having a length of 35 feet and stacked two-high on deck. Once this seemingly radical idea

of carrying boxes by ship had been proven sufficiently in the coastwise trade, the first true container ships, having cellular holds into which containers were loaded by cranes came into being. Their capacity was around 200 TEU –the designation "TEU" (for twenty-foot equivalent units) being the standard measure of capacity adopted by the industry.

Through the 1960s and 1970s vessel capacity grew, individually and collectively, as European and Far Eastern ship operators, following the lead of their American counterparts, realized that the container revolution had indeed taken place. During the latter part of this period, container ships of around 2000 to 2500 TEU were becoming more prevalent on the major trade routes. Size gradually crept upwards over the next 10or 15 years as did the quantity of trade in container cargo. In the late 1980s the 4000 TEU barrier in ship size had been crossed. The next phase, the age of the mega-container ship, came rapidly once that point had been reached.

The Mega-Container Ship is Unveiled

The definition of the mega-container ship has changed in lock step with the construction of larger and larger vessels. In the mid-1980s, when United States Lines built its "Jumbo Econ" container ships (now owned by Sea-Land as its Atlantic Class), their 4354-TEU capacity was classified in the "mega" region. Today, "mega-container ship" describes only those vessels having a capacity in excess of 6000 TEU and the definition changes as each new generation of vessels is delivered.

Around 7700 TEU are carried on today's mega-carrier, which is about 1138 feet (347 meters) in length–almost a quarter mile, or, in the popular idiom, nearly "four football fields"– and has a beam of 140 feet (42.8 meters). The container stack is 17 wide.

Future Trends in Ship Size

For several years, designs have been available for vessels with capacities of up to about 8700 TEU. The design and construction of such vessels is well within the state of the art. In fact, a consensus among shipbuilders and ship operators is that a container ship able to load 15,000 TEU may well be a possibility. For such a ship to become a viable reality may require a complete rethinking of the way containers are handled to– and from the ship as well as to and from–and within the shoreside terminals.

Around 7,700 TEU are carried on today's mega-carrier, which is about 1,138 feet (347 meters) in length—almost a quarter mile, or, in the popular idiom, "nearly four football fields"—and has a beam of 140 feet (42.8 meters).

Although the ship may be technologically feasible, there must be a level of trade sufficient to support such a vessel. Of equal or greater importance, there must be shoreside facilities to match its capacity. The major problem is the need to minimize port time (There is a truism that a transportation asset, whether ship, aircraft, rail car, or truck must be in motion to assure its economic survival) In addition, and of great importance, the harbor waters, berths, and approach channels must be of sufficient depth and the berths themselves must be large enough and properly equipped to handle the larger (longer, wider, and deeper) vessel.

In the case of this mega-container ship, the terminal must have sufficient area to accommodate the larger number of boxes that will accumulate before the ship arrives and as she is being discharged and loaded; crane capacity (in terms of both the number of cranes and their cycle time) must be sufficient to minimize port stays; and, needless to say, the requirements for sufficient water depth and appropriate vessel berths must be considered.

We believe that we have not seen the practicable upper limit of container ship size in the 7000-TEU plus vessels now in existence. An eventual ceiling might be found around the 10,000 to 12,000 TEU level. Market forces will continue to influence the evolution of the system as long as it moves in a way that continues to provide improvements in cost, reliability, and speed and customer satisfaction.

The Question of Water Depth

One aspect of the mega-container ship, that must be faced by ship operators and port authorities alike is the water depth required to permit these vessels to operate efficiently. In the Far East and Europe, the

problem of water depth is not a serious one at most major ports, and where controlling depths are marginally satisfactory, steps are taken to ensure that a safe environment is available for the ships serving the ports concerned. Under-keel clearance of not less than one meter (slightly more than 3'-3") is available, at any state of the tide.

A 50-foot deep channel would accommodate nearly all container ships now in existence. As ship capacity increases to 8000 and 10,000 TEU, the required water depth will not increase proportionally. This is due to other changes in the configuration of the vessels. For example, they will be wider–up to 22 containers from the current maximum of 17 and they will be longer.

The question of how to achieve sufficient water depth is a vexing one for many U. S. ports, particularly on the East Coast. There must be found a way around the fiscal, environmental, and other roadblocks that are thrown in the way of port progress. To do otherwise is to steer the nation irrevocably towards second-class statehood.

Environmental Impact of the Mega-Carrier

Much has been said of the economic superiority of the mega-container carrier in terms of cost of transportation per TEU-mile. The mega-carrier also displays an increasingly important characteristic which may directly affect air quality. In an operational environment in which the contribution to atmospheric pollution by marine sources is coming under closer scrutiny (even though the total release of exhaust gases from all marine sources accounts for a small percentage of the worldwide total release), the operation of a mega-carrier will result in a measurably lower release of pollutant gases than from an equivalent transportation capacity in smaller ships.

Given the much improved fuel efficiency of modern ships, the relatively small contribution to air pollution from marine sources, and the continuing research to improve engine performance, we believe that the shipowner is doing his part to keep the spectre of fouled air under reasonable control.

In the other significant marine environmental concern–the discharge of oil into navigable waters–a continuing effort by all players is resulting in measurable improvement.

What Is Intermodalism?

The term intermodalism is heard with increasing frequency in the 1990s, but the concept has been a driving force in container transportation since the beginning. Intermodalism may be defined as the ability of a transportation system to move freight from source to destination over a number of modes without intercession by shipper or consignee. In other words, a container may originate in an inland point in the United States, travel over road and rail to a port, then by ship to a port, perhaps on another continent, and thence by rail and road to the final destination, all without touching the cargo within the container.

The concept is simple, its execution, difficult. The container must move swiftly and connect at each modal change point speedily, but of even greater importance is for the transportation company to assure that the sometimes complex and burdensome paperwork which follows the box is processed with dispatch. This is of importance with any domestic shipment involving road and rail modes only, but the value of true intermodalism is tested in international shipments, where customs documentation adds another layer to the complexity of the process.

For intermodalism to have existed in the former regulatory climate in the United States was nearly impossible. Dating back to the mindset of the "robber baron" days of the late 19th Century, it was not possible under law for a transportation company to operate in more that one mode. For this reason, when the Founder of Sea-Land Service, Malcolm McLean, started his marine container business, he was forced to divest himself of his extensive trucking interests, which, of course, could have formed an important part of an early intermodal system.

This and similar cases are typical examples of existing regulatory processes being unable to recognize and adjust to innovative change and, more importantly, not being able to ameliorate the legislative morass that is encountered when innovative change is encountered.

Seamless Transport Ashore and Afloat: The Intermodal Pipeline

An intermodal cargo transportation system between continents may be likened to a pipeline. To run at peak efficiency with maximum throughput, the pipeline must offer minimum resistance to flow. This is accomplished by utilizing proven design and

construction practices. It must also be free of operating constrictions such as partially closed valves.

In the intermodal case, the features designed into the system include ships of a size, seakeeping ability, and speed properly considered for reliable operation, logically located ports; efficient rail and highway transport; and efficient and unobtrusive regulatory formalities. In the ideal operation of such a system, the cargo will flow into the source location and be carried to the final destination through several changes of mode (e.g., truck to rail to ship to rail to truck) as if, in a manner of speaking, all valves were fully open.

But in actual operation, the intermodal pipeline is susceptible to the partial closing of too many valves, at least one of which may be present–and poised all too ready to close–at each change of mode. What valves are likely to close?

- The first valve is accessibility of the port from the open sea. Can the port terminals be reached without the need for a long inland passage by the ship?

- Next, is the port appropriately located for transfer of cargo to the rail or highway mode? Do these connections have easy access to remote destinations? Is there a significant local market? Is there a ready source of personnel to man the terminals?

- Of significant concern is the question of terminal expandability. Can this be accomplished, considering the probable expansion of world trade in the future?

- Has the port sufficient water depth, in channels and alongside the berths, to permit the safe and efficient movement of the largest ships which are likely to enter the port? What are the prospects for future increases in water depth? Of much greater importance, can the ship operator be assured that the water depths can and will be maintained over the long term?

- Is there sufficient length of berthing area fitted with container cranes to accommodate the perceived normal maximum throughput without causing an inordinately long queue of vessels waiting to berth?

- Is all necessary documentation and information existing, accurate, and available when needed?

The Ideal Container Port

Commercial waterside land is increasingly under pressure as the beautifiers of the world lay claim to more and more of this valuable commodity through gentrification, preservation, zoning changes, designation as wildlife areas, and other artifices. Elsewhere in the world, land reclamation has been used with great success to provide port acreage. In this country, such an approach would likely be greeted with dismay, anger, and no small measure of "not in my backyard" attitude.

Where, then, can and should a port be located? Ideally, the time-sensitive nature of container-based liner services, where departures are regulated by the clock, calls for the landside terminal to be as close to the open sea as possible, but with easy connections to the rail and highway portions of the system. The container port need not be in the middle of a metropolitan area as was the case in the 19th Century, but it should not be too far distant from significant local markets.

Finally, the container port should have its own support infrastructure, should be distant from residential areas (but not so far away as to create manning difficulties), and should not result in unduly great competition with other vessel types for access channels, anchorage, and support facilities.

The Protection of Local Waters Through Ballast Water Exchange

An increasingly important problem in ship operation is the possibility of introducing foreign animal species into an area in ballast water, that has been carried from another part of the world and discharged. This was first noted on the Great Lakes with the zebra mussel, but other species have appeared in various locations around the world.

A number of solutions have been proposed, all of which have positive and negative features. One of the most promising is ballast water exchange, in which water taken aboard in one port is discharged into the open sea and replaced with deep-ocean water as the ship proceeds to her destination. The key to the success of this practice is to ensure that the safety of the vessel in terms of stability is not compromised at any time during the transfer.

Other ideas include chemical treatment aboard the vessel and the discharge of ballast into holding tanks ashore, both of which appear to have significantly

greater operational challenges. The former would require additional equipment and an additional task aboard the ship and the latter a complex shoreside installation.

The problem of rogue species is solveable, but the implementation of a workable way to avoid the problem will take dedication on the part of all parties concerned.

Competition within the Port

Competition within a port between various types of vessels must be given consideration, particularly when the mega-ship is a regular visitor. We have dwelled above on the mega-container ship, but there are other vessels, in the "mega" category, and some of these do compete within American ports.

The original mega-ships–tankers and bulk carriers above 250,000 dead weight tons (ships which have a length of more than a 1,000 feet and a beam of 140 feet or more–are not a factor in the United States, but a proliferation of mega-cruise ships is being seen in American waters, primarily in the Southeastern ports which serve the Caribbean region. Some of these vessels approach the largest of the tankers and bulk carriers in physical size.

Not to be forgotten are the smaller ships which traverse the waters of many ports, including recreational and fishing vessels, towboats, and flotillas of barges, ferries and other vessels which must also use these waterway. The question of competition is not so much one of priority as of having a common right of way, much as exists on the landside highway system.

A Plea for Safe Navigation

From the shipowner's viewpoint, the safe operation of a container port is built around three issues: an efficient vessel traffic control system, regular maintenance dredging of berths and channels as the need arises, and unfailing accuracy in the charting of all waters from the open sea to the berth.

Vessel traffic control schemes are expensive and require continuing dedication on the part of the system operators. Not only should the marine community take a cue from the air traffic control system, but the marine system itself should be a free-standing operation in which the persons who man a local system should be marine professionals intimately familiar with the area's needs and not subject to periodic replacement.

Regular maintenance dredging must be carried out as necessary. We hear too frequently of areas, that have become shoaled in the wake of competition for the appropriation of funds. This problem must be removed from the political arena.

The charting of waters throughout the port and its approaches must be undertaken with unfailing accuracy. Again, we hear the shipmaster's horror stories about uncharted obstacles, obsolete charts, and similar impediments to safe navigation. The advent of electronic chart displays makes the problem of keeping up-to-date charts a simpler one, provided that the argumentative discussion of electronic chart standards is solved.

The litany of concerns about in-port menaces to navigation includes a variety of hazards, typical of which are the following:

- Competition with other vessel traffic on a crowded waterway.
- Narrow and/or tortuous waterways.
- Channels with insufficient water depth.
- Extreme tidal variations or local current problems.
- En route physical hazards on the surface, such as the presence of bridges.
- En route submerged man-made hazards, such as the presence of pipelines or underwater cables.
- Limited overhead clearance (air draft).
- Local regulations prohibiting night arrivals and departures.
- Frequent weather-related delays caused by fog or ice.

Some of these hazards are to be found in every port. Some ports have more than their fair share. The Houston Ship Channel and the lower Mississippi River, for example, offer challenges to any ship visiting the ports at those waterways' ends.

Although not directly a part of the port challenges, another concern relating to navigation is the question of protection of marine mammals. The maritime community is keenly aware of the importance of this issue and will, I am sure, continue to monitor these environmental concerns.

The Port: Commonweal or Private Preserve?

A port serves much more than the ships that call there or population that inhabits the local area. Even those persons who will never smell saltwater—from the hard rock miner in Vanadium, New Mexico, to the general store owner in Ida Grove, Iowa, to the black dirt farmer in Issaquena County, Mississippi—are direct beneficiaries of the international trade which passes through any port. In actual fact are they and nearly 275 million others not the real owners of the American port system?

The provision and maintenance of facilities for the common carriage of freight has long been a responsibility of government. Although it is realized that the user has his own responsibility in respect to this–his own terminal and facilities, whether owned or leased, for example–the fact remains that, because the port itself is there for the commonweal, an equitable method of public funding on behalf of the real owners must be considered.

Those persons in New Mexico and Iowa and Mississippi are the owners of the national parks, the monuments and activities in our nation's capital, and untold other aspects of life, and they benefit in an intangible way from all of these. They, too, benefit from the ports in a much more discernable manner.

Concluding Remarks: The Challenge

The challenges facing the shipowner and the port operator are certainly real. For the nation to ignore the needs of the ports in this increasingly competitive, globally oriented world of commerce equates, as I mentioned earlier, to the acceptance of second-class statehood.

We sincerely believe that with a continuing dialogue among the port users, the operating authorities, the support and regulatory organizations (be they local, state or federal–such as customs authorities, pilots, police and public safety groups), and government, solutions will be found to the problems and the challenges that confront us. The road ahead may present a difficult journey, but the goal of building a cargo pipline, with fully open valves, will be reached.

My closing thoughts turn to a parable totally unrelated to maritime commerce: the metric system. The United States is one of three nations, which, after nearly a century of domestic debate, does not use metric measurements. The others are Liberia and Myanmar. Question: Is this where we belong?

DEEPWATER OFFSHORE OIL DEVELOPMENT: OPPORTUNITIES AND FUTURE CHALLENGES

Paul L. Kelly
Rowan Companies, Inc.

Introduction

As we move into the next millennium, a larger percentage of oil and natural gas will come from the oceans. The United States has a significant opportunity to influence the future course of events from both a private sector and government perspective and guarantee that there will be secure access to this important source of energy in the years ahead.

Petroleum production from offshore federal lands currently accounts for 20 percent of our oil production and 27 percent of domestic natural gas production.

Extraction of petroleum resources from beneath the seabed is a major maritime activity in the Gulf of Mexico, offshore southern California, and in some regions of Alaska. Petroleum production from offshore federal lands currently accounts for 20 percent of our oil production and 27 percent of domestic natural gas production. The offshore oil and gas industry, including the support services sector, provides Americans with approximately 85,000 well-paying jobs, a number which is likely to more than double in the next two decades. Oil production in the Gulf of Mexico, where there is a high level of industry interest and activity in waters as deep as 8,000 to 10,000 feet, is expected to double by the year 2002. Revenues from OCS oil and gas development generate an average of $3-4 billion a year in federal receipts and help fund the Land and Water Conservation Fund and the National Historic Preservation Fund.

Oil production in the Gulf of Mexico, where there is a high level of industry interest and activity in waters as deep as 8,000 to 10,000 feet, is expected to double by the year 2002.

Deepwater Successes

Offshore petroleum production is a major technological triumph. New exploration, drilling, and production-related technologies have brought about world-record complex industrial projects in 3,000 to 5,000 feet of water, which would have been unimaginable a generation ago. Exploration wells have been drilled in almost 8,000 feet of water and 10,000 feet seems within reach. There are at least 8 known fields at depths exceeding 1,500 feet of water with 1 billion barrels or more of oil in place. These are located offshore 5 countries– the United States, Brazil, Nigeria, Cabinda, and Angola. In all, there have been 52 deepwater discoveries in the U.S. Gulf, 20 offshore Brazil, and 17 offshore West Africa, for a combined total of almost 23 billion barrels of oil equivalent. Much of this technology can be used in other ocean exploration endeavors and in scientific research, as well as in non-ocean fields such as communications and medicine.

Subsalt Plays

The same 3D seismic technology that has enabled oil and gas explorers to look into ever-deeper water at deeper geological targets has also enabled improvement in subsalt imaging in the Gulf of Mexico. Approximately 60 percent of the ocean floor in the Gulf contains salt structures beneath it which, until the advent of this new technology, kept us from seeing potential hydrocarbon–bearing structures below them. The subsalt play in the Gulf holds excellent potential for significant new finds and perhaps a number of giant fields. Only 44 wildcat wells have been drilled in the subsalt compared to more than 600 wildcats in the Gulf's deepwater. Anadarko Petroleum's discoveries last year at Tanzanite and Hickory represent important new oil and gas discoveries in the shallower waters of the Gulf, and similar potential discoveries lie in deeper water.

Safety and the Environment

Advances in technology and pacesetting safety management systems have also contributed to an improved Outer Continental Shelf (OCS) safety and environmental record. Over the past 20 years, less than 0.001 percent of the oil produced from the OCS has been spilled from production facilities. There has not been a spill larger than 1,000 barrels from oil and gas platforms on the Outer Continental Shelf since 1980; in fact, natural seeps introduce approximately 100 times more oil into U.S. marine waters than do spills from offshore development and production activities. Today industry, the Department of the Interior's Minerals Management Service, and the U.S. Coast Guard are working in partnership to raise the bar for environmental and safety performance even higher.

Moving beyond Conflict to Consensus; Extension of Moratoria Premature

Under the past two administrations, the Minerals Management Service (MMS) in the Department of the Interior has committed itself to resolve conflicts raised in connection with OCS oil and gas development and build a consensus among stakeholders as to where, when, and how activities should proceed. A parallel theme has been science-based decision-making. This approach is being used in the current 1997-2002 five-year OCS leasing program, and our coastal state administrations seem to be much more satisfied with the degree of communication and consideration that now exists between the federal government and the states regarding OCS oil and gas policy. For this reason, I believe it was premature for President Clinton last June, at the National Ocean Conference held in Monterey California, to extend OCS moratoria beyond 2000. We should have let these consensus-building policies work and evaluated their success before extending moratoria further.

Another consideration is the incredible advances in drilling technology made over the past decade, which make the extraction of oil and natural gas from the ocean much safer from an environmental standpoint and much less intrusive physically. A number of the areas in moratoria contain important reserves of natural gas, which cannot be spilled and is more and more the fuel of choice. Moreover, despite current appearances, the world will have a difficult enough time as it is supplying the energy needs of the 7 billion citizens who will inhabit our planet by 2010–at least a billion more than there are today, another China. We need to leave ourselves some flexibility to deal with changing international conditions or evolving domestic conditions and attitudes.

Global Leadership

As exploration of the ocean for hydrocarbons globalizes, the U.S. private sector and government have an unparalleled opportunity to lead the world in terms of management, technology, and our ability to demonstrate how to extract these resources in an environmentally sound manner for the benefit of all mankind.

Benefits of Offshore Oil Technology for Other Ocean Research and Activities

In 1998, we experienced a mini-boom in state-of-the-art mobile offshore drilling rig construction. Rigs delivered last year cost around $1.2 billion; rigs on order or planned will cost their owners at least an additional $12 billion, an average cost of $205 million per unit. New construction will peak in 1999 at 34 deliveries, then taper off to almost nothing as rig demand reacts to continuing low oil prices. Research done for such facilities on subjects such as composite materials, synthetic mooring lines, and other topics targeted at reducing the weight of materials in deep water should benefit many sectors in the marine environment. An industry/government coalition known as "Deep Star" has spent more than $6 million in research on deepwater technology challenges in the last few years.

Parallel developments have occurred in the offshore service vessel fleet, where new deep-draft, very large, high-horsepower anchor handling/tug/supply vessels have evolved to move these large new sophisticated drilling rigs, handle their anchors, chain and mooring lines, and meet all kinds of service demands of the new generation of deepwater rigs and production platforms.

As stated recently in a report of the National Research Council,[1] "ocean observations have always been the driver of new knowledge and predictive capabilities in the ocean and its basins. Ocean drilling has produced sediment cores that provide our best long-term records of natural climate fluctuations. Submersible observations (both piloted and robotic) opened our eyes to hydrothermal vents and the unique life forms that surround them." Many of the technological improvements enabling us to make these observations are driven by the needs of oil and gas explorers in the ocean. Certainly this is the case

with drilling, submersible vessels, and robotics. Much of our knowledge of seabed geology and geomorphology is directly owing to the offshore oil and gas industry. Just last month, a Louisiana-based company announced the development of a new process that gives a clearer picture of the ocean floor for better planning of drilling and construction. A new scanning sonar system collects seafloor features data in conjunction with proprietary image enhancement and analyzes software. The combination gives greater definition and resolution of seafloor features and hazards. Today in Houston we have a large-screen, interactive visualization center which allows engineers and earth scientists to course through 3D volumes of subsurface data worldwide. Also, companies are discussing the possibility of making available to the scientific community video film taken by various petroleum companies around wellheads in ultra–deep water for purposes of examining the marine ecosystem at these depths and identifying organisms not previously seen. As all these examples indicate, there is much potential for acquiring knowledge about the ocean environment through more joint efforts among industry, government, universities, and the scientific community at large. Today, scientists are using offshore rigs and platforms to study everything from marine organisms, physical oceanography, and meteorological data to bird migration. The day is approaching when abandoned offshore oil and gas platforms will be used for aquaculture projects. A converted offshore drilling rig is preparing to leave Russia for Long Beach, California, where it will be stationed to begin its new life as a privately owned commercial offshore rocket launch platform. Seventeen satellite launches are already contracted. Opportunities for the use of this technology are diverse and just abound!

Challenges Ahead

Before the potential of the deep water can be fully unlocked, there are a variety of economic, technological, environmental, and regulatory challenges to be overcome.

Costs reduction is a very important factor, particularly in the low oil price environment we are experiencing currently. One of the biggest challenges is the addition of a drilling function to a floating production, storage, and offloading system (FPSO) so as to have minimum reliance on shore-based facilities. MMS is currently studying FPSOs for application in the deepwater Gulf of Mexico along with industry. Another means of reducing costs is to operate through a "hub system" which handles production from two or more producing zones at a single facilities measurement point. This provides technical and regulatory challenges for the industry and the MMS as they meet their respective responsibilities to produce and measure production.

Deeper and colder waters create real and expensive problems with hydrates, paraffin, and solids build-up, so much research is being done to enhance flow assurance with solutions such as new types of insulation materials and coiled tubing. At the same time, the depths of some of the wells themselves have brought us to new pressure and temperature (excess of 200ºC) frontiers that have to be dealt with.

Multilateral completions are driving the need for more sophisticated downhole production systems.

For the geophysical industry, ever deeper water, deeper geophysical targets, the need to get the appropriate velocity field below salt and other complex frontier stratigraphy present far greater challenges to accurate acquisition of 3D seismic data than do normal depths and geology. The technological cutting edge that is reducing these obstacles to accurate surveys is proving to be the towing of longer cables on multi-streamer programs.

Deeper geological targets may require streamer lengths between 4,000 and 6,000 meters or more, rather than the standard lengths up to 3,600 meters. When four to eight streamers of the longer lengths are towed over large areas it can be a challenge to deploy them and maintain their positions.

These examples should give you some idea of the challenges deepwater operators are dealing with every day.

Law of the Sea Treaty

In closing, I want to make one more point that, as petroleum exploration moves into deeper and deeper waters, it is important that the United States become a party to the Law of the Sea Treaty this would assure the United States of a minimum of 200 nautical miles of OCS jurisdiction and establish rules and procedures for delineating the outer limits of the geological continental shelf, which in some areas extends considerably farther. That component of the Treaty which protects the right of both commercial and military ships and aircraft to move freely through and over straits used for international navigation, to engage in "innocent passage" through States' territorial seas, and to enjoy high seas freedom of passage

through exclusive economic zones, also is important to U.S. energy security as our sources of petroleum globalize and diversify in the years ahead and we become even more dependent on secure ocean transportation.

There presently exist about 200 undemarcated claims in the world with 30 to 40 actively in dispute. There are 24 island disputes. The end of the Cold War and global expansion of free market economies have created new incentives to resolve these disputes, particularly with regard to offshore oil and gas exploration. During the first 6 months of 1997, alone 172 licenses, leases or other contracts for exploration rights were granted in a variety of nations outside the United States. These countries are eager to determine whether or not hydrocarbons are present in their continental shelves, and disputes over maritime boundaries are obstacles to states and business organizations. We have two such cases here in North America, where bilateral efforts are underway to resolve the maritime boundaries between the United States. and Mexico in the Gulf of Mexico and between the United States. and Canada in the Beaufort Sea. Both of these initiatives have been driven by promising new petroleum discoveries in the regions. As I understand it, the Canadians do not seem to be in a hurry to resolve that boundary line. On the other hand, negotiations with Mexico are expected to resume in the spring of this year, after the Mexicans complete some geological analyses and technical research now underway.

The Law of the Sea Convention provides stability and recognized international authority, standards, and procedures for use in areas of potential boundary dispute as well as an additional forum for dealing with such disputes and other issues.

Notes

1 *Opportunities in Ocean Sciences: Challenges on the Horizon,* Ocean Studies Board, Commission on Geosciences, Environment and Resources, National Research Council.

CHALLENGES FACING THE U.S. COMMERCIAL FISHING INDUSTRY

Pietro Parravano
Pacific Coast Federation on Fishermen's Associations

- The Fishery Conservation & Management Act of 1976 (HR 200). now referred to as the Magnuson-Stevens Act, was the most significant piece of fisheries legislation passed in this century. It established,- a) U.S. control of fisheries in waters offshore the nation out to 200 miles in a Fishery Conservation Zone (FCZ) (later incorporated by President Reagan into the U.S. Exclusive Economic Zone (EEZ)) - b) U.S. policy to "Americanize" the U.S. fishery with a phase-out of foreign fishing offshore the U.S. and the development of a domestic fleet fully capable of harvesting the fishery resources of the EEZ; and c) federal management of U.S. fisheries in the EEZ through eight regional fishery management councils and the Department of Commerce-

- The Fishery Conservation & Management Act did contain language to "prevent overfishing," to manage fisheries for "optimum yield" —implying sustainable fisheries, and "managing fisheries throughout their range" —implying, at least in the case of anadromous fish that some consideration would be given of the habitat factors affecting those stocks. This language was not explicit enough, and various regional councils and Commerce subsequently allowed overfishing, did not manage for sustainability, and turned a deaf ear on pleas to speak out against the dam operations, water diversions and long that were decimating west coast salmon stocks.

- The Maguson-Stevens Act has succeeded in gaining U.S. control of the fisheries of the EEZ; phasing out foreign fishing and "Americanizing" (with the exception of some foreign ownership of U.S. -registered factory trawlers) the fishing fleet operating in the EEZ; and developing the system of federal management of fisheries based on recommendations made to Commerce by the eight management councils.

- The "Americanization" policy carried out following the 1976 passage of HR 200 put its emphasis on building a fleet capable of harvesting the fish that were being taken by the foreign fleets as well as develop harvesting, processing and marketing for "underutilized fish species, rather than developing a sound data base on which to make management decisions. Too little emphasis was given research to determine what level of exploitation (elect size and capability) the various fish stocks within the EEZ could sustain. Indeed, there was even reliance on some of the self-serving research done by the foreign fleets that had operated in the EEZ.

- The "Americanization" policy was one of "bigger is better" that promoted the construction (or reconstruction) of large trawlers, factory trawler / processors, and large longlining vessels (mostly all of 25 meters in length or greater) through programs of tax deferrals (Capital Construction Fund) and loan guarantees- Commerce also promoted management measures allocating huge chunks of the catch to the large trawl and factory trawl operators (in some instances Commerce overruled its regional council recommendations, in order to allocate more quota to the large operators).

- The "Americanization" policy as carried out by Commerce gave short shrift to the smaller fishing vessel operators the more traditional fisheries, and the "family fishing" vessel owner-operators. Little, if any, financial assistance was provided these fleets (as opposed to the large trawl and longline operators) even to improve safety or product quality. At the management level, the small boat fleets lost part (sometimes all) of its fishery to a reallocation to the trawlers for "bycatch." In other instances the smaller, more traditional flees were denied limited entry permits or had there catch levels significantly reduced in order to accommodate the large fleets.

- The "Americanization" policy, with its emphasis on fleet construction rather than research, has led to a vast overcapitalization of the U.S. fleet with far more catching capacity than resource to support that harvest capability. It has led to overfishing of many species and the near total collapse of the groundfish fishery in New England. The policy also caused Commerce, for at least 15 years following the passage of HR 200, to ignore the plight of the smaller and more traditional fisheries and most, specifically, fail to act in a timely manner to prevent the near

extinction of some Pacific salmon species (and their fisheries) from federally or state permitted dam operations, water diversions and logging,

The regional council process has been fraught with conflict. The intent of providing regional input into federal fisheries management has been subverted in a number of ways. State fishery managers, jealous of their turf, often act to prevent councils from taking actions to help a fishery where such an action might conflict with a state administration's policy. The public members are often financially conflicted and too often are association heads, lawyers or executive directors, instead of commercial or sport fishing men and women with "on-the-grounds" experience as envisioned in HR 200. The councils do not have independent legal counsel; they depend on NCAA General Counsel for their legal advise. They are also subservient to Commerce with it comes to their funding,

Overfishing is a problem around the world and much of it is coming from government-subsidized fishing operations, most notably large trawl and factory trawl operations.

The problems facing U.S. fisheries are not unique to this nation. Overfishing is a problem around the world and much of it is coming from government-subsidized fishing operations, most notably large trawl and factory trawl operations. Most of the large trawl and factory trawl operations are owned or controlled by corporations where the driving force is short term profits — satisfying shareholder demands for maximum quarterly dividends — rather than long term sustainability.

- Loss of habitat and pollution are also a major factor in the depiction of many of the world's fisheries. Coastal aquaculture operations, intended to increase fish production, are, ironically, one of the major sources of habitat loss and pollution (as well as a source of introduced exotic species, disease and parasites) in much of the world. Farmed shrimp and salmon operations are particularly troublesome.

- Throughout the world, most small boat and traditional fishing family operations have been conducted on a sustainable basis. But increased demand for fish coupled with newer and larger fishing vessels, many government subsidized and corporately owned.

- Many of the successful efforts over the past two decades in the U.S. aimed at sustainable fisheries have come at the state level or from fishery and conservation non-governmental organizations (NGOs). In California, for example, the effort to save that state's salmon resource has come from fishing groups, not the regional councils or Commerce. This is not surprising, responsible fishing groups, such as PCFFA, want sustainable fisheries that prevent waste and provide the consumer the very best product at an affordable price.

- In response to the failures of the FCMA and the "Americanization" policy, Congress, at the urging of conservation and some fishing groups, amended the Magnuson FCNU during the 1996 reauthorization, with the Sustainable Fisheries Act, explicitly prohibiting overfishing and calling for a reduction of bycatch in fisheries and an active consultative role on the part of Commerce aimed at preventing the destruction of essential fish habitat (EFH). That act also calls for the protection of fishing communities.

- To date, the regional councils and Commerce have not met their statutory timelines to develop plans to prevent overfishing or documents identifying essential fish habitat as called for in the Sustainable Fisheries Act. And, at least in the case of New England, the council and Commerce are certainly not following the spirit of the 1996 act in protecting fishing communities and fishing families. On the west coast, management measures are resulting in the waste of vast amounts of groundfish and the loss of the small boat fleet; and, in New England it appears the small boat operator is being sacrificed.

- Fishery planning for the next 25 years, based on the experience of the past quarter century needs to focus on:

  1. Full implementation of the Sustainable Fisheries Act. Overfishing has to be stopped, needless waste must be prevented by reducing fisheries bycatch and essential fish habitat must be protected. Fishing communities and fishing families have to be protected.

2. Small-boat and fishing family (owner-operator) operations should be fostered and supported, These types of operations tend to have a much stronger commitment to resource sustainability and culturally derived desires to pass along "their" fishery to future generations. An emphasis on small-boat and family fishing operations is also consistent with the language calling for protection of fishing communities in the Sustainable Fisheries Act.

3. With firm federal objectives for fishery conservation and management in hand (i.e., prevent overfishing reduce bycatch, protect habitat, protect fishing communities), fishery management decisions should be left at the regional state and local levels, provided they are consistent with the overall federal objectives.

4. More funds will be needed for research purposes, to develop better and more selective types of fishing gear, and to provide the regional fishery councils greater autonomy. With greater autonomy, the selection of public members to the regional councils should be limited to persons from the commercial, sport and conservation sectors with "on-the-ground" knowledge of fishing operations.

5. Greater emphasis must be made on "value-added" fisheries and fisheries that have low-impact and high value, consistent with providing consumers high quality, healthful and affordable sources of fish.

6. Aquaculture operations to supplement existing fisheries should be fostered only where they are non-polluting, do not damage habitat, or result in the introduction of exotic species, disease or parasites into the wild. Only aquaculture operations with good conversion ratios (e.g, amount of feed to amount of edible meat) should be supported.

7. Fishing men and women who have a first band knowledge of the marine environment, have to be an integral part of fishery research, management, and decision making concerning the uses of the marine environment (e.g., the designation of marine protected areas).

COASTAL TOURISM AND RECREATION: THE DRIVER OF COASTAL DEVELOPMENT

By Biliana Cicin-Sain and Robert W. Knecht
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While there is general recognition that coastal tourism and recreation are important in the coastal zone, we believe that their impact is systematically undervalued both economically and as the most important driver of coastal development in many U.S. coastal areas. In California alone, it is estimated that coastal tourism is the largest "ocean industry," contributing $9.9 billion to the California economy compared to $6 billion for ports, $860 million for offshore oil and gas, and $550 million for fisheries and mariculture combined (Wilson and Wheeler 1997). Travel and tourism are estimated to have provided $746 billion to the U.S. domestic product, about 10% of U.S. output, making travel and tourism the second largest contributor to GDP, just behind combined wholesale and retail trade (Houston 1995). Although there are no precise estimates of the magnitude of coastal travel and tourism in the United States, studies have shown that beaches are America's leading tourist destination, ahead of national parks and historic sites. Approximately 180 million people visit the coast for recreational purposes, with 85% of tourist-related revenues generated by coastal states (Houston 1996, 3).

The following examples highlight the very high value of coastal travel and tourism in the United States (YOTO 1998, F5). A 1996 EPA study on the benefits of water quality improvement, in terms of the numbers of people involved and the economic value of the activities in which they partake, found that saltwater fishing generates expenditures of over $5 billion annually, and over 200,000 jobs. Over 77 million Americans participate annually in recreational boating, with the total number of recreational boats by the year 2000 estimated to be 20 million. Over 80 million Americans participate in outdoor (non-pool) swimming, and in seven states, beachgoers spent $74 billion. Finally, birdwatching generates around $18 billion annually, a great deal of which occurs in coastal regions.

Given these figures, it is significant to note that there is no federal agency with a mandate to manage coastal travel and tourism, and that there is no overall national policy in place to plan for, and achieve, sustainable tourism in the United States. Although it is recognized as a highly valuable revenue earner, promotion and marketing of travel and tourism in the United States lags well behind other countries; the United States ranks 31st in international tourist market advertising, with Spain, for example, spending ten times more in advertising than the United States (Houston 1996, 3).

...studies have shown that beaches are America's leading tourist destination, ahead of national parks and historic sites.

A major reason for the lack of a formal program at the national level is that travel and tourism is viewed as a sector that requires relatively little formal management and is primarily a private sector endeavor. The benefits of tourism to coastal areas are great, yet its adverse effects are often not immediately visible, which leads to a sort of "management apathy." Also, most aspects of coastal travel and tourism that need managing are already dealt with at one governmental level or another, but in separate programs and run by different agencies, rather than as a coordinated, interconnected whole.

The YOTO paper on coastal tourism and recreation (YOTO 1998) (prepared largely by the authors) notes that sustainable development of coastal tourism depends on a number of factors, including:

- Good coastal management practices, especially related to location of infrastructure and provision of public access;
- Clean air and water, and healthy ecosystems;
- Maintenance of a safe and secure recreational environment, specifically relating to management of hazards, and provision of adequate levels of safety for boaters, swimmers and other recreational users;
- Beach restoration, including beach nourishment and other efforts that maintain and enhance the recreational and amenity values of beaches; and

- Sound policies for coastal wildlife and habitat protection.

Healthy and sustainable coastal tourism requires attractive, safe, and functional recreational beaches, clean coastal waters, and healthy coastal ecosystems producing abundant fish and wildlife. In most parts of the burgeoning U.S. coastal zone, these factors do not exist by chance. Most recreational beaches have to be maintained with occasional replenishment of sand lost to storms and erosion. Clean and healthy coastal waters are the result of effective programs of pollution control—of municipal sewage treatments, of septic tanks, of agricultural run-off, and a large number of other point and nonpoint sources. Coastal fish and wildlife depend on the existence of healthy ecosystems; wetlands have to be protected and, where already degraded, restored. Failure in any of these areas can seriously affect tourism. A failed sewage treatment plant can close a beach to swimming—in 1996, there were nearly 3000 such closings or advisories (Heinz 1998) at U.S. beaches. The state of New Jersey reportedly lost $800 million in tourism revenues following reports that medical wastes had washed up on some of its beaches (Bookman, pers. com. 1997).

Healthy and sustainable coastal tourism requires attractive, safe, and functional recreational beaches, clean coastal waters, and healthy coastal ecosystems producing abundant fish and wildlife.

While there are already programs in place dealing with each of these areas, there is no agency or mechanism in existence to coordinate them toward the overall goal of sustainable tourism development. Federal programs most relevant to coastal travel and tourism include the following:

- *Coastal management and planning* is administered by NOAA's Office of Ocean and Coastal Resource Management (OCRM) and includes programs in 34 states and territories. Three management practices under the Coastal Zone Management program are particularly important in the context of sustainable tourism development: provision for the management of coastal development; provisions to improve public access to the shoreline; and provisions to protect and, where necessary, to restore coastal environments.
- *Management of clean water and healthy ecosystems* is a second, and especially important, category in this context. There are a number of federal agencies and programs involved with water quality, including the Clean Water Act (e.g. the National Estuary Program) administered by the EPA; protection of the marine environment from oil spills, covered by the Oil Pollution Act of 1990 and administered by the U.S. Coast Guard; and NOAA's work with states under the CZMA to deal with nonpoint source water pollution.
- *Management of the impacts of coastal haz ards, including flood and erosion protec tion* and the use of siting methods such as setback lines, is dealt with under both the FEMA National Flood Insur ance Program and the Coastal Zone Management Program. Also impor tant here is safety and accident preven tion for visitors involved in coastal rec reation—the U.S. Coast Guard is the principal federal agency responsible for user safety and accident prevention. Beach restoration and nourishment programs are managed at the federal level through the Army Corps of Engineers. Increasingly, however, it is local communities, sometimes with state assistance, that are being forced to undertake such restoration programs.

Given the very large contribution to the economy associated with coastal tourism and recreation, it would seem that special policy and pragmatic coordination efforts are needed among the federal, state, and local agencies responsible for the activities mentioned above. We note four policy challenges in this regard.

Policy Challenges

1) *Federal policies and programs essential for sustainable tourism development are interrelated and should be treated as such*. Consideration should be given to the creation of a standing interagency group devoted to coastal tourism among the various federal agencies with programs in this area. State and local government representatives should also be included.

***2) Little guidance is currently available to states and communities for sustainable tourism development in coastal areas*.** The federal government could play a role in providing guidelines to communities and states (standards, codes of conduct, manuals, etc.) to assist in their efforts to manage coastal tourism and recreation sustainably.

3) ***At present, there is little systematic collection of data and information on the magnitude, nature, and economic and social impacts of tourism in the coastal zone.*** This needs to be changed to provide greater information on issues, trends, and the value of tourism at all levels in the United States. The availability of this kind of information will help attract the appropriate level of attention to this issue.

4) ***Recreational beaches are in great demand in the U.S. both by its own citizens and foreign tourists. Yet there is no comprehensive national program of beach standards yet in effect***. EPA is launching a beach action plan dealing primarily with water quality (EPA 1998) and the House of Representatives passed, in 1999, the Beaches Environmental Assessment, Cleanup and Health bill which sets minimum standards for beach water quality, requires the EPA to establish performance criteria for beach monitoring and closure notification, and to establish a national beach water pollution database. While these are significant steps, we think that a national program on beach standards should be broader in scope. The European Blue Flag program, now in place at about 1,000 beaches in different nations of the European community, provides a good model. The flag can only be flown at beaches that meet pre-set standards in water quality, safety (lifeguards, first aid, storm planning), beach management (erosion control, replenishment, clean-up), and environmental information and education (information on fish and wildlife, beach dynamics, tides, currents, etc.). While the program has been encouraged by the European Union and individual governments, the actual operation (judging beaches against the standards) is performed by nongovernmental committees set up in each nation. The U.S. could benefit from a program similar to this one.

Acknowledgments

This paper is a summary of the paper on tourism and recreation prepared for the Year of the Ocean (YOTO 1998) by the authors in collaboration with other contributors. It is excerpted from Cicin-Sain and Knecht (1999).

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ASSESSING THE ECONOMIC BENEFITS OF AMERICA'S COASTAL REGIONS

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Although coastal areas comprise one-fifth of the land area of the contiguous 48 states, they account for more than half of the nation's population and housing supply. In 1990, over 133 million Americans lived in the 673 counties along the Atlantic and Pacific Oceans, the Gulf of Mexico, and the Great Lakes. Since 1960, these areas increased by 41 percent. That rate was above the national average–a trend that is expected to continue. About 820,000 new homes are constructed in coastal areas each year. These areas also account for about half of all new industrial, office, retail and recreational building.[1]

The public discussion of this growth is too often focused solely on the so-called problems caused by this growth. Coastal growth poses challenges–and sometimes damages–to the environment. The increase of housing units taxes drinking water supplies and sewage systems. Human intervention, mostly through the construction of channels and dams, disrupts the natural sand system, causing sandy beaches to erode. This development not only harms recreational opportunities and decreases local and regional tax revenues, it also undermines the protection that coastal property owners need from storm surges. That in turn raises the issue of flood insurance and disaster relief policies. There are tensions between commercial and recreational fishermen, and an increasing shortage of fish for both interests. The pollution of estuaries and beach waters, as well as the relatively unexplained increase in harmful algal blooms and hypoxia, each take their toll on coastal interests.

Each of these issues, of course, is quite important, and the political process at all levels often deals with them on a one-by-one basis. Should the Federal government support beach nourishment? Should it "subsidize" coastal flood insurance policies? By taking just these two issues alone, we can see symptoms of myopic public policy-making. Let us assume for the sake of discussion that the Flood Insurance Program provides lower-than-market-cost insurance policies for at least certain coastal homeowners. Let us also assume that current proposals to deny Federal flood insurance to certain coastal homeowners with repetitive losses will affect more than a handful of coastal property owners. By increasing the cost of living for these homeowners, what is gained and what is lost? The public would likely believe that a significant increase in insurance premiums will encourage these homeowners to retreat from the coast. But suppose that we instead invest in repairing and nourishing the protection these homeowners get from sandy beaches. By incurring this cost (which is shared by Federal, State, and local taxpayers), what is gained and lost?

Too often we are able to measure costs quite easily. The Federal Shore Protection program, for example, costs about $100 million a year in Federal dollars.[2] What are the benefits of that rather modest expense? While the U.S. Army Corps of Engineers does a benefit-cost analysis in connection with every shore protection project, that analysis suffers from its own myopia. It places its greatest emphasis on the value of the private property that is immediately adjacent to the coastline. It is not reasonable to assume that a healthy beach with natural dunes and vegetation will benefit only that first row of homes and businesses. The homeowners spend money in the region; the hotels attract tourists, who also spend money; local residents who live inland come to the beach for recreation. They, too, spend money. There are a variety of service businesses, from T-shirt vendors to banks, whose existence depends on these expenditures. In addition, there is an environmental benefit derived from renourishing our beaches. Property owners do not retreat from an eroding shorefront. They build seawalls and other hard structures to protect their property. These hard structures, which often exacerbate beach erosion, provide an unfriendly home to the birds and turtles that nest in the sand.

If we know the costs of the Federal Shore Protection Program, what then, are its benefits? If we can also state with a fair certainty what it costs to "subsidize" the flood insurance policies of coastal residents, what is our measurement of the benefits derived from that "subsidy"? It is regrettable that we cannot answer the benefits side of the equation with the same certitude as the cost side. As long as we cannot quantify the benefits, those who make policies affecting coastal regions must make their decisions in a factual vacuum. In addition, the public is subjected

to the repeated carping of those who mistakenly believe that some form of forced retreat from the coast will return our coastal regions to their "natural" condition. There is every reason for each of us to support policies that result in sustainable coastal growth and which encourage –if not require– that responsible economic and environmental decisions be made along each of our coasts and in each of our coastal communities. However, even if the 54 percent of our population that lives along the coast retreated inland, it would not bring the coast back to the conditions that existed prior to European settlement 200-plus years ago, or the Industrial Revolution over a century ago.

We are, of course, not lacking in hard information about the benefits derived from our coastal regions. The immense natural resources of these regions are responsible for a significant amount of commercial activity. In 1993, the U.S. commercial fishing industry produced and marketed products valued at $10.8 billion. Saltwater recreational anglers generated $15 billion from 64 million fishing trips. In 1990, 2.15 billion tons of cargo valued at over $500 billion moved through the nation's 190 seaports. [3]

We also know a good deal about the attraction that coastal regions have for tourists. In 1997, total tourism expenditures in U.S. coastal congressional districts was over $185 billion, while tourism payroll was almost $50 million and tourism jobs in these districts were over 2.7 million. [4] Beaches and coastal regions are not only the Number One destination for domestic tourists, they also are the top destination for foreign tourists. Each year, the Federal government receives about $4 billion in taxes from foreign tourists, while state and local governments receive another $3.5 billion. Foreign tourists spent over $11 billion in Florida in 1992, $2 billion of that amount in the Miami Beach area alone. This Florida spending generates over $750 million in Federal tax revenues, more than the total received by the State and local governments combined. Focusing on Miami Beach alone, annual Federal tax revenues from foreign tourists ($2 billion) are about 17 times more than the Federal government spent on the entire Federal Shore Protection program from 1950 to 1993 ($34 million in 1993 dollars). If the Federal share of beach nourishment averages about $10 million a year, the Federal government collects about 75 times more in taxes from foreign tourists in Florida than it spends restoring that State's beaches. [5]

Foreign tourism to the United States in 1995 was expected to generate a trade surplus of $26 billion, compared to a surplus of $17 billion in 1992 and a deficit of $7 billion in 1986. During the 1995 to 2000 period, the number of tourism-related jobs is expected to double. [6]

When it comes to beach spending, we have a large amount of additional benefit-related information. On the one hand, for example, we know that 55 percent of the visitors to Broward County, Florida (the Ft. Lauderdale area) would not come if there were no beaches. Another 27 percent would come less often. Out-of-state visitors generate $350 million in economic benefits to that county annually. In addition, Broward's beaches generate county property tax collections in excess of $28 million a year and create nearly 18,000 jobs. [7]

From discussing the State and county levels, let us spend a moment looking at the impact of beach nourishment at the local level. In 1993, the Federal government spent $5.5 million, while the State and local governments spent another $4.3 million, nourishing 5 miles of beach on Anna Maria Island (which lies on the West Coast of Florida between Tampa and Sarasota). That beach restoration added $67.5 million to local property values, and boosted the island's economy by $25.9 million and 711 jobs. Property values for areas of the county that are away from the beach restoration area increased by $32.1 million, mostly due to increased beach recreational opportunities. [8]

The immense natural resources of these regions are responsible for a significant amount of commercial activity.

Moving to the West Coast, California's beaches experienced more visitor attendance days in 1996 than all of the State's other tourist attractions – including Disneyland– combined. Beach tourism spending contributes over $10 billion in direct benefits to the State and another $17 million in indirect benefits–almost 3 percent of the total economic activity in the State. Beach tourism creates a half million California jobs and $1 billion in state sales, income, and gasoline tax revenues. [9]

Now, going from the Nation's largest State to one of its smallest, Delaware receives 5.1 million "person

trips" each year in a State where just over 21,000 people actually live in beach communities and another 373,000 people live within day-use travel distance. Beach tourism generates $173.2 million in expenditures each year. Just as significant, beach erosion results in an estimated loss of over 471,000 visitor days a year, a figure which is estimated to increase to over 516,000 after five years. During that 5-year period, beach erosion will cost an estimated $30.2 million in consumer expenditures, the loss of 625 beach area jobs, and the reduction of wages and salaries by $11.5 million. Business profits will drop by $1.6 million and State and local tax revenues will decrease by $2.3 million. Finally, beach erosion will reduce beach area property values by nearly $43 million over the five-year period. [10]

It is critical that we develop a comprehensive set of data on all of the benefits derived from America's coastal regions.

Our nation's estuaries are also major tourist and recreational attractions. For example, nature tourism in Corpus Christi, Texas is the fastest growing component of a tourism sector that generates $23 billion annually. Recreational fishing provides aggregate net benefits to the area of $83 million, including $37 million per year in state and local taxes. The economic impact of water quality-dependent uses in Long Island Sound is estimated at more than $5 billion annually. Commercial and recreational fishing contributed more than $1.2 billion of the total, while beach going has a direct benefit of more than $800 million annually. [11]

Let us conclude this partial review of the economic impact of our coastal regions with data from the U.S. Environmental Protection Agency. America's coastal waters support 28.3 million jobs and generate $54 billion in goods and services every year. The coastal recreation and tourism industry is the second largest employer in the nation, serving the 180 million Americans who visit our coasts every year. The commercial fish and shellfish industry contributes $45 billion to the economy every year, and recreational fishing contributes $30 billion. [12]

It is critical that we develop a comprehensive set of data on all of the benefits derived from America's coastal regions. As stated above, policy makers cannot make sound decisions without this knowledge. 1998 was the Year of the Ocean. The year may be finished, but our work has just begun. A critical and somewhat overlooked component of the activities related to the Year of the Ocean is our coastline. What we do in that one-fifth of our land that comprises coastal America has a significant impact on our oceans, and vice versa. The fact is that taken from a comprehensive point of view, we in the United States need to take major steps to improve our coastal management practices and policies. We must restore and maintain our eroding beaches, improve the quality of beach water and coastal community drinking water, protect and enhance coastal wildlife, promote policies that mitigate coastal hazards, and in general improve the quality of our coastal living environment.

Since our inception in 1996, the American Coastal Coalition has supported the full assessment of the economic and ecological benefits of beach nourishment. Today, I announce our support for a major study by the National Academy of Sciences of the economic and ecological benefits of our nation's coastal regions.

Notes

1 Data cited are from NOAA. The H. John Heinz Center for Science, the Economy, and the Environment found in November 1997 that 112 million people live in counties entirely or substantially within 50 miles of the coast.

2 Over the past 45 years, the average annual Federal shore protection outlay is actually less than $50 million. It is only in the last three to four fiscal years that it has reached $80 million to $110 million.

3 Data from Heinz Center report, op. cit. In addition, in 1996, saltwater recreational fishermen spent $8.7 billion on a variety of items to participate in their fishing. These dollars had a ripple effect of $25.1 billion, supported the equivalent of 288,000 full-time jobs, and generated $1.24 billion in State and Federal taxes, according to a 1998 study by the American Sportfishing Association.

4 Data from American Coastal Coalition analysis of a June 1998 study by the Travel Industry Association of America.

5 Data derived from an article by Dr. James R. Houston, published in the *American Shore and Beach Preservation Journal.*

6 See "Coastal Tourism and Recreation" by Biliana Cicin-Sain and Robert W. Knecht, published in *Year of the Ocean Discussion Papers*, March 1998.

7 Data from 1997 study by Broward County Department of Natural Resource Protection.

8 Data based on a February 1997 study by Regional Research Associates, Inc., Boca Raton, FL.

9 Data from a May 1997 study by the University of San Francisco's Public Research Institute.

10 March 1998 study by Jack Faucett Associates (Bethesda, MD) in cooperation with independent consultants Linda Kent (Bethesda, MD) and Christopher Jones (Charlottesville, VA) for the Delaware Department of Natural Resources and Environmental Control.

11 Cicin-Sain and Knecht, "Coastal Tourism and Recreation" in *Year of the Ocean Discussion Papers.*

12 July 9, 1998 testimony of Robert H. Wayland, II, Director of EPA's Office of Water, before the Senate Environment and Public Works Committee.

A PROFILE OF RECREATIONAL BOATING IN THE UNITED STATES

Ryck Lydecker and Margaret Podlich
Boat Owners Association of the United States (BOAT/U.S.)

"There is nothing, absolutely nothing, half so much worth doing as simply messing about in boats."

With apologies to Water Rat in Kenneth Grahame's *Wind in the Willows*, there is nothing half so much worth the coastal planner's attention than the future of recreational boating in this country.

To get a sense of boating's future as we sail into the next millennium, it is important to understand the roots of a recreational activity that directly involved, as on-the-water participants, 75 million Americans last year.[1] Recreational fishing alone contributed more than $108 billion to the economy in 1996, and supports 1.2 million jobs, creating wages of about $28 billion. It is a huge industry, with U.S. anglers outnumbering golfers nearly 2 to 1.[2]

...recreational boating comprises America's largest fleet, dwarfing the total vessels in merchant shipping, commercial fishing, passenger traffic, the Navy, and the U.S. Coast Guard.

Another way to look at the significance of this pleasurable activity is that recreational boating comprises America's largest fleet, dwarfing the total vessels in merchant shipping, commercial fishing, passenger traffic, the Navy, and the U.S. Coast Guard.

There are over 16,800,000 boats in use nationwide. With 75 million people cruising, sailing, fishing, water skiing, racing, camping, wildlife-watching or just exploring, it's easy to see that boating is very much a social activity, and a real family sport.[3] In fact, in a recent nationwide survey of marina customers, nearly 50% were reported to be families with children. The second largest group was retired couples or singles at 20%.[4]

The Yachting Misnomer

Despite the fact that 50% of all registered boats are less than 16 feet long, and 93% of all registered boats are less than 26 feet long,[5] boating has always suffered from the "yachting" stigma. In the public's eye, boating has been the exclusive domain of the rich. The person who probably had more to do with etching that erroneous view in the public psyche than anyone was J.P. Morgan, the great and certainly very wealthy yachtsman of the early part of this century. When asked how much one of his legendary steam yachts cost, Morgan is said to have replied, "If you have to ask how much it costs, you can't afford it."

Certainly when the 20th Century dawned, spending time in a boat for any other purpose than wresting a living from the water was unheard of. Boating for the middle class only arrived, like so many other leisure pursuits, after World War II. Participation roughly doubled in each decade until the number of boats in use hit 13 million in 1985.

But Morgan's legacy stuck and boaters were seen as "fat cats" in the 1980s, wealthy yachtsmen to be

1998 Boaters and Boats in the United States: Population Estimates

Boaters and Boats	Number
People participating in recreational boating	74,847,000
Water skiers	10,314,000
All Boats in use	16,824,000
Outboard boats owned	8,300,000
Inboard boats owned	1,609,000
Sterndrive boats owned	1,673,000
Personal watercraft	1,100,000
Sailboats owned	1,669,000
Miscellaneous craft owned (canoes, rowboats, dinghies, and other craft registered by the states)	949,000
Other (estimated canoes, rowboats, etc. not registered by the states)	1,524,000
Marinas, Boatyards, Yacht Clubs, Dockominiums, Parks and other	10,320

Source: "Boating 1998" prepared by the National Marine Manufacturers Association, Chicago, IL
The "in-use" figures are based on actual state and Coast Guard registrations and estimates of non-registered boats.

saddled with taxes disguised as "user fees" to help balance the federal budget. After a protracted struggle, cooler heads in Congress prevailed when they realized that boaters already had been paying their way for years through motorboat fuel taxes and fishing gear excise taxes.

Today these taxes go into the Aquatic Resources Trust Fund (Wallop-Breaux), which pumps about $350 million annually into boating safety education, law enforcement, environmental protection, public access, and fishery restoration. *As a result, there is hardly a stretch of water anywhere that hasn't benefited in material ways from America's boaters.*

Boaters count on being able to get to the water (access), being able to enjoy the water and related wildlife (natural resources), and having the time and desire to pursue boating for recreation (opportunity).

Boating Benefits

Alongside these economic benefits, recreational boating offers our nation's citizens lifelong opportunities for healthy, outdoor, family activity. It provides an important cultural link to our nation's maritime heritage, and a critical gateway for youth through such nationwide programs as Sea Exploring (Sea Scouts), Red Cross and YMCA water sports, and 4-H camps as well as countless local sailing schools, canoe clubs, and community boatbuilding programs.

It seems fair to speculate, then, that recreational boating may be the largest clearly defined constituent group for NOAA and its National Ocean Service, National Marine Fisheries Service, even its marine weather services, as well as for the U.S. Coast Guard, whether these agencies realize it or not.

Issues for the Future

As we think about the coast and coastal issues heading toward the year 2025, there are several core issues important to this large user group. Boaters count on being able to get to the water (access), being able to enjoy the water and related wildlife (natural resources), and having the time and desire to pursue boating for recreation (opportunity). These three elements constitute the base of possibilities for recreational boating into the next millennium.

Access

Boaters rely on being able to get to the water, and use the water for a variety of activities ranging from fishing and sailing to cruising and overnight boat camping. In order for boaters to peacefully co-exist with other user groups on our coastal waters, waterways must be seen as a common resource that is available to all. They must be protected as a public open space, able to accommodate a variety of users.

Access to these waters must be maintained through both public and private lands. Those lucky enough to own waterfront property should be able to launch their boat from their own yard, and those not so fortunate should have ready access to public launch sites and marinas open to the public. To insure that average citizens can get to the water, ramps, access points, boat parking facilities in the form of marina and transient dockage, moorings, and anchorages, as well as on-land dry storage and winter storage, must be available to the general public.

Once on the water, boaters rely on clearly marked, maintained, and dredged channels, along with accurate, updated, and available charts. In recent years, federal budget cuts have reduced the channel maintenance and charting abilities of the government, and recreational areas are often the first to suffer. Innovative ways of maintaining charts for the recreational boater may be necessary, including the use of trained volunteer labor for sounding harbors. Volunteer data collection may be the key to safety, when you realize that millions of recreational boats can lose their way, run aground, or hit bridges and buoys without updated charts.

Boaters use a variety of destination choices, ranging from developed city docks (Baltimore Inner Harbor) and historic maritime areas (Mystic Seaport), to islands (Catalina Island) and remote areas with diverse wildlife (Apostle Islands National Lake Shore). Freedom to explore the waterways is our birthright. To make it our legacy, we must make coastal stewards out of all citizens, educating all how to preserve those areas we explore.

Natural Resources

Like other recreational users of the coast, boaters rely on clean, unpolluted water. "Going boating" con-

jures up images of relaxing in an aesthetically pleasing, natural area, with crisp, clear water, fresh air, and interacting with fish, birds, and other wildlife. No one wants to spend precious leisure time on a river with oil slicks, floating garbage, and dead fish. As a result, individual boaters and the marine industry as a whole have been increasingly involved in initiatives to clean up our waterways, restore aquatic habitat, and protect natural resources. They all rely on clean coastal waters that sustain an abundance of fish and wildlife, whether they are pulling fish out of the water for dinner, or swimming in the water, or just getting splashed with a rogue wave.

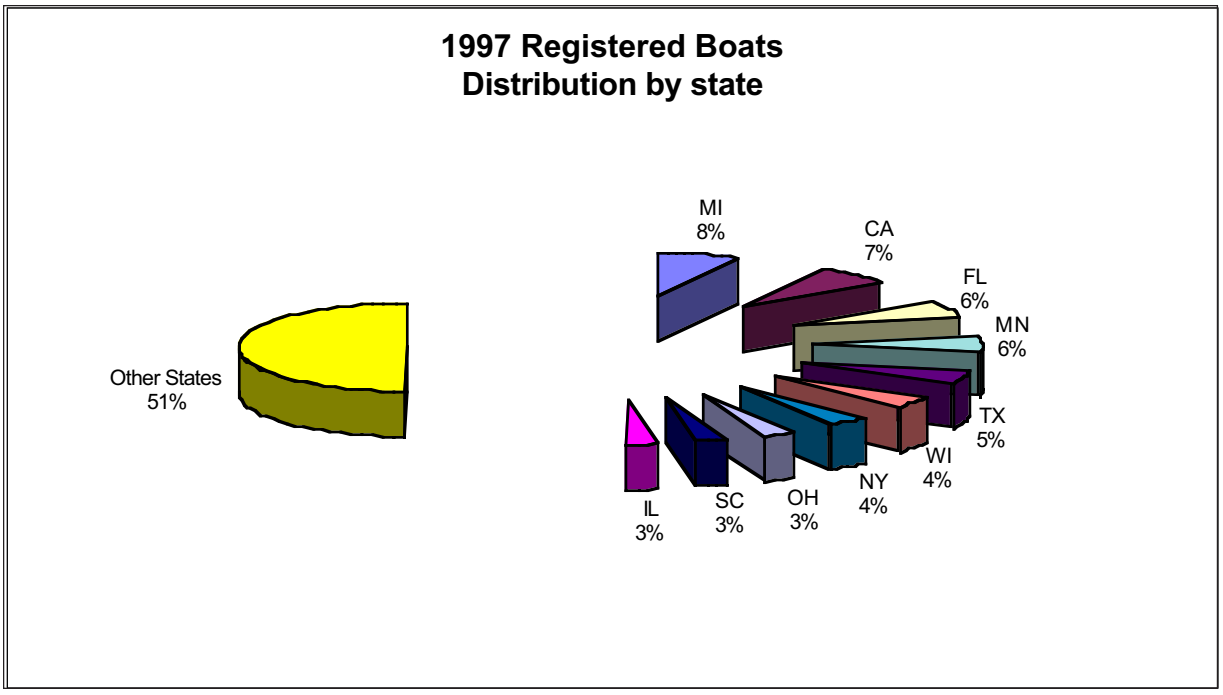
In order to improve coastal water quality, new methods of reducing both point and nonpoint source pollution will be required. This will be increasingly difficult as coastal populations soar by 2025 and put more stress on the coastal areas. With more potential polluters in the same coastal area, we'll have to do even more to keep pace with existing water quality issues, much less improve them.

Flexible, timely management of fish and wildlife is required. Diversity and sustainability must be embraced in this management as key ingredients for the long-term viability of our oceans. Both commercial and recreational interests must be brought in to the solutions to current overharvesting of fisheries, and bycatch must be better addressed. The introduction, spread, and control of alien species should also receive special attention, since they continue to threaten entire native populations and ecosystems, and pose grave consequences for recreational boating and fishing.

Opportunity

The water is clean, there are fish to catch, birds to watch, and the access ramp is right down the street. What's stopping the average citizen from taking to the water – from "simply messing about in boats?"

Access to a boat is probably the first thing. While there is approximately one boat in this country for every 17 people,[6] many people may not have the resources to own their own boat. Those people that do buy a boat are often precariously on the edge of selling it, depending on variables in their own lives, costs, available free time, and hassles associated with owning the boat. Individual boaters must find a



Source: "Boating 1998" prepared by the National Marine Manufacturers Association, Chicago, IL.

This chart reflects the 12,309,724 boats registered in the states in 1997. The 10 states shown above host nearly half of all registered boats in the country. Note that 3 of the 5 states (CA, TX, FL, GA, VA) with the greatest rise in predicted population are already among the states with the largest number of registered boats.

balance between limited free time and the time it takes to do maintenance work before leaving the dock. In order for boaters to continue boating, boaters will have to feel that the "recreation" element surmounts the perceived obstacles to this use of their limited free time. These obstacles are often cited as costs, fees, government regulations, and maintenance.

No matter who owns the boats, it can be assumed that recreational boating will be only one activity among many at the water's edge. Resolving user conflicts over the use of these waters will be a rising challenge in the next century.

Another challenge for the industry and for coastal managers may be how to address carrying capacity issues through better use of existing boats. Since most boats are used less than 10% of the time, getting more use out of one boat may be an option that works better for the boater and for the coastal environment. Encouraging timeshare boat owning arrangements and community boating and boat rental programs may help more people enjoy life on the water, without a correlated increase in infrastructure needs.

Alongside the needs of the individual, there are needs for some infrastructure to maintain safe boating standards. Most of these recreational needs piggyback well with existing commercial requirements. For example, maintaining adequate law enforcement, search and rescue services, weather forecasting and satellite navigation, and educational programs will be required to serve a growing, diverse boating population.

Challenges

The speakers at this workshop told us an indisputable fact:
The bulk of our nation's population is heading for the coast.

They are going there for a reason. They want to be able to walk on the sand, to show their kids a sea bird, to watch the dolphins off the beach. They want to be able to swim, to fish, to boat, and to appreciate the waters of that coast.

They don't want to walk a beach polluted by sewage outfalls or industrial waste. They don't want to see a fish floating upside down in the surf. They don't want to be afraid to touch the water.

We must remember these hard facts while considering the future of the limited natural resources on our coasts. *We must remember that the average citizen's ability to interact with the water may win or lose that person's active commitment to coastal water issues. Recreational boating plays a key role in this ongoing quest to create stewards of the coast.*

Notes

1. *Boating 1998,* National Marine Manufacturers Association, Chicago, IL.

2. "Fishing's $40 Billion Allure," *USA Today,* February 16, 1999.

3. *Boating 1998,* National Marine Manufacturers Association, Chicago, IL.

4. "1998 Annual Industry Review," *Boating Industry Magazine,* February 1999.

5. *1997 State Registered Boat Data,* U.S. Coast Guard, 1997.

6. U.S. Census Bureau, on-line information estimating the current U.S. population at 272,085,093 (www.census.gov).

MARINE AQUACULTURE IN THE UNITED STATES: CURRENT AND FUTURE POLICY AND MANAGEMENT CHALLENGES

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Introduction

Aquaculture in the United States has the potential to become a major growth industry in the 21st Century. Global seafood demand is projected to increase by 70 percent by the year 2025 (Joint Subcommittee on Aquaculture, JSA 1993). With harvests from capture fisheries stable or in decline, aquaculture would have to increase production by 700 percent to a total of 77 million metric tonnes annually to meet the projected demand (JSA 1993). The potential of aquaculture worldwide to meet the challenges of food security and to generate employment has been demonstrated by its rapid growth at an annual rate of 10 percent since 1984 (as compared with 3 percent for livestock meat and 1.6 percent for capture fisheries production) (FAO 1997).

The United States currently imports more than 60 percent of its fish and shellfish.

The United States currently imports more than 60 percent of its fish and shellfish. In 1996, $6.8 billion of seafood products were imported, while $3.0 billion were exported. In 1997 seafood imports increased to $7.8 billion, while exports decreased to $2.7 billion, representing a $5.1 billion trade deficit (NOAA—NMFS, 1998). Seafood products are the nation's largest agricultural import, second only to petroleum (JSA 1993). Each year, Americans consume more than $800 million of foreign–grown aquaculture products. Obviously, domestic aquaculture pro-duction has not grown at a rate necessary to offset the consumer demand for seafood.

The U.S. marine aquaculture industry is extremely young. While the culture of freshwater species such as catfish and trout has existed for many decades, the cultivation of marine species has emerged only over the last 30 years.

Nevertheless, the development of the U.S. aquaculture industry is felt to be vital to the future of the nation because it promises to produce: (1) high quality seafood to replace that supplied through the harvests of wild stock in decline or at maximum sustainable yields; (2) products for export to help reduce the nation's foreign trade deficit; (3) stock enhancement of important commercial and recreational fisheries species; (4) economic development opportunities for rural and suburban communities; and (5) new employment opportunities for skilled workers (National Research Council, NRC 1992).

Marine Aquaculture in the United States

The U.S. marine aquaculture industry is extremely young. While the culture of freshwater species such as catfish and trout has existed for many decades, the cultivation of marine species has emerged only over the last 30 years. Total production from all domestic aquaculture operations grew from 572.5 million pounds in 1990 to 693.7 million pounds in 1996, a 21 percent increase, while marine aquaculture production alone went from 49.3 to 66.8 million pounds, a 35.5 percent increase over the same time. In 1996, about 86 percent of U.S. marine aquaculture yield was represented by oyster and salmon production, with oyster production declining and salmon production greatly increasing from 1990 to 1996. More than 50 species made up the remaining 12 percent. While the U.S. marine aquaculture industry is relatively small, it remains vital since most of the huge seafood deficit in fishery products comes from the import of marine, not freshwater, seafood (Sandifer 1994).

Aquaculture is now practiced in more than 80 precent of the states and territories of the United States. Nevertheless, cultivation of all marine species,

except oysters, is in the early stages of commercial development in the United States, and many operations have yet to achieve economic stability (NRC 1992). It goes without saying that the U.S. marine aquaculture industry has not kept pace with the growth of the world industry during the last 25 years (NRC 1992).

The future for marine aquaculture in the United States is much less certain than that of its freshwater counterpart. One serious problem is that most marine aquaculture is conducted in shallow coastal and estuarine waters, which are affected by increasing population pressures and industrial and residential development. By the year 2010, 70 percent of the total population of the United States will live within 120 kilometers of the coast (Culliton et al. 1990). In addition, whereas the transition from fishing to aquaculture in freshwater systems is analogous to that of hunting to farming, marine aquaculturists face an additional hurdle — they have no property interest in the "lands" they need (Nixon 1994). Because the ocean has traditionally been viewed as a common property resource, there are also conflicts with other commercial and recreational users which may slow or prevent the development of marine aquaculture (Harvey 1994).

Growth of the domestic marine aquaculture industry is dependent upon the attainment of 4 basic requirements (DeVoe and Mount 1989): high water-quality locations; access to the aquaculture site; assertion of exclusive fishing and culturing rights; and financial investment. These authors also argue that government commitment, in the case of marine aquaculture, may be the most critical. Government must demonstrate its support by clearly defining the term aquaculture, providing supporting policy statements and implementation strategies, offering incentives (which do not necessarily have to be solely financial) to underscore its commitment, and defining and streamlining its regulatory and legal requirements.

Issues Confronting Marine Aquaculture

There are a number of issues that have constrained the development of marine aquaculture in the United States. The complex and diverse nature of the industry, conflicts with other, traditional, uses of the nation's coastal and ocean waters, environmental concerns, and the existing legal and regulatory climate all contribute to this situation.

Nature of the Marine Aquaculture Industry

Marine aquaculture represents a relatively new use of the nation's coastal resources, and it must compete for access to those resources (Nixon 1994). Newcomers to the industry, as well as local authorities, suffer from a lack of experience, inappropriate advice on site selection, inadequate evaluation of market opportunities and product diversification, and a lack of understanding of marine aquaculture development in relation to other forms of competition (Chamberlain and Rosenthal 1995). Much of this confusion stems from its uniqueness and complexity.

A number of finfish, shellfish, and crustacean species are cultivated in the United States, including catfish, trout, salmon, striped and hybrid bass, tilapia, hard clams, oysters, mussels, crawfish, and penaeid shrimps. The industry is technologically diverse, with ponds, raceways, silo, circular pools, closed (water reuse) systems, cages and net–pens, sea ranches, rafts, and long lines used according to the species cultured (JSA 1983). Aquaculture remains a relatively young scientific discipline that is developing rapidly, with incorporation of a variety of modern technologies, most not yet fully adapted for widespread use (Rosenthal 1985). Indeed, there has been a trend toward intensification in both traditional and contemporary culture systems.

There are a number of issues that have constrained the development of marine aquaculture in the United States. The complex and diverse nature of the industry, conflicts with other, traditional, uses of the nation's coastal and ocean waters, environmental concerns, and the existing legal and regulatory climate all contribute to this situation.

Aquaculture practices range from extensive, with few inputs and modest output, to intensive, with high inputs and output. On an annual yield per hectare of water basis, increased intensification requires greater

resource use, ranging from simple pond culture to intensive tank and closed system aquaculture (Muir 1985). These varying technologies are what make aquaculture the diverse industry it is, but they have wide—ranging resource needs, produce differing environmental impacts, and require a suite of technological and management responses.

Further complicating the future of marine aquaculture is the complexity that stems from unique factors that distinguish it from other forms of agricultural activity, including: (1) the interaction of marine aquaculture with other marine and coastal activities and interests–interactions that are often characterized by conflict; (2) the fact that although marine aquaculture is ocean–based, it depends on the use of land and freshwater resources as well; and (3) the numerous environmental and regulatory considerations involved in the development and use of coastal zone land and water resources, usually held in the public trust (NRC 1992).

Coastal and Ocean Use Conflicts

While culturists, scientists, and resource managers face the task of resolving these issues through research studies, monitoring programs, and technical assistance support, the marine aquaculture industry continues to deal with its "growing pains." In a recent survey of state aquaculture coordinators, industry representatives, and extension specialists, Sand-ifer(1994) found that only 9 out of the country's 24 coastal states and 5 territories reported moderate growth, and 8 no growth. Asked to identify the major factors responsible for this situation, the respondents indicated that of 12 limiting factors, the top three were use conflicts (92%), permitting (92%) and the regulatory environment (88%) (Sandifer1994).

Use conflicts represent one of the primary issues U.S. marine aquaculturists must face, and are likely to become more pronounced and frequent in the future (Chamberlain and Rosenthal 1995). DeVoe et al. (1992) found through a survey of the marine aquaculture industry and state regulatory agencies that the competing use of the coastal zone by recreational users, commercial fishermen, and developers was frequently encountered. The escalating costs of acquiring access to coastal lands and waters in the country exacerbate the problem.

In 1992, the National Research Council of the National Academy of Sciences predicted that, due to increasing pressures along the coastal zone, the best opportunities for future commercial aquaculture development are in recirculating (closed) systems on land and in confinement systems in the open ocean. Research and development emphasis has been on closed system aquaculture rather than on offshore facilities. Yet, after more than 20 years of R&D activity, the economic viability of closed system aquaculture remains elusive. The United States is only now exploring the potential for establishing facilities in unprotected offshore areas.

Aquaculture and the Environment

Much has been published over the last 15 years on the environmental impacts of marine aquaculture (e.g., Ackefors and Sodergren 1985, Weston 1986, Rosenthal et al 1988, DeVoe 1992, Goldburg and Triplett 1997, Naylor et al.1998, also see Estuaries, Vol 18: 1A, 1995). However, ecological concerns had been raised by a number of authors in the 1970s (Odum 1974, Ackefors and Rosen 1979). One of the major challenges to the marine aquaculture industry in the United States will be how it responds to these environmental sustainability issues (Chamberlain and Rosenthal 1995).

Aquaculture practices can generate environmental impacts as a function of (1) the applied technique, (2) site location, (3) size of the production, and (4) capacity of the receiving body of water (Ackefors and Sodergren 1985). These can include impacts on water quality, the benthic layer, the native gene pool, and the ecosystem as a whole, and impacts from non-native species, disease, and chemicals.

The state of knowledge regarding the environmental impacts of aquaculture is rapidly improving. Whereas two decades ago very little research data were available, there has been a surge in the number and scope of research and monitoring programs seeking to document these effects. Much work worldwide has focused on the effects of net-pen culture on the environment, with the International Council for the Exploration of the Sea (ICES) leading the way. In the United States, early research efforts dealt with fish hatchery effluents and catfish ponds. As the domestic industry diversified, so did environmental research, with major federal studies examining the impacts of marine shrimp pond culture and salmon net—pen culture, and the issues regarding species introductions, the use of chemicals in aquaculture, and effluent discharges.

Legal and Regulatory Structures

The current regulatory environment for marine aquaculture in the United States is a major constraint to its development (NRC 1978, NRC 1992, JSA 1993, and others). No formal federal framework exists to govern the leasing and development of private commercial aquaculture activities in public waters (NRC 1992).

In a 1981 study commissioned by the Joint Subcommittee on Aquaculture, the Aspen Corporation examined the federal and state regulatory framework for aquaculture (Aspen Corp. 1981). As many as 11 federal agencies are directly involved in regulating aquaculture and another 10 are indirectly involved. However, only a limited number of permitting and licensing requirements are directly imposed by federal agencies. More characteristic are federal agency programs that indirectly regulate fish farmers (e.g., restrictions on drug use, federal laws administered by states, etc.).

Some 50 federal statutes (with accompanying regulations) were found to have a direct impact on the aquaculture industry, although the actual number of statutes that affect an individual operation vary depending on its size, location, the species being cultured, and other factors. In total, over 120 statutory programs of the federal government were found to significantly affect aquaculture development. About one-half require direct compliance from the fish farmer.

Seven federal agencies have regulatory programs that directly affect the marine aquaculture industry: the U.S. Army Corps of Engineers, the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the U.S. Food and Drug Administration, the U.S. Department of Agriculture, the U.S. National Marine Fisheries Service, and the U.S. Coast Guard. Federal oversight of the marine aquaculture industry is fragmented; there is no overall federal framework to address aquaculture development in the coastal zone or offshore waters. Further, while recent evaluations of marine aquaculture suggest that offshore locations may represent a viable alternative (NRC 1992), no formal policies have been developed to manage aquaculture development in the U.S. Exclusive Economic Zone. As a result, existing federal policies vary from one agency to another (and may even differ among divisions within the same agency) and the permitting process can be time-consuming, complex, and costly.

The majority of laws and regulations that specifically authorize, permit, or control aquaculture are usually found at the state level. The Aspen Corp. study examined 32 state regulatory programs and discovered that over 1,200 state laws have some significant bearing on aquaculture operations. Policies and regulations were found to affect aquaculture in eight major areas: aquaculture species use; water quality; water use; land use; facility and hatchery management; processing; financial assis-tance; and occupational safety and health.

Major aquaculture problems that arise from state laws and regulations are caused by the lack of uniformity of laws among the states, the sheer number of permits, licenses, and certifications that must be obtained, and the difficulty in obtaining them (NRC 1978, 1992). Each state has its own unique legal, political, and economic climate for aquaculture, and culturists must navigate the regulatory environment differently in each. Only a few states have developed the information management capability to present the applicant with a comprehensive list of all the legal requirements that must be met. State regulatory programs can be and usually are more restrictive than federal guidelines and regulations dictate. The result is that state agencies vary greatly as to what standards they apply to aquaculture (McCoy 1989), and some still apply laws designed for other applications such as those for public fisheries management (NRC 1978, 1992).

Federal agencies which establish the ground rules that most state agencies must follow have adopted vague, confusing, and poorly conceived regulations, or none at all (McCoy 1989). This translates into inconsistencies in the development and application of laws and regulations at the state level (deFur and Radar 1995). Few states have a comprehensive regulatory plan which satisfactorily balances economic development and environmental protection. As a result, regulations governing aquaculture are scattered throughout state statutes and do not necessarily fit aquaculture (Breaux 1992). Complicating matters is the fact that existing permit programs do not have provisions for determining the capacity of the coastal and estuarine system for aquaculture, land-based or in situ (deFur and Radar 1995).

The complexity that results from the involvement of many federal, state, and local agencies responsible for all aspects (including advocacy, promotion, conduct, and regulation) of marine aquaculture leads to an array of planning acts, policies, and regulations

(NRC 1992). Federal laws are applied differently in various geographic regions of the country (NRC 1978), and the industry remains concerned about the lack of coordination among agencies regulating aquaculture (JSA 1993). Unfortunately, the federal government has yet to make any significant headway in reducing regulatory constraints (McCoy 1989).

Another limitation to the current regulatory regime for marine aquaculture in the United States is the lack of long-range and whole systems planning (deFur and Radar 1995). Aquaculture policy appears to be made by granting permits on a case-by-case basis (Rubino and Wilson 1993), and the requirements are often determined using regulations and technical standards not originally developed or intended for aquaculture (Ewart et al, 1995). Each permit is considered individually by the issuing agency, usually with no provision for examining cumulative impacts (deFur and Radar 1995).

Marine Aquaculture and Federal Policy

On September 26, 1980, the National Aquaculture Act of 1980 was passed to "promote aquaculture in the United States" through a declaration of a national policy, development and implementation of a national aquaculture development plan, establishment of a coordinating group of federal agency representatives, establishment of a National Aquaculture Information Center, and encouragement of aquaculture activities and programs in both the public and private sectors. The 1980 Act was amended in 1985 and 1990, and reauthorized most recently in 1998.

The Act clearly states an aquaculture policy for the country: that it is "in the national interest, and it is the national policy, to encourage the development of aquaculture in the United States." The National Aquaculture Act of 1980 gives principal responsibility for the development of aquaculture to the private sector but jointly assigned three federal agencies aquacultural-related responsibilities- the Departments of Agriculture, Commerce, and Interior. An Interagency Agreement was reached among these agencies regarding "Designation of Areas of Responsibility in Aquaculture."

The Joint Subcommittee on Aquaculture (JSA) was created to serve as a federal interagency coordinating group to increase the overall effectiveness and productivity of federal aquaculture research, technology transfer, and assistance programs. While receiving no direct funding, the JSA, composed of the heads or their designees of more than 12 federal agencies, is generally thought of as a model coordinating mechanism. The JSA exists now as a statutory committee that operates under the aegis of the National Science and Technology Council (NSTC) of the Office of Science and Technology Policy in the Office of the Science Advisor to the President. The JSA reports to the NSTC's Committee on Health, Safety and Food Research and Development, which is one of nine research and development committees established by NSTC to prepare coordinated R&D strategies and budget recommendations for accomplishing national goals. Chairmanship of the JSA was originally planned to rotate among the Secretaries of the three primary departments; however, the 1985 amendments specifically established the Secretary of Agriculture as permanent chair of the JSA.

The JSA completed the first and only version of a national aquaculture development plan in 1983. Volume I of the plan presented information on the status of aquaculture, current technologies, impediments to development, existing federal programs, recommended programs and actions, and anticipated impacts. Volume II reviewed those aquatic species that have or show potential for development as aquaculture products. Unfortunately, no assessment regarding progress on the original plan's recommendations was ever made. It was not until 1996 that revision of the 1983 plan was considered. A draft updated national aquaculture development plan is now being finalized for submission to the NSTC for review and comment.

The National Aquaculture Act of 1980 and its amendments provide a federal policy framework for and endorsement of aquaculture in the United States. The 1983 plan constituted the first coordinated effort in the United States to assess the aquaculture industry, identify its needs, and suggest steps to improve the climate for aquaculture development. The JSA also provides a mechanism whereby information exchange and program coordination can occur. Nevertheless, although the 1980 Act was reauthorized in 1998 as part of the Farm Bill, recent failure of legislation explicitly extending and funding the 1980 Act suggests that difficulties persist in seeking a consensus on a government policy for aquaculture.

The Future of Marine Aquaculture in the United States

The reasons that marine aquaculture has not progressed as rapidly as freshwater aquaculture are as complex as the nature of the industry itself. These issues manifest themselves not only at the federal

level, but in each of the nation's coastal states as well. Progress is occurring throughout the country, albeit at a fairly slow pace. The potential of marine aquaculture remains high as research information and technologies continue to be generated for cultivating a diversity of marine species, ameliorating the real environmental effects of the industry, and developing cost—effective and sustainable culture techniques and practices. Realization of that potential is being severely limited by many institutional and legal constraints and sustainability issues.

These issues are not new to the industry or to government. Conclusions of two National Research Council (National Academy of Sciences) panels that met in 1978 and 1992 to review the growth and potential of the U.S. aquaculture industry are enlightening. In 1978, an NRC panel concluded that constraints on the development of the U.S. aquaculture industry "tend to be political and administrative, rather than scientific and technological" (NRC 1978). Fourteen years later, a second NRC panel stated that "solutions to the environmental problems constraining marine aquaculture will involve approaches that combine technological 'fixes' with improved regulatory and management structures, as well as public education" (NRC 1992). It is unfortunate that many of the issues identified in 1978 and again in 1992 remain unresolved to this day.

Becker and Buck (1997) identify an important factor that has not seriously been considered by aquaculture pundits; that is, the federal government has actually put itself in a conflict-of-interest position vis-à-vis its roles in aquaculture. On one hand, it acts as enforcer of regulatory requirements aimed at protecting consumers, natural resources, and the environment and, on the other, as administrator of programs that support and promote the growth of the industry. What results is a tug-of-war where progress is difficult to achieve. Obvious in their analysis is the view that complete consensus on the future role of the federal government in support of aquaculture will be difficult to achieve.

In addition to the many federal departments and agencies that are involved in aquaculture policy, regulation, management, and/or support, Becker and Buck (1997) point out that jurisdiction over aquaculture–related issues is divided among several congressional committees as well. In the Senate, aquaculture and related issues are divided among the Committees on Agriculture, Nutrition and Forestry; Commerce, Science and Transportation; Energy and Natural Resources; Environment and Public Works; and Labor and Human Resources. On the House side, the Agriculture Committee, Commerce Committee, and Resources Committee have jurisdiction over components of aquaculture. Of course, each of these committees has different mandates and responsibilities which may overlap at times, and each has its own agenda and perspective on aquaculture issues and needs. These committees must also deal with a wide range of constituencies, some of which may take positions counter to those of the marine aquaculture industry. Here again, reaching agree- ment on issues related to aquaculture can be difficult.

Whither U.S. Marine Aquaculture Policy?

There have been many studies and analyses conducted over the last 20 years by federal agency, congressional office, academic, and industry authors examining the issues facing the U.S. marine aquaculture sector and offering a myriad of recommendations and strategies to address them (e.g., NRC 1978, DeVoe and Mount 1989, NRC 1992, Rubino and Wilson 1993, Stickney 1994, DeVoe 1994, DeVoe 1997). While these authors and others have provided reasonable and proactive suggestions for enhancing the marine aquaculture industry, the situation in general has changed little over that time. Why?

The United States must return to the more fundamental issues to address the lack of growth of the marine aquaculture industry. More to the point, the country must:

1. Reevaluate and Reaffirm the Nation's Aquaculture Policy

While Japan continues to focus use of its coastal and marine resources on food production, the United States continues to look to the coast and ocean for recreation, tourism, and other economic pursuits. We as a country of plenty have not had to look to the seas to provide sustenance for our citizens. Pressures to effect a major cultural change in the way we now use our coastal and marine resources have not risen to a critical level; why change when we can import seafood from overseas? The impetus to unite the industry, U.S. Congress, the federal agencies, the states, and constituents together to create this cultural shift has been lacking. As a result, marine aquaculture's place among the many uses of the nation's coastal and ocean waters is not as yet established.

The National Aquaculture Act of 1980 contains a clear and unambiguous statement in support of aquaculture development in the United States. The United States, through Congress and the Administration, with the support of industry and the involvement of all constituencies, must take a hard look at the current situation and decide if it wishes to aggressively pursue the policy. Many scholars, academics, industry leaders, and others have offered a wide range of possible solutions to address the constraints limiting marine aquaculture development, but without strong commitment and leadership by the federal government to work toward this goal, the current situation will be hard to improve.

2. Support Sustainable Marine Aquaculture

Marine aquaculture in coastal and offshore waters of the United States must be developed with an eye toward sustainability — with a goal of producing products while conserving natural resources. Its development must have a solid ecological perspective that is compatible with the social, economic, and environmental goals of coastal communities, which will require the active involvement of community leaders and other relevant parties in the process. The development and use of risk assessment tools, best management practices, and educational and training programs must be incorporated into all federal efforts to develop and support the industry. The development of environmental criteria for marine aquaculture operations must be base on the generation of science-based information. These and other factors must be incorporated into federal policies and plans if we are to see the marine aquaculture sector grow in the future.

3. Strengthen Policy Development through Improved Coordination

Assuming the United States is truly committed to the development of the marine aquaculture industry, mechanisms must be put into place to refine existing and establish new implementation measures to guide its growth. The fundamental framework to meet this challenge already exists with the Joint Subcommittee on Aquaculture. Currently, JSA plays an important role in coordinating federal agency activities and ensuring communication among the agencies in the areas of research, transfer, and assistance programs in aquaculture, and providing recommendations for federal aquaculture policy. The potential for enhancing the role of the JSA in dealing with and resolving the many issues facing marine aquaculture lies with its membership. However, it presently operates without a budget, participation by any of the agencies is not mandatory, and there is no formal voting structure nor dispute resolution process in place. Areas where the role of the JSA could be strengthened include:

a. Status of the JSA

* The role of the JSA in the administration should be expanded to include policy development and implementation.

* The permanence of the JSA should be established through the provision of a stable source of funding and staff assistance to improve coordination and consistency of policy development and implementation.

* The JSA should enhance the involvement of key representatives from the marine aquaculture industry, environmental community, and other constituencies in its deliberations and decision-making.

b. Federal Permitting and Regulatory Structure

* The JSA should be charged with designing a streamlined planning and permitting framework for marine aquaculture activities in the coastal zone, emphasizing joint local, state, and federal coordination in consultation with the marine aquaculture industry, the states, and pertinent constituencies.

* The JSA should be charged with the primary responsibility for developing a coordinated management and regulatory framework for offshore aquaculture activities, in consultation with all relevant federal and state agencies and constituencies.

c. Federal Research and Development Activities

* The JSA should conduct an assessment of all ongoing federal funding programs to assess the nature and scope of current activities and whether they are meeting the needs of the industry and the public.

* The JSA should, based on the assessment, develop a coordinated, cross-cutting funding plan to ensure that future key needs and issues related to marine aquaculture are being addressed in an efficient and non-duplicative manner.

Conclusion

The key to the future of marine aquaculture in the United States is the creation of technological and political systems that provide for sustainable marine aquaculture. Sustainable aquaculture will only be achieved if all facets of the industry — production and technology, economics and marketing, business and financing, natural resource needs and protections, and administrative and legal institutions — are dealt with simultaneously. This is a lofty goal, given the diverse nature of the marine aquaculture industry, but the modus operandi of the last three decades in dealing with the needs of the industry will not be enough. Systems that will move the industry forward will require an unequivocal commitment by the nation's political leadership to create them, by the federal bureaucracy to implement them, by the academic community to generate and extend information to improve them, and by the industry to put them into practice. Coordination, cooperation, communication, and education will be the primary tools required to move the United States toward a viable and sustainable marine aquaculture industry.

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OFFSHORE MARINE AQUACULTURE IN THE U.S. EXCLUSIVE ECONOMIC ZONE (EEZ): LEGAL AND REGULATORY CONCERNS

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Future development of marine aquaculture in the U.S. Exclusive Economic Zone (EEZ) is constrained by legal and regulatory concerns which need to be addressed in order for the industry to become financially viable and internationally competitive. These concerns relate to property rights for aquaculture operators, conflicts with competing uses of public waters, and regulatory gaps and overlap. Failure to resolve these issues creates uncertainties for the economic viability of offshore aquaculture projects, making it difficult for potential investors to obtain financing. While some states have addressed these concerns for projects within the portion of the EEZ under their jurisdiction (for most states, out to 3 nautical miles), the federal government approach with respect to aquaculture facilities in the federal portion of the EEZ (from the state boundary out to 200 nautical miles offshore) is piecemeal. Most importantly, there is no clear legal basis for granting property rights that are needed to protect the large investments necessary to build and operate offshore aquaculture facilities in the open ocean.

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A major study coordinated by the National Research Council's Marine Board concluded there are significant opportunities for future growth of marine aquaculture in the United States.[1] More recently, the Environmental Defense Fund gave the industry a qualified blessing when it concluded that "aquaculture need not be a polluting industry."[2] However, the industry will continue to face serious obstacles until the legal and regulatory regime is modified to clarify rights and jurisdictions, eliminate overlap, and fill regulatory gaps.

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This paper describes the current federal regulatory framework, identifies important elements that need to be included in an improved government framework, reviews the major legal obstacles to offshore aquaculture, and presents an overview of recent U.S. government planning initiatives.[3]

Current Federal Regulatory Framework

Federal authority over offshore marine aquaculture rests primarily with two agencies: the Army Corps of Engineers (Corps) and the Environmental Protection Agency (EPA). Under the Rivers and Harbors Act,[4] as amended by the Outer Continental Shelf Lands Act (OCS),[5] the Corps is responsible for issuing permits for structures located in navigable waters. In its "public interest review"[6] of requests for aquaculture facilities, the Corps considers the benefits and detriments to the public interest, including environmental, economic, aesthetic, navigation, property rights, and international interests. Under the Clean Water Act,[7] EPA asserts regulatory authority over discharges from aquaculture facilities as "concentrated aquatic animal production facilities."[8] Other federal agencies, including NOAA's National Marine Fisheries Service and the Fish and Wildlife Service, have an opportunity to review and comment on any permit proposed for issuance by the Corps or EPA. In addition, NOAA's regional Fisheries Management Councils have authority over the harvesting of species covered by fishery management plans.[9] Federal leasing of portions of the seabed beyond state waters for aquaculture is not presently possible under the Outer Continental Shelf Lands Act.[10]

Elements of An Improved Government Framework for Aquaculture

The Marine Law Institute[11] has developed a set of 10 recommendations to improve the regulatory framework for aquaculture:

1. Marine Zones - The responsible government agency should identify marine zones favorable to sea farming and consistent with desired environmental conditions and potential use conflicts.

2. Common Application Procedure - All state and federal permits and leases should share a common application procedure, siting criteria, and site evaluation and monitoring protocols.

3. Property Interests - Aquaculture leases or licenses should convey an exclusive property interest in the cultured species as well as in the right to harvest it from the leased area, as far as it is consistent with public rights of navigation and fishing. This is necessary to secure the sea farmer's investment against negligence, theft, and vandalism, and to allow for civil causes of action against persons who interfere with or damage aquaculture facilities.

4. Agency Coordination - State and federal agencies should adopt memoranda of understanding on coordinating enforcement, research, and technical assistance.

5. Cooperative Arrangements - Maximum acreage limitations should not apply to contracts, joint ventures, or partnerships between small-scale sea farmers and larger aquaculture companies so that cooperative arrangements can be implemented.

6. Economic Priorities - Government agencies should provide priorities in licensing or leasing to fishermen displaced by conservation restrictions on the capture fisheries as an appropriate non-discriminatory means of promoting local economic benefits from sea farming.

7. Community Relations - Sea farm applicants should be encouraged to enter into private agreements with local fishermen's organizations, cooperatives, or community groups for work in the sea farming operation, to prevent use conflicts and promote local economic benefits and acceptance of sea farms.

8. Public Hearings - Agency public hearing procedures should balance the due process rights of sea farm leaseholders with the public right of participation in decisions affecting public resources. Hearings should be formal enough to exclude interventions not relevant to the licensing decision, but not so formal that small-scale sea farm applicants are faced with prohibitive application costs.

9. Insurance Pool - Public and private efforts should work to create an insurance pool to compensate sea farmers for losses due to product destruction or water impoundment orders to protect public health.

10. Small-Scale and Experimental Farming - State and local licensing authorities should adopt license-by-rule procedures for small-scale and experimental farming, with reduced application requirements and expedited procedures.

Legal Obstacles to Consider in Revising the Regulatory Framework

In 1978, the National Research Council[12] identified the major legal obstacles to development of the aquaculture industry. These concerns remain relevant to current discussions about the federal regulatory framework.

1. Limited availability of property rights or other interests that can secure a producer's investment

2. Poorly defined standards that fail to reduce conflicts among competing users of public resources

3. Poorly defined agency jurisdictions leading to delays in defining applicable standards or regulations

4. Redundant regulations due to overlapping agency responsibilities

5. Inappropriate restrictions designed to protect wild stocks

Any changes in the federal regulatory framework need to keep these obstacles in mind in the development of provisions relating to property rights, conflicts with other users, and regulatory requirements.

Property Rights

The key concern with respect to the legal framework affecting marine aquaculture is: how secure is the interest that the sea farmer receives from the government? For the interest to function as a property interest, it needs to have some or all of the following

attributes: transferability, duration and renewability, and revocability only for failure to perform specified conditions.

In addition, special legal principles designed to protect public uses, known as public trust rights, come into play.[13] These public property interests must be balanced against the sea farmer's needs for a secure interest in the cultured species and for protection against damage from other activities.

Future federal regulatory policy must also consider the legal differences between the lease and license forms of tenure. Leases have certain advantages over licenses in terms of security of tenure. Neither, however, can convey permanent, exclusive control of an area of the ocean because of the public property rights and other principles mentioned above.

Finally, the federal government needs to provide for criminal sanctions and a civil right of action against individuals who violate the sea farmer's rights as lessee of the seabed and water column.

Conflicts Among Competing Users

Even when the sea farmer's lease or license is backed by criminal sanctions against persons damaging or interfering with the farm, peaceful co-existence among all users of the marine environment cannot be ensured. The process for issuing leases or licenses must therefore protect the sea farmer from conflicts with other marine uses. Other public and private uses of the marine environment that are potentially affected by aquaculture activities (navigation, fishing, etc.) need to be identified in the statutory authority for the leasing of public waters or submerged lands, and a mechanism for considering information about other uses needs to be included in the decision process. Failure to consider other uses in the licensing process can result in serious use conflicts, leading to court challenges that interfere with operations and could ultimately produce judicial decisions adversely affecting future sea farming opportunities.

Agency Regulatory Requirements

The issue of fragmentation and overlapping agency mandates has two sides. An apparently redundant regulatory requirement may actually serve a useful purpose. Jurisdictional overlap can improve the security of the interest the sea farmer obtains when it signals that an agency with a different constituency has accepted an aquaculture project both in principle and in reality. The objective should be to provide the sea farmer with the advantages of obtaining the approval of multiple agencies without imposing heavy costs in time and money to obtain them.

The administrative process should include a speedy mechanism for exempting aquaculture from regulations that are designed to conserve wild fish stocks, such as restrictions on harvesting or limited vessel-days at sea . These decisions should not have to be made on a case-by-case basis or require a special waiver or exemption, and conflicts of interest should be avoided. Because fishermen are likely to oppose aquaculture ventures they perceive as producing competition for limited fishing grounds or seafood markets, the federal regional fishery management councils (which include strong fishing industry representation) are not an appropriate authority for EEZ aquaculture decisions.

Current Status of U.S. Government Planning Efforts

The U.S. government has begun to focus on the issue of offshore aquaculture in the Exclusive Economic Zone, although much more remains to be done. The major initiatives come from the interagency Joint Subcommittee on Aquaculture (JSA) and the National Oceanic and Atmospheric Administration (NOAA).

The JSA's draft National Aquaculture Development Plan[14] calls for "an appropriate and harmonized Federal regulatory framework" for aquaculture. The plan highlights "the complex, fragmented, and uncertain regulatory environment" and points out that "as a result, aquatic farmers may either be required to comply with a daunting and expensive array of regulations or, as exemplified by offshore marine aquaculture initiatives, be forced to operate in a highly uncertain regulatory framework" (Section 4.4.8). The plan's list of needed regulatory improvements includes "permits and regulations for commercial aquaculture operations in public waters, including Federal marine waters" (Section 5.8). Although the Plan was revised in 1996, the draft has yet to be formally adopted by the JSA.

Within NOAA, marine aquaculture issues are being addressed in several ways. In February 1998, NOAA adopted an agency-wide aquaculture policy, elements of which have been incorporated in its strategic plan. The agency has also drfated an aquaculture policy for the entire Department of Commerce, which is expected to be adopted in February 1999. In addition, the National Marine Fisheries Service (NMFS) has drafted legislation for aquaculture

leasing in the EEZ. The proposed legislation is undergoing internal review within the Department of Commerce, and its prospects are uncertain at this time.

NOAA's strategic plan[15] includes agency promotion of robust and environmentally sound aquaculture development. The plan recognizes the need for a timely regulatory process, and specifically mentions the need to emphasize "a regulatory framework and permitting process for aquaculture in the EEZ." The plan includes the following performance measures for the next 5 years:

1. Promote the commercial rearing of at least seven new species.

2. Reduce the time and cost of permittingenvironmentally sound aquaculture ventures.

3. Provide financial assistance for environmentally sound aquaculture ventures.

4. Identify areas in coastal waters and the EEZ suitable for environmentally sound aquaculture development.

5. Develop and implement environmentally sound aquaculture technologies and practices.

NOAA's implementation strategy specifically mentions the need to develop a coordinated policy on the use of the EEZ for private aquaculture, to address user conflicts affecting aquaculture development, and to determine requirements for the siting of aquaculture operations in the EEZ.

Conclusion

Progress with respect to federal regulation of offshore marine aquaculture in the U.S. EEZ is slow. The National Marine Fisheries Service (NMFS) funded a regional open ocean aquaculture initiative for New England in Fiscal Year 1998, and regional fishery management councils have begun to incorporate aquaculture provisions in their fishery management plans. However, as noted above, this may not be the most desirable approach to developing a regulatory framework for offshore aquaculture in federal waters.

A window of opportunity for addressing the issues discussed in this paper was missed in the most recent reauthorization of the National Aquaculture Act[16] (June 1998), which made no modifications to the existing federal approach. However, funding for marine aquaculture is included in the Clinton Administration's National Oceans Initiative, announced in June 1998. If enacted, the proposal will provide $ 3 million annually over a 3-year peirod beginning in fiscal year 2000. Adoption of JSA's draft National Aquaculture Development Plan could serve as a vehicle for promoting needed change in the legal and regulatory framework for offshore aquaculture and devising a federal policy for leasing federal waters in the EEZ.

Notes

1. Committee on Assessment of Technology and Opportunities for Marine Aquaculture in the United States, National Research Council (U.S.), *Marine Aquaculture: Opportunities for Growth:* Report of the Committee on Assessment of Technology and Opportunities for Marine Aquaculture in the United States, Marine Board, Commission on Engineering and Technical Systems, National Research Council (Washington: National Academy Press, 1992).

2. Rebecca Goldburg and Tracy Triplett, *Murky Waters: Environmental Effects of Aquaculture in the U.S.* (New York: Environmental Defense Fund, 1997).

3. Portions of this paper are based on earlier work by one of the authors. See Alison Rieser, "Defining the Federal Role in Offshore Aquaculture: Should It Feature Delegation to the States?" in *Ocean and Coastal Law Journal* 2 (1997): 209-234.

4. 33 U.S.C. § 403 (1994).

5. 43 U.S.C. § 1333(e) (1994).

6. 33 C.F.R. § 320.4(a)(1) (1995).

7. 33 U.S.C. §§ 1251-1387 (1994).

8. 40 C.F.R. § 122.24(a) (1995).

9. The Magnuson Fishery Conservation and Management Act, 16 U.S.C. §§ 1801-1882 (1994), amended by Sustainable Fisheries Act, Pub. L. No. 104-297, 110 Stat. 3559 (1996) does not expressly authorize the regional fishery management councils or the National Marine Fisheries Service to license aquaculture projects in the EEZ. See William J. Brennan, "To Be Or Not To Be Involved: Aquaculture Management

Options for the New England Fishery Management Council," 2 Ocean & Coastal L.J. 261 (1997). However, NOAA's Office of General Counsel has concluded that aquaculture constitutes "fishing" under the Magnuson Act because it involves harvesting fish from the EEZ by U.S. vessels. See Memorandum from Jay S. Johnson, NOAA Deputy General Counsel, and Margaret F. Hayes, NOAA Assistant General Counsel for Fisheries, to James W. Brennan, NOAA Acting General Counsel (Feb. 7, 1993) (discussing the applicability of federal laws to aquaculture in the EEZ).

10. 43 U.S.C. §§ 1331-1356 (1994).

11. Marine Law Institute, *Legal Methods for Promoting Local Salmon Farming Operations in Down East Maine,* Report to the National Coastal Resources Research and Development Institute (1992).

12. National Research Council, *Aquaculture in the United States: Constraints and Opportunities* (1978):90.

13. According to the public trust doctrine, the states hold all navigable waters, and the lands under them, in trust for the common use of the public. Phillips Petroleum v. Mississippi, 484 U.S. 469 (1988). Traditionally, courts have protected the public right to fishing and navigation in public trust waters and lands, and have even expanded the scope of the public trust to include other uses such as recreation and ecological preservation.

14. National Science and Technology Council, Joint Subcommittee on Aquaculture. *National Aquaculture Development Plan of 1996* (Draft, 5 March 1996). See http://ag.ansc.purdue.edu/aquanic/publicat/govagen/usda/dnadp.htm

15. See http://www.nmfs.gov/bortniak/straplan/obj-4.html

16. National Aquaculture Act of 1980, as amended. 16 U.S.C. 2801.

THE POTENTIAL FOR THE MARINE BIOTECHNOLOGY INDUSTRY

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Introduction

The marine environment is a rich source of both biological and chemical diversity. This diversity has been the source of unique chemical compounds with the potential for industrial development as pharmaceuticals, cosmetics, nutritional supplements, molecular probes, enzymes, fine chemicals, and agrichemicals. Each of these classes of marine bioproducts has a potential multi-billion dollar market value (BioScience, 1996). Thousands of unique chemical compounds have been identified from a relatively small number of the ocean's biological and chemical diversity (Ireland et al, 1993). The oceans represent a virtually untapped resource for discovery of even more novel compounds with useful activity.

There are several marine-derived products currently on the market (Table 1). Although this discussion will focus on the current status and future potential of marine biotechnology related to the discovery, development, and sustainable use of marine-derived compounds with biomedical applications, the needs, approaches, and opportunities apply equally to other marine bioproducts. The challenge facing the marine biotechnology industry in the next millenium is to:

- identify new sources of marine bioproducts;
- develop novel screening technologies;
- provide a sustainable source of supply; and
- optimize production and recovery of the bioproducts.

Identification of New Sources of Marine Bioproducts

Marine bioproducts have, to date, been derived from relatively shallow-water organisms using routine methods, such as scuba diving. Evaluation of the pharmaceutical, cosmetic, nutritional, and chemical potential of products derived from deep water organisms has been limited, although at least one compound—discodermolide (Gunasekera et al, 1990; ter Haar et al., 1996), derived from a deep water sponge—has been recently licensed by Harbor Branch Oceanographic Institution to Novartis Pharma AG, and is in advanced preclinical trials for treatment of cancer.

Federal agency support (e.g., NSF, NOAA, ONR, NIH) for deep ocean exploration for biotechnology is limited, at best. Manned and unmanned submersibles are woefully underfunded and restricted to a few systems. The trend toward development of remote platforms for understanding the oceans and atmosphere has had little application relative to marine biodiversity—and the potential of this diversity to yield useful products. Despite the trend toward remotely operated systems, there is still a need for manned submersible programs to study and sample biodiversity in the deep oceans. Although some submersible systems are equipped with specialized tools and chambers that allow samples to be maintained under ambient conditions, i.e., high pressure and, low temperature, there is still a need for the development of versatile bioreactors that can be deployed and operated in extreme environments

Table 1. Some Examples of Commercially Available Marine Bioproducts

Product	Application	Original Source
Ara-A	antiviral drug	marine sponge, Cryptotethya crypta
Ara-C	anticancer drug	marine sponge, Cryptotethya crypta
okadaic acid	molecular probe: phosphatase inhibitor	dinoflagellate
manoalide	molecular probe: phospholipase A2 inhibitor	marine sponge, Luffariella variabilis
Vent™ DNA polymerase	polymerase chain reaction enzymes	deep-sea hydrothermal vent bacterium
Formulaid® (Martek Biosciences, Columbia, MD)	fatty acids used as additive in infant formula nutritional supplement	marine microalga
Aequorin	bioluminescent calcium indicator	bioluminescent jellyfish, Aequora victoria
Green Fluorescent Protein (GFP)	reporter gene	bioluminescent jellyfish, Aequora victoria
phycoerythrin	conjugated antibodies used in ELISAs and flow cytometry	red algae
Resilience® (Estée Lauder)	marine extract additive in skin creams	Caribbean gorgonian, Pseudopterogorgia elisabethae

(e.g., hypersaline, vent, anoxic, and deep-sea habitats). Such bioreactors could be used for collection, at-sea maintenance, and evaluation of novel macroorganisms and microorganisms so that their metabolites can be evaluated under physiological conditions that are as similar as possible to ambient conditions.

Another approach to the identification of new products is the incorporation of miniaturized biosensors into both collecting tools and bioreactors for rapid, in situ analysis of both wild and cultivated marine organisms for target molecules. A number of miniaturized biosensors and probes to study human disease processes are in development. Adaptation of these for in situ evaluation of marine-derived products would be an interesting bioengineering challenge. Potential applications are the identification of new or previously untested species, as well as analysis of gene expression that may be specific to a particular disease or therapeutic area.

With the enormous potential for discovery, development, and marketing of novel marine bioproducts comes the obligation to develop methods by which these products can be supplied in a way that will not disrupt the ecosystem or deplete the resource.

Development of Novel Screening Technologies

The biological evaluation of marine-derived extracts and pure compounds for pharmaceutical development has been based on assays developed for the high-throughput screening of large libraries of synthetic compounds. They measure a number of end-points, such as activation or inhibition of enzymes or receptors involved in human disease processes, inhibition of growth of human pathogenic microorganisms, and toxicity against human cancer cells (Ireland et al, 1993; McConnell et al, 1994; Munro et al, 1994). None of the assays used in major pharmaceutical drug discovery programs takes into account the role of marine-derived compounds in nature, i.e., the in situ biochemical functions of both primary and secondary metabolites, and how those functions may be applied to the discovery of new drugs and probes to study human disease processes. Marine organisms as model systems offer the potential to understand and develop treatments for disease based on the normal physiological role of their secondary metabolites. For example, the mechanisms of action Conus toxins are well-known (Hopkins, et al, 1995; Shon et al, 1997), and are currently being applied to the development of new classes of drugs. Development of in situ biosensors would enhance our ability to probe the expression of secondary metabolites in response to various stimuli, lead to a better understanding of the role of the secondary metabolites in nature, and perhaps provide clues to the potential biomedical utility of these compunds

Sustainable Use of Marine Resources

With the enormous potential for discovery, development, and marketing of novel marine bioproducts comes the obligation to develop methods by which these products can be supplied in a way that will not disrupt the ecosystem or deplete the resource. Supply of most marine-derived compounds is a major limiting factor for further pharmaceutical development. Often, the metabolite occurs in trace amounts in the organism, and a steady source of supply from wild harvest cannot provide enough of the target compound for preclinical studies. In general, the natural abundance of the source organisms will not support production based on wild harvest.

Some options for sustainable use of marine resources are chemical synthesis, controlled harvesting, aquaculture of the source organism, in vitro production through cell culture of the macroorganism or microorganism source, and transgenic production. Each of these options has its advantages and limitations. Not all methods will be applicable to the supply of every marine bioproduct, and most of the biological supply methods are still in development. The approach to be used will be based on a number of factors:

- Complexity of the molecule: Can it be synthesized using an industrially feasible process? Synthetic processes have been published for many marine bioproducts in development as pharmaceuticals. Unfortunately, most of these are multi-step processes that are not amenable to economic, industrial-scale synthesis.

- Abundance of the organism in nature: What do we know about the impact of collections on the habitat or species populations? Prior to large-scale wild harvest of an organism for recovery of

a bioproduct, harvesting feasibility studies should be conducted. These should define factors such as the standing stock of the organism, its growth rate and the factors that affect growth, and the harvesting and post-harvesting recovery of the target organism. These impact data could then be used not only to assess the potential of supply from wild harvest, but also to develop models for aquaculture and / or in vitro production. Unfortunately, this is rarely done.

- Source of the compound: Is it microbially produced? A significant number of marine bioproducts with pharmaceutical potential have been identified from heterotrophic marine microorganisms isolated from coastal sediments (Fenical, 1993; Davidson, 1995; Kobayashi and Ishibashi, 1993). In addition, some marine bioproducts originally isolated from macroorganisms, such as sponges, have been subsequently discovered to be localized in microbial associates (e.g., Bewley et al, 1996). If these symbiotic microorganisms can be isolated and cultured, optimization of production in marine microbial bioreactors may lead to an industrially feasible supply option. If the source of the compound is the macroorganism itself, development of in vitro production methods could provide bulk supply of the compound. Research in progress in our laboratory focuses on establishing cell lines of bioactive marine invertebrates that can be used as models to study in vitro production of bioactive metabolites and the factors which control expression of production (Pomponi et al, 1997, 1998). This could ultimately lead to in vitro production of marine bioproducts. More importantly, an understanding of the cellular and molecular processes that control production of these metabolites could be used to enhance upstream processing / culture optimization and to stimulate production of "unnatural" natural products—i.e., chemicals that the organism would not produce under normal conditions, but which may be more potent than the "natural" product.

- In situ growth conditions: Is aquaculture an option for deep-water organisms? Both in-the-sea and land-based aquaculture methods have been developed for production of bioproducts from shallow-water organisms. CalBioMarine Technologies (Carlsbad, CA) has successfully aquacultured the bryozoan, Bugula neritina, and Ecteinascidia turbinata, the ascidian from which the antitumor compound, ecteinascidin 743, has been isolated (Wright et al, 1990; Rinehart et al, 1990). These are both common, shallow-water organisms for which reproduction and growth have been studied, but the factors controlling production of the compounds are not yet completely known. The New Zealand deepwater sponge, Lissodendoryx sp., is the source of the antitumor compounds, halichondrins. The sponge occurs at 85-105 meters, but has been cultured successfully from cuttings on lantern arrays in shallower water, maintaining production of the bioactive halichondrins (Battershill et al, 1998). Current efforts are directed toward modification of metabolite production by altering the microenvironment (Battershill, personal communication). This indicates that aquaculture of some deep water sponges is feasible; however, species from deeper water may have more critical growth requirements, such as high pressure and low temperature.Although in-the-sea aquaculture is a cost-effective method of production, it may not afford the opportunity for over-expression of production of the compounds or for complete control of environmental parameters. Development of closed-system bioreactors for the culture of both shallow water and deep water organisms is a particularly challenging opportunity for marine bioprocess engineers.

- Biosynthetic pathway: Is genetic engineering realistic for the compound? If the biosynthesis of the target compound is understood, it may be possible to identify, isolate, clone, and express in a heterologous host the genes responsible for production of the metabolite. In many cases, of course, biosynthesis of the product is not known, or it is a multi-step process involving several enzymatic reactions. For these cases, transgenic production is not a trivial process. Alternatively, chemoenzymatic synthesis, by which marine bioproducts are synthesized in cell-free, enzyme-based systems, offers a complementary technique to in vitro and transgenic production methods for marine bioproducts (Kerr et al, 1996 a, b).

Optimization of Production

Perhaps the area in which marine biotechnology in general, and marine bioprocess engineering in particular, has the greatest potential is in the design and optimization of bioreactors for marine metabolite production. A variety of bioreactor designs have been implemented, with varying degrees of success. The opportunity to produce new, bioactive structural analogs of known compounds via manipulation of

culture conditions presents marine biotechnologists with a unique challenge for new bioproduct discovery. Innovations in media development (chemical engineering), bioreactor design (bioprocess engineering), and transgenic production (molecular engineering), coupled with efficient downstream processing and product recovery, will be necessary to meet the needs of both discovery and bulk production of novel marine bioproducts.

In summary, the marine biotechnology industry faces a unique challenge for the millenium: Inventing a new generation of tools and processes that will enable a greater understanding of the ocean and its resources and lead to the discovery of new bioproducts for the future, and designing methods for the sustainable development of these unique bioproducts.

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EMERGING CHALLENGES FOR U.S. MARINE BIOTECHNOLOGY

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Biotechnology has become a rapidly burgeoning industry worldwide.[1] It is expected to have profound impacts on health, agriculture, and aquaculture, by improving food products, enhancing environmental bioremediation, curing fatal diseases, and bringing potential socio-economic changes. Although still in the incipient stage, the field of biotechnology stands at the threshold of the next 'biotech century.'[2]

It is assumed that most of the issues applicable to the biotechnology field in general will also be applicable to marine biotechnology, because the latter can simply be defined as biotechnology applied to marine living organisms.[3] Marine biotechnology has recently been embraced as a field of great potential by molecular biologists and by the biotechnology industry because the oceans, covering nearly 70% of the earth surface and comprising 90-95% of the biosphere by volume of living organisms on earth,[4] contain a tremendous range of diverse biological resources and unique resources and conditions—for example, the largely unexplored deep-sea hydrothermal vents, and extreme ocean environments such as cold polar waters and the deep ocean floor characterized by intense pressure.[5]

Marine biotechnology has recently been embraced as a field of great potential by molecular biologists and by the biotechnology industry because the oceans...contain a tremendous range of diverse biological resources and unique resources and conditions...

In spite of the increasing attention on the part of molecular scientists and industry on the potential development of marine biotechnology, there are no coherent guidelines, framework conventions, guiding norms or principles to specifically govern the conduct of marine biotechnology development neither in the United States nor in other countries. A number of existing international agreements related to maritime jurisdictions, protection of biodiversity, and intellectual property, however, will significantly affect the operations of the U.S. marine biotechnology industry both in the U.S. and in the jurisdictions of other nations.

We see three important emerging issues or challenges which will affect the path of development of the marine biotechnology industry: 1) access to marine resources / organisms; 2) biosafety; and 3) intellectual property rights.

Issues of Access to Marine Genetic Resources/Organisms

The Convention on Biological Diversity (CBD)[6] and the 1982 Law of the Sea Convention (LOS Convention) are important treaties in the emerging international marine biotechnology field. The regime for governing access to marine resources / organisms under the jurisdiction of coastal nations for marine biotechnology purposes (both for samples and experimental research and for harvesting and production purposes) is in the process of redefinition. Traditionally, access to marine resources / organisms found within other nations' 200-mile Exclusive Economic Zones has been relatively easy and was governed under the terms of the 1982 LOS Convention which entered into force in 1994. Articles 237 through 265 provide that nations conducting scientific research get advance permission from the coastal nations in whose ocean zones such research is to take place. Provisions for sharing of benefits derived from the research under the LOS Convention only call for such measures as promotion of the flow of scientific data and information, the transfer of knowledge resulting from marine scientific research (especially to developing states), and the strengthening of autonomous marine science research capability of developing states (such as including local scientists in research cruises).

In contrast, the CBD paves new ground in international norms governing access to genetic resources, defined as "genetic material of actual or potential value." The Convention calls for the conservation of

biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources. The CBD recognizes the sovereign right of nations to control access to their genetic resources, and requires the users of genetic resources to take measures to promote equitable sharing of the benefits, including technologies, with the providers of those resources.

There is thus a current need to harmonize the provisions of the LOS Convention and the CBD regarding marine biotechnology prospecting and any follow-on activities that may be involved. It would seem desirable, from the standpoint of the development of the field of marine biotechnology, for coastal nations to agree on the properties of a unified regime governing access to marine organisms, and perhaps, formalize it as a protocol to the CBD. As part of the development of such a protocol, nations will have to face the difficult question of valuing the information contained within particular marine organisms relative to the R & D investment of the prospecting firm (both before and after prospecting) as it attempts to decode the organisms, determine any unique properties they possess, and where it can, develop those unique attributes into useful products or services.

...there is currently a major effort underway to develop an international agreement on safety in biotechnology...which calls for "the safe transfer, handling, and use of any living modified organisms resulting from modern biotechnology."

Another important issue relates to access to marine genetic resources / organisms in the deep seabed. There is a controversy whether the exploitation of hyperthermophiles in the deep seabed would fall under the LOS regime regarding marine scientific research, the deep seabed mining regime, the high seas fisheries regime, or whether a new regime is needed.

Unfortunately, the U.S. is not currently in a position to play an effective international role in harmonizing the provisions of the LOS Convention and the Biodiversity Convention concerning marine biotechnology since it is not yet a party to either convention. While the U.S. can participate as an observer at the meetings of both conventions, in the continued absence of ratification of these treaties, it will be difficult for the nation to significantly affect the interpretation and implementation of these conventions.

Issues of Biosafety

The greatest controversies surrounding the issue of safety in biotechnology (or "biosafety" as the issue has become known) have focused on the development of living modified organisms (LMOs) through modern biotechnology techniques. Contained use and field release have been distinguished as the main categories of intended use of LMOs. Biotechnology has been developed and applied under contained conditions since the early 1970s, and for direct applications and release in the environment since the mid-1980s. Under contained conditions, LMOs are developed and employed for research purposes and are regulated by well-established risk-management techniques for work in a laboratory environment. The field testing of LMOs, on the other hand, continues to pose questions about the interaction of LMOs with natural ecosystems, such as with respect to: possible unintended changes in the competitiveness of natural species; virulence or other characteristics of targeted species; possibility of adverse impact on non-targeted species and ecosystems; stability of the inserted genes.

Internationally, there are as yet no binding international agreements to address the transboundary movement of LMOs. However, given the rapid development in the use of biotechnology, the lack of sufficient knowledge regarding the interaction between LMOs and the environment, the problems which may exist with LMO transboundary movement, and growing concern of the developing countries (the major source of genetic raw materials) that they could be used as LMO testing grounds, there is currently a major effort underway to develop an international agreement on safety in biotechnology. This is taking place under the aegis of the Convention on Biological Diversity, which calls for "the safe transfer, handling, and use of any living modified organisms resulting from modern biotechnology." CBD's Article 8(g) requires contracting parties to "establish or maintain means to regulate, manage, or control the risks associated with the use and release of living modified organisms resulting

from biotechnology which are likely to have adverse environmental impacts that could affect the conservation and sustainable use of biological diversity, taking also into account the risks to human health," and, in the past several years, negotiations have been underway to produce a legally-binding protocol on biosafety under the CBD.

After the Sixth Meeting of the Open-Ended Ad Hoc Working Group on Biosafety (BSWG-6) held from February 14 to 22, 1999, in Cartagena, Colombia, the first Extraordinary Meeting of the Conference of Parties (Ex-COP) to the CBD was held February 22-23, 1999, at the same venue and attempted to finalize a protocol on biosafety for adoption by the ExCOP, but failed to pass it. The main areas of controversy were trade issues, treatment of commodities and domestic vs. international regulatory regimes. The continued debate on a protocol on biosafety will be transmitted to the resumed ExCOP session, no later than the fifth meeting of the Conference of the Parties.[7] Although the biosafety protocol has not yet been adopted, this attempt has catalyzed the attention of the biotechnology industry and of countries which have advanced biotechnology, in particular the U.S., because such a legally-binding treaty will greatly affect an individual nation's behavior and its domestic policies on biotechnology in the next century.

Issues of Intellectual Property Rights

The issue of intellectual property rights (IPRs) is a controversial subject in the context of the CBD, involving the developed nations (the North)—and generally those nations with advanced biotechnology— vis-à-vis the developing nations (the South)—generally nations endowed with rich genetic resources. The North wants stricter IPRs on new biotechnology discoveries, which may guarantee the biotech industry the recovery of their investments and costs, plus profits. In contrast, the South complains of inequitable sharing of benefits and lack of guarantees for compensation for the utilization of their genetic resources.[8]

The issue of the protection of IPRs on biotechnology is not an isolated phenomenon but is linked with issues of equitable benefit-sharing, compensation for traditional indigenous knowledge, community rights on the ownership of genetic resources, and transfer of technology. Therefore, the South adheres adamantly to the concept of a package deal, that IPRs must be dealt with as a cluster of all related issues, whereas the North, in particular U.S. and OECD member nations, argue that IPRs must be treated as a separate issue.

In the past, six major international agreements provided the policy framework for international patent law (from the Paris Convention in 1884, to the establishment of the World Intellectual Property Organization in 1970). More recently, adequate systems of intellectual property rights are being seen as an important component of free trade and, as such, are increasingly being dealt with in the World Trade Organization and GATT-related issues.

Traditionally, these intellectual property policies were generally thought to be relevant only to industrial application, and not to the store of valuable knowledge held by indigenous peoples around the world. Several of the international agreements and prescriptions emanating from the Earth Summit, especially the CBD and parts of Agenda 21, place strong emphasis on the protection of indigenous knowledge, on the awarding of benefits for the use of such knowledge, and on the transfer of technologies to the developing world, including those protected by patents and other intellectual property rights.

Novel forms of agreements are being negotiated, in different countries, among biotechnology companies, governments, NGOs, and the public, to govern bioprospecting, with the aim of achieving a proper balance between protection of biodiversity resources, protection of industry's interests, and protection of the public's rights to receive benefits from the exploitation of public marine resources / organisms. Evaluating the pros and cons of different types of agreements for bioprospecting and adapting appropriate forms to the special needs and requirements of the U.S. marine biotechnology industry in its operations in the U.S. and abroad is an important future challenge.

Work in progress

A detailed discussion of these issues may be found in *Policy Issues in the Development of Marine Biotechnology: Access, Biosafety, and Intellectual Property,* which is currently in preparation by the authors. The book, based on work funded by the Sea Grant program, examines the relevant international and national policy frameworks, analyzes the perspectives of various parties involved in these policy debates, including scientists working in the field, representatives of marine biotechnology companies, national

governments, international organizations, and international NGOs, especially from the developing world. Topics covered include the development of marine biotechnology around the world; current status of the marine biotechnology field; and issues of access to marine organisms, biosafety, and intellectual property rights. A set of findings and recommendations to address policy issues in each of the areas noted above that attempt to balance the competing interests at stake are also presented.

Notes

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4. Trends and Future Issues in the Coastal States

Panel Four examined recent and projected trends at the state level. The scope of ocean issues of concern to coastal states is broadening. Concern about fisheries management, maritime and boating issues, and direct involvement of local governments are new additions to what had been an agenda primarily concerned with environmental impacts. States have recognized the importance of guiding community development, conserving open space, discouraging sprawl development in rural areas, and protecting agricultural lands. However, it is also becoming clear that coastal communities need more support for an improved capacity to efficiently plan for and manage growth and development. In addition, states are also broadening their focus to include "deep blue water" issues in their overall coastal management efforts.

Building Capacity for Ocean Management: Recent Developments in U.S. West Coast States

Marc J. Hershman, School of Marine Affairs, University of Washington

Coastal States' Challenges

Sarah Cooksey, State of Delaware and Chair, Coastal States Organization

Development of a Comprehensive Ocean Policy for Florida

James F. Murley and Laura Cantral, Florida Governor's Ocean Committee

BUILDING CAPACITY FOR OCEAN MANAGEMENT: RECENT DEVELOPMENTS IN U.S. WEST COAST STATES

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Introduction

In a recent paper (Hershman 1996) this author summarized the ocean management initiatives of ten United States coastal states. These states were considered "activist" because, to varying degrees, they had taken steps to advance state policy, institutions, and management over the use of the ocean areas adjoining the state. The paper concluded that there was a trend toward increased state-level participation in ocean management within the United States, and that this trend was likely to continue because the state's role in these issues had become institutionalized. States are active in the national Coastal Zone Management (CZM) program, the National Sanctuary program and in regional bodies dealing with fisheries and pollution control. I concluded that as new ocean issues arise they are likely to be resolved through new policies and institutions that increase state responsibilities and powers. The purpose of this paper is to report recent developments in the West Coast states of California, Oregon and Hawaii to determine how their role in ocean affairs has progressed since 1996.

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California

California reached a major milestone in March 1997, with the issuance of "California's Ocean Resources: An Agenda for the Future" (the Ocean Agenda) (Wilson and Wheeler 1997). This comprehensive policy was developed by state government officials with broad-based participation from many sectors. It assesses the current situation in California's ocean waters from legal, economic, institutional, and scientific perspectives. It identifies four over-arching goals, details the economic importance of ocean resources to the state, describes the ocean ecosystem, lists the responsible management agencies, and offers recommended directions for the future in nine substantive issue areas. The recommendations address such issues as the need for better resource inventories, a better system of managed areas, improved fisheries management, and many others. The report, which took 5 years to develop, was presented and discussed at a statewide conference involving over 800 people.

In conjunction with the report's release and the conference, about 50 bills were introduced into the legislature, and 15 became law in 1997 (dubbed the "Coastal Flotilla" of bills by the environmental organizations partly responsible for advancing them). These deal with a range of issues addressing fisheries, water quality, habitat protection, and shoreline erosion. In 1998, the Marine Life Protection Act was adopted. This legislation strives to reform fisheries management for selected fisheries and to change the standards and procedures for fisheries management. It sets up pilot fishery management plans, restores professional management to the fisheries agency, and calls for an ecosystem approach to management.

Parallel to the legislative activity, the Governor issued Executive Order W-162-97 implementing many of the goals from the Ocean Agenda. The Executive Order calls for an inventory of water quality monitoring programs, development of a maritime policy through a special Executive Order, a comprehensive review of living resources management programs, an analysis of Federal agency responsibilities, an ocean information system, and a research agenda. The responsible agency for each goal is identified and due dates listed.

Many of these actions have been taken. A statewide Maritime Policy (Ex. Order W-182 -98) designed to strengthen the state's role in port-related issues was signed on August 28, 1998. The analysis of federal responsibilities was completed in June of 1998 (Wheeler and Rooney 1998). The ocean information system is now available on the web (ceres.ca.gov/

ocean). The state's Sea Grant Advisory Panel has identified the ocean research needs to support the plan. The inventory of water quality monitoring programs and the living resources review are still in progress (Baird 1999). (With a new Governor taking office in California, it can be assumed that some of these initiatives will be re-examined).

Finally, the state announced $3.6 million in grants to local governments under the coastal resources grant program, which under a 1996 law redefined the distribution of offshore OCS revenues and reduced local cost-sharing requirements (California, Governor's Office 1998). The 32 projects receiving funds are in the central coast region (in proximity to ocean areas where offshore oil and gas activity occurs) and address diverse needs such as impact reduction, acquisition, restoration, fishing, and water quality improvements.

Oregon

Oregon's ocean affairs over the past 3 years have centered on implementation of the Territorial Sea Plan (TSP) of 1994 (Oregon Ocean Policy Advisory Council 1994). The TSP establishes a management framework, a process for making resource use decisions, and a strategy for the rocky shore environments along the Oregon outer coast. The organization responsible for overseeing the plan is the Ocean Policy Advisory Council (OPAC), a broadly representative group. Implementation of the plan occurs primarily through various state agencies. A new role for local governments is emerging. The Oregon Coastal Management Program (OCMP) provides the technical, administrative, and legal support necessary for effective implementation (Bailey 1999).

The OPAC is currently undertaking a comprehensive review of the TSP for the purpose of clarifying policy. An example of one change is the rephrasing of the policy to protect renewable resources. The new policy being considered calls for "higher priority to be given to the protection and conservation of living marine resources." This statement of policy is intended to replace an earlier one that emphasized the priority of renewable over non-renewable resource use.

State agencies have upgraded their regulation of near-shore areas in conformity to the TSP. For example, the Department of Fish and Wildlife has issued regulations affecting fishing near rocky shores, the Department of State Lands has revised their procedures for review of kelp harvesting, and the State Parks Department has taken measures to protect rocky shores.

The OCMP is facilitating a dispute between the fishing industry and those installing submarine communication cables. The intent is to propose policy recommendations to the OPAC for inclusion in the TSP. These recommendations would address the ways damage to fishing gear can be reduced, how fishing areas can remain open even in the vicinity of cables, and procedures for establishing a fisheries compensation fund.

Four local communities are beginning to use the TSP as a framework for resolving site-specific problems. Problem-solving is facilitated and supported by the OCMP using a consensus-based process. Once policy recommendations are formulated, they are submitted to the OPAC for inclusion in the TSP. The community plan that is farthest along addresses Cape Arago, near Coos Bay and North Bend. A 15-month policy development process has been completed. The policies strive to balance growing recreational and tourist use of the rocky shore environment with the protection of marine creatures and their habitat. A primary recommendation is the establishment of an Intertidal Marine Protected Area. Plans for Port Orford, Cannon Beach / Ecola State Park, and Newport are being considered using the same approach as in the Cape Arago plan.

The OCMP promotes research to support implementation of the TSP. They oversee the multi-year and interdisciplinary Pacific Northwest Coastal Ecosystem Regional Study, which studies the links between ecological and socioeconomic systems. They are also promoting new research to address rock reef ecosystems cooperatively with California and Washington.

Hawaii

Hawaii adopted the Hawaii Ocean Resources Management Plan (HORMP) in 1991. The plan was the guiding document for comprehensive ocean and coastal resource management and contained 66 policies and 364 implementing actions for the 10 sectors and 16 designated agencies. During 1997, a status report on the implementation of the plan was produced by the Hawaii Office of Planning (1998) and published early in the year. That report gave the plan a mixed review, noting that many sectors ranked high in priority but received little attention (e.g., research and education, ocean recreation, beaches, and coastal erosion) and that sectors like fisheries and energy received low priorities and little

implementation. They did note that the waste management, marine minerals, and aquaculture sectors were being implemented appropriately given the status assigned to them.

The report addressed institutional issues as well, pointing out that in 5 of the 10 sectors identified no lead agency was assigned and as a result concerted efforts were lacking. They underscored the importance of the Marine and Coastal Zone Management Advisory Group (MACZMAG) as the forum "ideally suited" to address the findings of the 1997 review and to coordinate more effective implementation of the HORMP.

The MACZMAG is required by law to advise on the status of the state's CZM program and on the implementation of the HORMP. MACZMAG has 20 members, 6 non-governmental and 14 from local and state agencies. The non-governmental members issue a separate report yearly to the legislature. In their 1998 report, they point out the importance of more public awareness and participation in the work of the MACZMAG, and the need for greater independence by the state CZM program. At least one member made an impassioned plea for greater participation by state agencies and county officials in the work of MACZMAG.

The Hawaiian legislature passed several laws in 1998 dealing with management of marine fisheries. A West Hawaii Fishery Management Area (FMA) was established, requiring the state DLNR to formulate a plan designating a minimum of 30% of the FMA as "no-take" zones and establishing a mooring buoy system with no anchoring zones. The state's Department of Aquatic Resources was given greater rulemaking authority over certain fishing practices, and the law increased participation by fishers in the process. The state DLNR was given greater authority to protect irresponsible fishing practices.

The legislature also addressed boating recreation in a variety of ways. Thrill craft regulation was extended and a special advisory committee established to advise on education and training requirements for thrill craft operators. The Hawaii Maritime Authority was set up to address statewide issues and to change the management of small boat harbors (HB2998).

Hawaii addressed some challenging opportunities in new ocean uses during this 2-year period. The state will be a key link in a new submarine cable connecting the United States, Australia and New Zealand, due to be completed in 1999. The use of offshore floating platforms for many types of industry, and for launching communication satellites, is actively under evaluation and a site near Hawaii is being evaluated by Boeing's Sea Launch venture (but licensing issues remain). Mariculture issues received continuing attention in the legislature, but most of the measures did not pass. One bill establishing an offshore mariculture demonstration site passed. Finally, acoustic impact issues from the Navy proposal for monitoring submarines is of great concern to Hawaiian citizens.

It should be pointed out that many of the coastal and ocean-related bills introduced into the Hawaiian legislature in the last 2 years were sponsored by state Representative David Tarnas, a specialist in coastal and ocean affairs. The fact that he was not re-elected in 1998 may slow legislative action on behalf of coastal issues.

As Hawaii addresses implementation of the HORMP, some larger issues play a critical role. The first is the challenge of a stagnant economy. This reduces the ability of the state to finance coastal and ocean programs and pushes the state toward seeking novel avenues for economic development (such as leasing state lands for mariculture and investing in marine biotechnology). Next is the goal of Hawaii to expand its Exclusive Economic Zone (EEZ) to include the remote islands of the archipelago. Should this come to pass, it would greatly heighten the need for Hawaii to improve its ocean management capacity to account for such issues as the Johnston Atoll Chemical Agent Disposal Site.

Discussion

All three states have continued to advance an ocean program. In California, new initiatives came primarily from the executive branch, with considerable additional leverage exerted by the powerful coastal and marine environmental NGO's. In Oregon, the state government apparatus centered in the OCMP pursued its implementation program systematically with considerable accomplishment. The Hawaiian efforts at the executive branch level are still somewhat unfocused, and the legislative initiatives have been the primary vehicle for change.

Political and leadership changes can influence progress in a new subject area like ocean management. A new governor from a different political party is entering office in California, and a key legislator in Hawaii was not re-elected. (Similarly, a new governor is taking office in Florida and the Governor's

Ocean Committee established under Governor Chiles in 1997 likely will not survive). In California and Hawaii, new shifts have occurred in assignment of ocean responsibilities to executive agencies, similar to shifts made in the past. Interestingly, the Oregon program seems to maintain steady progress regardless of political changes since it is firmly rooted in a respected program activity of the executive branch. As noted in the earlier article (Hershman 1996, p.33), organizational change and revision of policy documents have hindered progress. With the exception of Oregon this pattern may still dominate.

Concern about fisheries management, maritime and boating issues, and direct involvement of local governments are new additions to what had been an agenda primarily concerned with environmental impacts.

There appears to be a substantive shift in at least three areas. One of these is fisheries policy. Over the past decade, issues centering on adverse impacts from offshore oil and gas, dumping or discharge of pollutants, and other effects from industrial-type uses primarily drove ocean policy development. I noted in the earlier article that fisheries-related issues were left untouched because of existing fishery management agencies (Hershman 1996, p. 34). However, in the past two years all three states have adopted new laws or policies dealing with fisheries management. California's new law seeks to change fisheries management by promoting pilot projects using new techniques. Oregon agencies have adopted new rules for rocky reef fisheries, and a major research initiative is underway to better understand ecosystem issues for rocky coasts. Hawaii has established a new fishery management regime for the West Hawaii region that includes mandatory no-take zones and use of buoys rather than anchoring. Given the national and international political attention to depletion of world fishery resources, it is not surprising that the states should start experimenting with new strategies.

A second policy shift since the last report is in the area of local government involvement in ocean affairs. Oregon has initiated local coastal planning for rocky shore areas, with the Cape Arago plan as the first to be completed. This strategy involves local communities in the evolution of the state's territorial sea plan. California's coastal grants program pays for specific projects, but there is no linkage with the Ocean Agenda. An interesting development in Washington State adds to this local government emphasis. When the proposal for a national marine sanctuary for the Northwest Straits reached political roadblocks, the U.S. Congress passed the Northwest Straits Marine Conservation Initiative (Title IV, HR 3461, 105th Cong., 2nd Sess.). This law establishes a new Northwest Straits Advisory Commission to pay for and coordinate the planning efforts of seven local governments in marine resource protection and restoration.

A third policy shift is in the area of maritime policy. California and Hawaii passed new laws establishing maritime policy for the state and designating responsible agencies. California's law was aimed at clarifying a state role in advancing the commercial ports of the state, especially in areas like dredging policy, intermodal coordination, and environmental policy. Hawaii's new maritime authority will strive to bring together the commercial shipping and recreational boating interests of the state under a single independent public entity to improve planning and coordinated use of maritime resources.

Conclusion

The experience of these three states suggests that the scope of ocean issues of concern to coastal states is broadening. Concern about fisheries management, maritime and boating issues, and direct involvement of local governments are new additions to what had been an agenda primarily concerned with environmental impacts. For these three states, one could conclude that their capacity for ocean management has improved since new laws and governmental responsibilities have been identified and added to the states' suite of management tools.

On the other hand, many of the cautionary comments mentioned in the 1996 paper still hold. With the exception of Oregon, there is considerable flux in defining responsibility for ocean issues in the states. Further, the states are dependent on federal programs such as the national CZM program, the National Marine Sanctuary program, and the National Sea Grant Program for much of their progress. This suggests that new initiatives often will be partnerships between federal and state programs.

These partnerships may restrain state initiatives but in return provide greater resources and staying power once a federal-state accommodation is reached. In fact, the institutional structure provided by federal programs may be the vehicle for overcoming the vicissitudes of state and local political forces.

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COASTAL STATES' CHALLENGES

Sarah Cooksey
State of Delaware and Chair, Coastal States Organization

Editor's note: *The following remarks represent the author's dual capacity as the Administrator of the Division of Soil and Water of the Delaware Department of Natural Resources and Environmental Conservation and as the current Chair of the Coastal States Organization (CSO). CSO was formed in 1970 to represent the interests of coastal states, including territories and commonwealths.*

The Coastal Zone Management Challenge

As we seek to enhance our nation's prosperity, revitalize communities and enhance economic development, we have a concurrent responsibility to address the increased demands that growth and development places on our coastal resources.

Congress was prescient when in 1972 it passed the Coastal Zone Management Act (CZMA) providing incentives for states, on a voluntary basis, in cooperation with local governments

> *...to encourage and assist the states to exercise effectively their responsibilities in the coastal zone through the development and implementation of management programs to achieve the wise use of the land and water resources of the coastal zone, giving full consideration to ecological, cultural, historic, and esthetic values as well as the needs for compatible economic development programs...(16 USC 1452(2))*

It is becoming increasingly clear the coastal communities need more support for an improved capacity to efficiently plan for and manage growth and development. An increased commitment is needed if we are going to achieve cost-effective investment in public infrastructure; identify and encourage a compatible mix of residential, commercial, and open-space uses; revitalize communities; and conserve and restore natural resources.

States have recognized the importance of guiding community development to make it more efficient, environmentally compatible, and integrated among the various government agencies. As of early 1998, 10 states have adopted comprehensive growth management acts that establish more rigorous requirements for local planning of community development and for related state and regional actions. States have also recognized the importance of conservation of open space, discouraging sprawl development in rural areas, and protecting agricultural lands. The public also has indicated its strong support for these initiatives. In 1998, nearly 200 ballot initiatives were approved by voters in calling for the management of development and the conservation of open space.

It is becoming increasingly clear that coastal communities need more support for an improved capacity to efficiently plan for and manage growth and development.

It is time for a major commitment through the CZMA to provide new and improved planning and management tools for local communities to help them better understand and address the extremely complex economic and ecological dynamics of coastal systems and communities.

Background

The CZMA incorporated the essential principles of the "smart growth" and "sustainable development" movements over 20 years before the terminology came into vogue. It is not surprising that these principles were recognized first as essential to proper management of coastal resources and development where the concentration of people and their demand for the use of natural resources was most acute.

Providing suitable incentives and encouraging cooperation among the federal, state, and local governments is more important today than ever before. Coastal areas become more crowded every day. The rate of growth is fastest in coastal counties, where population densities are already five times the national average. In addition to being home to over

50 percent of the U.S. population and most of its major cities, economic activity in coastal areas is vital to the nation–supporting 28.3 million jobs, incalculable indirect economic benefits as well as direct support for port and maritime trade, fisheries and mariculture industry, travel, recreation and tourism, oil and gas development; and, other ocean and coastal dependent industries.

The growing importance of wise coastal management in economic and human terms was dramatically demonstrated in 1998 by the outbreaks of harmful algal blooms and the expansion of the "dead zone" of the Gulf coast, as well as the extensive damage that resulted from hurricanes and the effects of El Nino events. These events demonstrate the need for increased support for state and local efforts to control land-based sources of coastal pollution and to improve planning for coastal hazards. The potential impacts of human activities on coastal resources and conflicts among the competing uses for coastal resources will increase substantially in the years ahead as population and development increase.

The growing importance of wise coastal management in economic and human terms was dramatically demonstrated in 1998 by the outbreaks of harmful algal blooms and the expansion of the "dead zone" of the Gulf coast, as well as the extensive damage that resulted from hurricanes and the effects of El Niño events.

The CZMA is the only federal statute which sets forth a comprehensive voluntary federal-state partnership based on the goal of maximizing sustainable economic and environmental objectives. The CZMA also provides a framework to enhance integration among federal, state, and local governments, encourage interagency coordination, provide incentives and assistance to communities, streamline the regulatory process, and encourage proactive planning and coastal management at the local level.

Summary of CSO's proposals for Reauthorization of the CZMA in 1999

(1) Provide increased support for the development of new tools, which will build capacity at the state and local level through technical assistance and targeted support to states and communities, to implement place-based management in our nation's critical coastal areas.

(2) Provide for increased support for state coastal programs to address the cumulative and secondary impacts of development and land-based sources of polluted runoff.

(3) Provide funding under the Coastal Zone Management Fund for regionally significant projects, international projects, emergency response to coastal hazards, and innovative demonstration projects addressed at local communities.

(4) Clarify the role of and provide increase support for the National Estuarine Research Reserves and seek to build closer links to coastal program

(5) Enhance federal support for base programs under the CZMA consistent with increased challenges and responsibilities, particularly in the nation's largest states where base grants have been capped for the past seven years despite substantial increases in state and local need.

What Are the Current Trends in Coastal Management in the First State - Delaware?

Many things are happening in the Coastal Management arena:

We have almost completed construction of a 5,550-square-foot building for research and education for coastal management, the first phase construction at our Delaware National Estuarine Research Reserve. That building will be used for targeted, focused education and research for current CMP needs.

We have a new process to focus decision-making. Partnering with NOAA, Delaware Coastal Programs has institutionalized a method that uses internal and external experts and the public to problem solve in a much shorter time frame. Successful projects that have used this process include the Pea Patch Island Special Area Management Plan, COMPAS Delaware: Kent County Resource Protection Module, Dredging in Delaware, and Delaware Coastal Zone Act Environmental Indicators Project). The process recognizes the importance of good planning, but is ori-

ented toward implementation of methods to provide for reasonable growth and development while conserving and protecting our irreplaceable coastal resources.

DEVELOPMENT OF A COMPREHENSIVE OCEAN POLICY FOR FLORIDA

James F. Murley and Laura Cantral
Florida Governor's Ocean Committee

Background

The state of Florida is a thin strip of land measuring nearly 35.7 million acres, and bounded on three sides by the ocean. Approximately 8,400 miles of tidal coastline wrap around it, and off its southern tip lie the only living coral reefs in North America – third largest in the world. Florida's territorial waters stretch for 3 miles off the Atlantic coast and 3 marine leagues in the Gulf of Mexico, with approximately 6 million acres of submerged lands underneath. Without doubt, Florida's ocean is its most distinctive feature.

Much of that distinction lies in the ocean's cultural, environmental, and economic importance. Florida's very identity is intimately linked to the ocean; millions come to the state to experience the ocean's ability to relax, rejuvenate, comfort, and inspire. In addition to its intangible powers, the ocean is literally life-giving. It is the source of oxygen we breathe, water we drink, food we eat, and medicines that maintain our health. As an economic engine, it is the basis for some of Florida's most important industries, including fishing, shipping, and tourism. But while its abilities are great and its resources vast, they are not inexhaustible. Increasing demands for Florida's ocean resources, coupled with an ever-growing ability to recover those resources, are threatening the health and vitality of Florida's ocean.

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When the United Nations proclaimed 1998 to be the International Year of the Ocean, it provided an excellent opportunity to highlight the importance of the ocean to life on this planet. The proclamation spurred many efforts and activities aimed at raising awareness of the ocean's value, and encouraged individuals, organizations, and governments to look for ways to make changes needed to sustain the world's precious ocean resources.

Following that lead, the late Governor Lawton Chiles proclaimed 1998 the Year of the Ocean for Florida, and encouraged the state to focus on the importance of the ocean to its cultural, economic, and environmental health. Governor Chiles also appointed the Florida Governor's Ocean Committee (FGOC). This Committee is responsible for promoting public awareness of the significance of the ocean to Florida, as well as guiding the state's efforts to develop and implement a coordinated and comprehensive ocean resources management strategy.

This article discusses Florida's efforts to develop an ocean management approach that is coordinated and comprehensive, and that can account for a wide variety of uses and activities. It includes a brief history of the current ocean planning initiative, describes the preliminary projects that laid the groundwork for the creation of the Florida Governor's Ocean Committee, and summarizes the Committee's work to date.

History

Impetus for developing an ocean management strategy for Florida began with the Florida Coastal Management Program (FCMP), which is housed in the state's Department of Community Affairs. The Program's motivation sprang from a number of factors. For example, even though in recent years the state has made great progress in terms of responsible management of Florida's coastlines and near-shore waters, management of offshore resources continues to be conducted on an issue-by-issue basis, often with conflicting and contradictory results. As the coordinating agency for the nine state agencies that regulate coastal activities, it became apparent to the FCMP that the state needs an integrated framework to manage offshore ocean resources and to eliminate inconsistencies between different agency responsibilities. Furthermore, through administration of the federal consistency review process, it became clear to the FCMP that there are conflicts between private and public activities–for example, between fishing

activities and military missile testing over the Gulf of Mexico.

In addition, the need for an ocean management structure could be seen through the analysis of important emerging trends in the state. Information from a number of sources, including the FCMP's own trend reports, Florida Assessment of Coastal Trends and The State of the Coast, has consistently maintained that pressures on coastal and ocean resources will continue to grow as transportation needs, boating activity, tourism, and population growth all increase at astronomical rates.

Finally, influences outside the state had a bearing on FCMP's decision to initiate ocean planning efforts for Florida. By recognizing the need to address "deep blue water" issues, Florida joined the efforts of several other state coastal management programs, including Oregon, California, Hawaii, Maine, Massachusetts, and North Carolina, in focusing attention on offshore resources and activities and including them in their overall coastal management efforts. Provisions in Section 309 of the federal Coastal Zone Management Act, which authorize the use of federal coastal zone funds to support ocean policy projects, helped enable the FCMP to fund a series of preliminary projects to develop an understanding and appreciation of the need for comprehensive ocean resource management. With the Year of the Ocean proclamations, the time was ripe for a policy dialogue on ocean issues.

By recognizing the need to address "deep blue water" issues, Florida joined the efforts of several other state coastal management programs... in focusing attention on offshore resources and activities and including them in their overall coastal management efforts.

Preliminary Projects

To give shape and direction to the ocean management effort, the FCMP funded a series of preliminary projects that were designed to provide not only baseline data on the status of Florida ocean resources, but also to generate support for ocean planning and ultimately to justify the creation of a high-level group that would be charged with developing coordinated ocean governance strategies for the state, including the means to ensure their implementation.

The first in a series of three preliminary projects is a comprehensive analysis of the status of marine law and policy in Florida. Looking Seaward: Development of a State Ocean Policy for Florida updates an earlier study completed in 1989, and is a detailed overview and assessment of law and policy related to the management of Florida's "deep blue water" ocean resources. With financial support from the FCMP, the report was developed by the Florida State University College of Law, and provides background and perspective on ocean issues. It also summarizes the ocean management efforts of other states, reviews federal and state law and policy regarding Florida's ocean resources, and offers suggestions for improving the state's managerial regime.

The second preliminary project is entitled the Statewide Ocean Resource Inventory (SORI). Complementing Looking Seaward's focus on legal and policy issues surrounding ocean resources, SORI is designed for use by the marine resource management community and attempts to provide accurate and up-to-date information about ocean resources. Funded by the FCMP and developed by the Florida Department of Environmental Protection's research arm, the Florida Marine Research Institute (FMRI), SORI is an ArcView-based Geographic Information System (GIS). Using data compiled by and permanently housed at FMRI, SORI enables a user with World Wide Web access to view and download existing ocean resource information. While it does not contain all the data ever collected on ocean resources, it continues to grow and evolve, and is a valuable tool to help policy-makers identify what is known and what is not known about Florida's ocean resources.

While the first two projects addressed legal and policy issues surrounding ocean resources and the resources themselves, the third in the series of preliminary projects focused on ocean users and management issues related to the use and protection of Florida's ocean resources. Invited by the Executive Office of the Governor and the Florida Coastal Management Program, the Florida Ocean Policy Roundtable was comprised of state agency representatives, maritime industry professionals, and technical experts – all knowledgeable about the numerous issues facing Florida's offshore areas. The purpose of the Roundtable meetings was to encourage discussion at the state level concerning ocean resource

management in Florida and to identify current and potential problems and conflicts that result from the existing management regime. The participants identified numerous issues, including issues related to marine habitat, water quality, fisheries management, oil and gas development, boating and marine recreation, as well as legal and policy issues and conservation and protection considerations. Of the many issues identified by the Roundtable as important and in need of consideration, fisheries management and marine habitat, the development of ocean energy resources, and marine pollution were identified as top priority issue areas.

With the preliminary projects complete, the next step toward the development of a comprehensive ocean management strategy was the formation of a formal policy committee, known as the Florida Governor's Ocean Committee (FGOC). To assist the FGOC, a final discussion piece was prepared – a synthesis document entitled Florida's Ocean Horizon. Intended to be a coherent package that conveys the challenges and opportunities facing Florida as it develops a comprehensive ocean policy, the document describes and offers highlights from Looking Seaward, SORI, and the Ocean Policy Roundtable. While not intended to dictate to the FGOC what issues it should consider, it served as a point of departure for the Committee's discussions by focusing on the three priority issue areas as identified by the Roundtable.

The Florida Governor's Ocean Committee

The Florida Governor's Ocean Committee was created by executive order on January 9, 1998. The Committee is composed of 24 members representing government, conservation, education, science, recreation, and business interests. The FGOC is chaired by University of South Florida President Betty Castor. It is assisted by 6 ex officio members representing federal agencies, and is staffed by the Florida Coastal Management Program, Florida State University, and 1000 Friends of Florida. Process design and facilitation services for the Committee's meetings are provided by the Florida Conflict Resolution Consortium.

The FGOC is charged with several important responsibilities including identification of instances where current responses to ocean issues are inadequate or conflicting; development of strategies that address those inadequacies or conflicts; improvement of coordination of management efforts by local, state, and federal governments; and, finally, promotion of public awareness of the importance of the ocean to Florida.

The first challenge facing the FGOC was how to organize its consideration of Florida's many ocean issues. Consequently, considerable effort was put into developing a structure for the Committee's discussions and a process for formulating a package of recommendations to the Governor. Using the priority issues identified by the Ocean Policy Roundtable as a frame of reference, the discussion of the issues was organized into three broad issue areas: environmental protection, living marine resources, and economic development. In addition, issues related to intergovernmental coordination and public outreach and education were added to the Committee's work plan.

The Florida Governor's Ocean Committee met for the first time in February 1998. The Committee's work is being conducted in two phases. Phase I, recently completed, explored the issues related to environmental protection, living marine resources, economic development, intergovernmental coordination, and public outreach and education through the course of five full committee meetings and numerous small working group meetings. The result is the development of two documents. The first, entitled Florida's Ocean Challenges, is a companion to the Committee's earlier discussion piece, Florida's Ocean Horizon, and serves as the Committee's interim progress report to the Governor. The report describes what the Committee sees as Florida's "Ocean Assets" – those resources that make a valuable contribution to the state's quality of life – such as living marine resources, recreation and tourism, ports, national defense operations, and marine education and research capacity. The report also includes what the Committee sees as "Ocean Management Challenges" – those issues, conflicts, or problems that threaten the health of Florida's ocean resources. Consideration of those ocean assets and challenges forms the basis for the development of "Ocean Management Strategies"–recommendations about actions the state can take to better manage ocean resources in a way that balances protection with reasonable and responsible use.

The Ocean Management Strategies are contained in the Committee's Draft Final Report. They are organized into five broad categories that address:

- Improving information on and understanding of ocean resources

- Creating an improved ocean management framework that is more coordinated and comprehensive
- Achieving and sustaining diverse marine ecosystems that are capable of supporting multiple uses
- Raising awareness, promoting education, and fostering stewardship of the ocean
- Facilitating greater financial support for ocean research, education, and management

Each strategy contains a number of recommended specific actions aimed at implementing the ocean management strategies, including suggestions for state agencies that should play a lead or implementing role in executing strategies and specific actions.

In addition, the Committee has proposed one "Overarching Recommendation." It recommends that the Florida Legislature create a Florida Ocean Council to provide leadership on ocean issues, coordinate ocean resource management, and identify priorities for research, education, and information needs. The Council would be a nonregulatory oversight group, with the primary purpose of providing clear policy direction on ocean issues and reducing duplication among agencies with responsibility for managing ocean resources and activities.

The Draft Final Report will be the focus of Phase II of the Committee's work, which will consist of a dedicated public outreach effort and the refinement of the draft. The draft will be presented to Governor Bush, state and federal agencies, and the public for comment and refinement in the early months of 1999. The Committee will then meet again in Spring 1999 to review the public comments and make necessary adjustments to the Draft Final Report before finalizing the report and delivering it to the Governor on June 30, 1999.

Conclusion

As of this writing, the Committee is preparing for its next meeting, during which it will reach consensus upon and formally adopt its Draft Final Report. State government is presently in a period of transition; Florida's new governor was inaugurated on January 5, 1999. With a new administration and many legislative changes, there is some uncertainty about the next steps for implementing the FGOC's work. There is, however, a surprising amount of consensus among the Committee members on what the important goals and strategies should be. In addition, there is strong Committee support for establishing a nonprofit group to advocate for ocean issues and education. Finally, there is a move to have the FGOC appointed by the Legislature as the Florida Ocean Study Commission, with a one-year term to further refine and develop recommendations. In any event, the work that has been done so far lays a solid foundation for future efforts. Through the leadership of the FGOC, Florida stands poised to develop a truly comprehensive ocean management strategy. As a result, the state will be able to better manage its ocean resources and ensure that future generations will have a healthy, vital ocean to depend upon and to enjoy.

Appendix I. Biographies of Authors and Moderators

Tundi Spring Agardy

Tundi Spring Agardy joined Conservation International in June 1997. As Senior Director of Coastal and Marine Programs, she oversees CI's global marine conservation work and provides the organization counsel on marine policy and science. Through research and applied work in tropical marine ecology and biodiversity conservation, Tundi has instituted marine protected areas and other coastal management measures around the world. She is author of Marine Protected Areas and Ocean Conservation, a comprehensive treatise published by Academic Press, UNESCO's Guidelines on Coastal Biosphere Reserve Planning, numerous scientific publications on marine biodiversity, species conservation, and marine protected areas, and several other popular and technical books on the sea.

Tundi is an avid diver and has done extensive marine research and surveys in many parts of the globe. In her current capacity as Senior Director at Conservation International and her former position as Senior Scientist at WWF, and as an independent consultant to the World Bank, UNDP, and private consulting firms, she has undertaken field research in Algeria, the Black Sea region, Canada, Cape Verde, throughout the Caribbean, Guinea Bissau, Indonesia, Mexico, Papua New Guinea, Tanzania and Zanzibar. Prior to coming to Washington, Tundi spent three years as a research fellow / scientist at the Woods Hole Oceanographic Institution. She received her Ph.D. in Biological Sciences and her Masters in Marine Affairs from the University of Rhode Island, and did her undergraduate work at Wellesley and Dartmouth Colleges.

Don Boesch

Don Boesch is a Professor in and President of the University of Maryland Center for Environmental Science. Previously, he was the first Executive Director of the Louisiana Universities Marine Consortium, and was Professor of Marine Science at Louisiana State University. An internationally known marine ecologist, he has conducted research in coastal and continental shelf environments along the Atlantic Coast, and in the Gulf of Mexico, eastern Australia and the East China Sea.

Don Boesch is particularly active in extending knowledge to environmental and resource management at regional, national and international levels. He is a science advisor to the Chesapeake Bay Program and to Maryland agencies and in such diverse regions as Alaska, San Francisco Bay, Southern California, coastal Louisiana and south Florida. Over a twelve-year period he was a member of the Marine Board and the Ocean Studies Board of the National Research Council, chairing committees that produced significant reports on marine environmental monitoring, ecosystem science and coastal science and policy. He has served on numerous agency advisory committees and currently serves as Vice-Chair of the Governing Board of the Consortium for Ocean Research and Education (CORE).

Charles A. Bookman

Charles A. Bookman (Charlie) works with the Special Projects Office of NOAA's National Ocean Service, where he is responsible for the National Dialogues on Coastal Stewardship.

Last year, Charlie directed the Year of the Ocean Project at The Heinz Center, which brought together leaders from industry, government, academia and environmental organizations to address the nation's stake in the oceans. "Our Ocean Future," the report of that effort, has been widely discussed.

Charlie directed the Marine Board of the National Research Council from 1986-1997. The Marine Board organized teams and implemented more than 80 high-level assessments of important national issues affecting oceans and coasts. The activities of the Marine Board were supported by 24 government agencies.

Charlie is a graduate of the URI Marine Affairs program and also Columbia University. He conducted oceanographic research at Lamont-Doherty Earth Observatory of Columbia University, and helped develop the Maryland Coastal Zone Management Program. He is a past director and member of the executive committee of the Marine Technology Society and also the Society of Naval Architects and Marine Engineers.

Susan Bunsick

Susan Bunsick is pursuing a Master's degree in marine policy at the University of Delaware, where she is focusing on policy issues in the development

of offshore marine aquaculture in the United States. Earlier, she spent many years working in Washington, D.C., most recently as a consultant in international energy for the U.S. Energy Information Administration. Ms. Bunsick holds an M.A. in Public Affairs from the George Washington University and a B.A. in Public Service from the Pennsylvania State University.

Laura Cantral

Laura Cantral is a consultant in Tallahassee, Florida. She has worked in the coastal and ocean management field for more than ten years. Her primary work experience has been related to ocean policy issues, and she serves as a legal and policy advisor through research, writing, workshops, and conferences. Her academic training is in law, and she has taught legal research and writing. She also conducts workshops on enhancing communication and leadership skills for scientists and resource managers. Cantral works closely with NGOs and public sector entities, including academics, managers, policy-makers, and scientists, to address a variety of issues related to understanding, using, and managing coastal and marine resources.

Biliana Cicin-Sain

Biliana Cicin-Sain is Professor of Marine Policy in the Graduate College of Marine Studies at the University of Delaware where she also holds a joint appointment in the Department of Political Science and in the School of Urban Affairs and Public Policy. Professor Cicin-Sain serves as Co-Director of the Center for the Study of Marine Policy and as Editor-in-Chief of Ocean and Coastal Management, an international journal devoted to the analysis of all aspects of ocean and coastal management. She chairs the Secretariat of the Ocean Governance Study Group and has written many articles and books on coastal and ocean governance; most recently, *Integrated Coastal and Ocean Management: Concepts and Practices* (1998), and *The Future of U.S. Ocean Policy: Choices for the New Century* (1999).

Among her current advisory positions, she is a consultant to the United Nations (UNESCO), the World Bank, the Inter-American Development Bank, and NOAA, and serves on the Marine Board, National Research Council, and the Department of Interior's Scientific Committee on the Outer Continental Shelf. She has a PhD in political science from UCLA and has done postdoctoral work at Harvard University.

Sarah Cooksey

Sarah Cooksey is an Environmental Program Administrator for the State of Delaware's Coastal Management Programs. Since 1992, Ms. Cooksey has been responsible for ensuring that federal and state actions are consistent with state policies to provide reasonable growth and development while conserving and protecting Delaware's irreplaceable coastal resources. She utilizes Delaware's National Estuarine Research Reserve as a field site to implement research and education to better coastal management. She was recently elected by her peers to serve as Chair of the Coastal States Organization. CSO represents Governors of coastal states, islands and territories on important coastal issues.

Prior to working for the State of Delaware, Sarah worked at the United States Environmental Protection Agency in Washington, D.C. At EPA she worked on industrial and municipal National Pollution Discharge Elimination System permits, specializing in water quality based effluent controls. Sarah has a Masters Degree in Biology from Towson State University. She is married, has two young sons and enjoys spending time with her family at the beach and in the garden.

Thomas J. Culliton

Thomas J. Culliton is a Physical Scientist in the Special Projects Office of NOAA's National Ocean Service. Mr. Culliton has led or participated primarily on marine assessment, marine monitoring and integrated coastal management projects during his 14-year tenure at NOAA. He has also worked extensively on planning activities associated with NOAA's National Marine Sanctuary Program. He has authored several papers related to population and development in coastal areas. He holds both an MA in geography and a BS in physical geography from the University of Maryland.

Richard Delaney

Richard Delaney is the Director of the Urban Harbors Institute. The Institute was founded in 1989 at the University of Massachusetts, Boston. It is a public policy and scientific research institute dedicated to public service, research and education. The Institute conducts multidisciplinary research on urban harbor planning issues ranging from water quality and coastal resource protection to harbor management and port planning. Previously, Mr. Delaney has

served as President of the Coastal States Organization and as Director of the Massachusetts coastal zone management program.

Rick DeVoe

Rick DeVoe is Executive Director of the South Carolina Sea Grant Consortium, Research Associate of the Belle W. Baruch Institute for Marine Biology and Coastal Research at the University of South Carolina, and Associate Faculty Member of the Graduate Program in Marine Biology at the University of Charleston, S.C. He earned degrees from Fairleigh Dickinson University (B.S. in Marine Biology), CUNY / City College of New York (M.S. in Biological Oceanography), and the University of Rhode Island (M.M.A. in Marine Affairs).

DeVoe was involved in establishing the agency's programmatic and procedural protocols for administering and managing the Consortium's grant programs. Now, as Consortium Executive Director, he serves as the Principal Investigator for the state Sea Grant Program and other Consortium federal, state and private grants, which totaled more than $4.1 million in FY1998. DeVoe has also published articles on policy and management aspects of marine aquaculture development in South Carolina and the United States, and is currently involved in federal Sea Grant initiatives in marine aquaculture and coastal natural hazards.

Tim Eichenberg

Tim Eichenberg is Program Counsel for the Center for Marine Conservation in Washington D.C. and Co-Chair of the Clean Water Network, a coalition of more than 1000 organizations working to reauthorize the Clean Water Act. He has served as Legal Counsel for the California Coastal Commission, the Environmental Defense Center, and the Marine Law Institute. He has written extensively on ocean and coastal issues, and has lectured at he University of Maine Law School, Golden Gate University Law School, and the Environmental Law Institute. He is a graduate of the Washington University School of Law and Earlham College, and was a Post-Doctoral Fellow in Marine Policy at the Woods Hole Oceanographic Institution. He is a member of the Bar in California and the District of Columbia.

Nancy Foster

Nancy Foster, Ph.D., was recently appointed the Assistant Administrator for Ocean Services and Coastal Zone Management. Prior to that she served as the Deputy Assistant Administrator for the National Marine Fisheries Service (NMFS) in the National Oceanic and Atmospheric Administration, U.S. Department of Commerce. She also served as the Acting Assistant Administrator for Fisheries from January through October 1993.

Dr. Foster received her M.S. in Marine Biology from Texas Christian University and her Ph.D. in Marine Biology from the George Washington University where her doctoral research focused on the ecology and systematics of polychaetous annelids. She began her career with the National Oceanic and Atmospheric Administration in 1977, first with the Office of Research and Development, followed by 9 years as the Deputy Director then Director of the National Marine Sanctuary Program and the National Estuarine Research Reserve Program.

Richard Grainger

Richard Grainger is Chief, Data and Information Service of the Food and Agriculture Organization of the United Nations.

Allen Hammond

Allen Hammond is Senior Scientist and Director of Strategic Analysis at World Resources Institute. His responsibilities include institute-wide leadership for new analytic approaches and for WRI's Communications 2000 effort; he also directs the Strategic Indicator Research Initiative and writes and does research on long term sustainability issues. Prior to his current position, he was director of the WRI Program in Resources and Environmental Information where his responsibilities included oversight of the World Resources series and he leads WRI's policy research on environmental and sustainable development indicators. His WRI publications include Resource Flows: The Material Basis of Industrial Economies; Environmental Indicators; editor-in-chief of World Resources 90-91, 92-93, and 94-95; and editor-in-chief of the Information Please Environmental Almanac for 1992, 1993, and 1994.

Dr. Hammond is an accomplished scientist and science journalist whose experience includes serving as founder and editor of Science 80-Science 86 magazine for the American Association for the Advancement of Science, founding editor of the National Academy of Sciences' Issues in Science and Technology, and research news editor of Science. In addition, he was a broadcaster for CBS radio and is

the author or editor of 9 books and numerous scientific publications. He has won a number of national magazine awards and other journalistic honors. Dr. Hammond has served as a consultant to the White House science office, to several U.S. federal agencies, and to the United Nations. He has degrees from Stanford (in engineering) and Harvard (in applied mathematics).

Marc Hershman

Marc Hershman is a professor and Director of the School of Marine Affairs, University of Washington. His expertise includes business, environmental issues, fisheries, international affairs, and oceanography in a variety of subjects that include coasts, shores and beaches, ocean and coastal development policy, offshore drilling, and ports. His interests include the need to simplify regulation of wetlands; coastal zones; development of wetland mitigation banking and law; and planning and managing coastal resources.

Don Hinrichsen

Don Hinrichsen lives in London and is contributing editor to Amicus Journal and People and the Planet. He is also United Nations consutant specializing in environment and populations issues.

Thomas Hourigan

Thomas Hourigan is the Biodiversity Coordinator at the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS). He has responsibility for both U.S. domestic and international marine biodiversity policy and initiatives, including those under the Convention on Biological Diversity. He is spearheading the development of a NOAA Marine Biodiversity Initiative, including the Aquatic Restoration and Conservation (ARC) Partnership for Marine, Estuarine and Freshwater Living Resources as well as components recently announced by President Clinton as part of the new Lands Legacy Initiative. Before coming to NMFS, Dr. Hourigan was the Senior Policy Advisor for Biodiversity and Climate Change at the U.S. Agency for International Development, where he led the development of the Agency's Biodiversity Policy and Strategy. He received his doctorate from the University of Hawaii working on the ecology of corals and coral reef fishes, followed by postdoctoral research in Antarctica and Japan.

Dosoo Jang

Dosoo Jang is currently a John A. Knauss Marine Policy Sea Grant Fellow at the International Programs Office of the National Ocean Service, NOAA, where he is specializing in international exchanges on coastal management between the United States and Asian nations. Mr. Jang is completing his doctoral degree in marine policy at the University of Delaware on policy issues facing the U.S. marine biotechnology industry. Earlier, he served as Chief Research Assistant, Center for the Study of Marine Policy, University of Delaware. In 1997, Mr. Jang received the Walter B. Jones Memorial and NOAA Excellence Award for "Excellence in Coastal and Marine Graduate Study," and in 1998, he was a consultant for the Intergovernmental Oceanographic Commission in Paris.

Paul L. Kelly

Paul L. Kelly is senior vice president of Rowan Companies, Inc., with responsibility for special projects and government and industry affairs. Rowan is a major provider of international and domestic offshore contract drilling and helicopter services. Through its subsidiary, LeTourneau, Inc., Rowan also operates a mini-steel mill, a manufacturing facility that produces heavy equipment for the mining and timber industries, and a marine division that has built over one-third of the worldwide fleet of mobile offshore jack-up drilling rigs.

Mr. Kelly represents the oil service/supply industry on the U.S. Secretary of Interior's Outer Continental Shelf Policy Committee, serving as chairman of the Committee from 1994 to 1996. He also serves as a member of the U.S. Coast Guard's National Offshore Safety Advisory Committee (NOSAC), which provides advice to the U.S. Department of Transportation on offshore mineral and energy issues. He is a member of the American Petroleum Institute Executive Committee of Exploration Affairs, as well as an advisory member of the executive committee of the Gulf of Mexico Offshore Operators Committee.

Mr. Kelly has written widely on the subject of energy policy and is a member of the Editorial Board of World Oil. He has appeared on behalf of industry in numerous Congressional and federal agency hearings dealing with offshore oil and gas issues. Most recently, during 1997, Mr. Kelly served on an OCS Policy Committee Working Group which produced a report for the Secretary of Interior recommending that an OCS impact assistance and ocean/coastal

resource protection program be added to a revived and enhanced Land and Water Conservation Fund. He represented the offshore petroleum industry on the U.S. Steering Group planning activities related to the UN "1998 International Year of the Ocean." Mr. Kelly holds B.A. (Political Science) and law degrees from Yale University.

Robert W. Knecht

Robert W. Knecht is Professor of Marine Policy in the Graduate College of Marine Studies of the University of Delaware. He is also Co-Director of the Center for the Study of Marine Policy and holds joint appointments in the School of Urban Affairs and Public Policy and in the Department of Political Science. From 1972 to 1980, as Assistant Administrator for NOAA in Coastal Zone Management, he directed the initial implementation of the Federal Coastal Zone Management Program. He has written many articles on national ocean policy.

Ryck Lydecker

Ryck Lydecker is Associate Director for State Affairs for the Boat Owners Association of The United States (BOAT/U.S.), with 500,000 members, the nation's largest organization of recreational boaters. He is also Associate Editor of BOAT/U.S. Magazine, covering boating, fisheries, public policy and marine resource issues.

As a free lance writer he has written about boating, fisheries, marine policy and maritime issues for consumer magazines, trade publications and newspapers for over 20 years. In addition, Lydecker covered boating policy and politics as Washington Correspondent for Boating Industry Magazine for nearly 10 years. Prior to that, he served as Communications Manager for the University of Minnesota Sea Grant Program and was subsequently selected for a three-year assignment to NOAA's National Sea Grant College Program as Director of Communications.

Howard Marlowe

Howard Marlowe is president of Marlowe & Company, a Washington, D.C. public affairs consulting firm. He has 25 years of experience as a lobbyist working with Congress and the executive branch. Founded in 1984, Marlowe & Company provides Washington representation, coalition-building, grassroots lobbying, and public relations services to its clients. One of those clients is the American Coastal Coalition, of which Mr. Marlowe serves as President. The ACC is a national advocacy organization for local governments, business people, property owners and others who live or do business in the coastal regions of the United States.

James F. Murley

James F. Murley has spent his entire professional career working to strengthen local communities. He first joined the Florida Department of Community Affairs in 1983 as its director of Resource Planning and Management. In that position, Jim helped draft and gain passage of Florida's landmark Growth Management Act. In 1987, Jim left DCA to head 1000 Friends of Florida—a nonprofit, public interest group that works to promote sensible planning, economic development and environmental preservation. Jim was lured back to DCA in 1995 by Governor Lawton Chiles who called him a "seasoned leader on growth management issues with nearly two decades of experience under his belt."

While at DCA, Jim oversaw a department with an important mission—to help Floridians create safe, vibrant and sustainable communities. The Department of Community Affairs protects Floridians from natural and man-made disasters, encourages sound land-use planning and environmental protection and promotes a broad spectrum of economic development initiatives which includes involvement with the WAGES Welfare Reform Board.

Jim is a 1974 graduate of George Washington University Law School where he specialized in environmental and land use law. Before coming to Florida, he worked for the National Oceanic and Atmospheric Administration in coastal zone management. In February, Jim will be taking over as interim director of the FAU-FIU Joint Center for Environmental and Urban Problems in Fort Lauderdale, Florida.

Michael Orbach

Michael Orbach is professor of anthropology in the Department of Sociology and Anthropology and senior scientist with the Institute for Coastal and Marine Resources at East Carolina University. His BA in Economics from the University of California at irvine, and his MA and PhD are in Cultural Anthropology from the University of California at San Diego.

From 1976 to 1979 Mike served as social anthropologist and social science advisor to the National Oceanic and Atmospheric Administration in Wash-

ington, D.C. From 1979 to 1982 he was the Associate Director of the Center for Coastal and Marine Studies at the University of California at Santa Cruz, during which time he also served as a member of the scientific and statisitical committee of the Pacific Fisheries management Council. He has been at ECU since 1983.

Mike has worked with coastal and marine policy issues on all coasts of the U.S. and in Alaska, the Pacific and Central America. He has published widely on marine social science topics including fisheries limited entry and effort management, IndoChinese fisherman adaptation, marine mammal-fishery interactions and state, regional and federal fisheries and marine policy including "Hunters, Seamen and Entrepreneurs", an ethnography of the San Diego tuna fishermen published by the University of California Press.

Margaret Podlich

Margaret Podlich is the Director of the BOAT/US Clean Water Trust, a national nonprofit organization promoting environmentally sensitive boating and angling through education. She is also an environmental advisor to the Boat Owners Association of the United States, the largest membership association of recreational boaters nationwide.

During her career, Ms. Podlich has conducted numerous education projects with boaters, at the Trust, and previously at the Center for Marine Conservation, and the Chesapeake Bay foundation. She is a lifelong boater who actively competes at the local, national, and international level in sailboat races.

Shirley A. Pomponi

Shirley A. Pomponi received her Ph.D. in Biological Oceanography in 1977 from the University of Miami, Rosenstiel School of Marine and Atmospheric Science. Since that time, she has conducted research on the systematics, ecology, physiology, and cell biology of marine sponges at the University of Miami, the University of Maryland, and Harbor Branch Oceanographic Institution. She joined Harbor Branch in 1984, and was Group Leader of the Sample Acquisition Program for the SeaPharm Project and then the Division of Biomedical Marine Research. In 1994, she was appointed Director of the Division of Biomedical Marine Research, a multidisciplinary research program for the discovery of novel, marine-derived, biologically-active compounds with therapeutic potential. A major emphasis of her research is on the development of methods for sustainable use of marine resources for drug discovery and development, and in particular, on developing cell lines of bioactive marine invertebrates and determining the role of associated microorganisms in the production of bioactive secondary metabolites.

Pietro Parravano

Pietro Parravano has served as Pacific Coast Federation of Fishermen's Associations (PCFFA) president for the past seven years. His work on behalf of fishing fleets and his work to protect fish stocks and habitat earned him the 1997 "Highliner of the Year" award given each year by National Fisherman magazine. He is an ardent advocate in the U.S. and abroad on behalf of fishing family operations. He served as president of his local that first gained prominence when Half Moon Bay fishermen successfully halted a plan by the Port of Oakland, California and the Army Corps of Engineers to dump dredge spoils in a near shore site off San Mateo County, California that was prime crab and fishing grounds. As a result of these efforts, all dredge materials from San Francisco Bay disposed of in the ocean must be dumped off the shelf at a site in 1200 fathoms, approximately 50 miles west of the Golden Gate.

Alison Rieser

Alison Rieser is Professor of Law at the University of Maine School of Law in Portland, Maine and Director of the School's Marine Law Institute, where she oversees legal and policy research on fisheries management, coastal land and water use, marine biodiversity protection, and international maritime relations. She teaches courses in coastal zone law, marine resources law, environmental law, and law of the sea. Professor Rieser is a consultant to state and federal agencies and faculty advisor to the Ocean and Coastal Law Journal. She is co-author of the leading textbook in coastal and ocean law and has published numerous articles on environmental law and ocean law. Her previous government service includes work with the U.S. Environmental Protection Agency and the National Oceanic and Atmospheric Administration. She spent two years at the Woods Hole Oceanographic Institution as a Research Fellow in marine policy and ocean management before joining the Law School. Her bachelor's degree is from Cornell University and her law degrees from George Washington University and Yale Law School.

Rod Vulovic

Rod Vulovic is a graduate of the University of Belgrade with degrees in mechanical engineering as well as in naval architecture and marine engineering. Mr. Vulovic is Vice President of Sea-Land Service, Inc., responsible for the ocean transportation services. This encompasses all aspects of fleet operations, maintenance repair, crewing, asset acquisitions and chartering for both U.S. flag and foreign flag fleets.

Maureen A. Warren

Maureen A. Warren is a geographer and Branch Chief in the Special Projects Office, National Ocean Service, NOAA, working for over 20 years in the field of coastal and marine resource assessment and management. She has contributed to and coordinated the development of four regional and one national data atlas projects, several management plans for coastal protected areas, and authored or co-authored numerous publications and presentations. Ms. Warren presently supervises a staff of geographers and physical scientists in the Integrated Planning Branch who are involved in the integration of information and resources for planning and decision making, consensus-based design and planning to address coastal resource use issues of national significance, data synthesis and analysis projects related to coastal resource use and resource use conflicts, and use of the Internet as a medium for information dissemination. Ms. Warren holds undergraduate and graduate degrees in geography from the Hunter College, CUNY and the University of Pittsburgh respectfully, and has completed graduate coursework in the doctoral program in geography from the University of Maryland.

Appendix II: Workshop Agenda

Trends and Future Challenges for U.S. National Ocean and Coastal Policy

Friday, January 22, 1999
Hotel Washington
15th St. and Pennsylvania Ave.
Washington, D.C.

8:30 A.M.

Welcome and Introduction
Nancy Foster, NOS/NOAA

8:45 to 10:15

PANEL 1. The Context of the Next Twenty-five years: Continued Economic Globalization, Resource Decline, Population Pressures on the Coast, Changes in Social Values: National and Global Perspectives.

Biliana Cicin-Sain, University of Delaware, Chair

Ocean and Coastal Futures: The Global Context
Allen Hammond, World Resources Institute

Global Trends in Fisheries and Aquaculture
Richard Grainger, Fisheries Department, UN Food and Agriculture Organization

The Coastal Population Explosion
Don Hinrichsen, UN consultant and author

Coastal Megacities and Sea Level Rise
Rosemarie Hinkel, University of Delaware

Trends in U.S. Coastal Regions, 1970-1998
Charles Bookman, Thomas Culliton, and Maureen Warren, National Ocean Service, NOAA

10:15 to 10:30 Coffee Break

10:30 to Noon

PANEL 2. The State of the Coastal and Marine Environments: Trends in Non-point Source Pollution, Habitat, and Biodiversity.

Michael K. Orbach, Duke University, Chair

New Approaches to Environmental Management: Lessons from the Chesapeake Bay
Donald F. Boesch, Center for Environmental Studies, University of Maryland

Perspectives on Marine Water Quality
Tim Eichenberg, Center for Marine Conservation

Conserving Ocean Biodiversity: Trends and Challenges
Thomas Hourigan, National Marine Fisheries Service, NOAA

Global Trends in Marine Protected Areas
Tundi Agardy, Conservation International

Noon to 1:00 Lunch

1:00 to 3:15

PANEL 3. Industry-Driven Changes and Policy Responses

Robert W. Knecht, University of Delaware, Chair

Changing Ship Technology and Port Infrastructure Implications
Rod Vulovic, Sea-Land Service, Inc.

Deepwater Offshore Oil Development: Opportunities and Future Challenges
Paul L. Kelly, Rowan Companies, Inc.

Assessing the Economic Benefits of America's Coastal Regions
Howard Marlowe, American Coastal Coalition

A Profile of Recreational Boating in the United States
Rick Lydecker and Margaret Podlich, Boat Owners Association of the United States (BOAT/US)

Marine Aquaculture in the United States: Current and Future Policy and Management Challenges
M. Richard DeVoe, South Carolina Sea Grant Consortium

Aquaculture in the U.S. Exclusive Economic Zone (EEZ): Legal and Regulatory Concerns
Alison Rieser* and Susan Bunsick**
*University of Maine School of Law, **University of Delaware

The Potential for the Marine Biotechnology Industry
Shirley A. Pomponi, Harbor Branch Oceanographic Institution, Florida

*Challenges Facing the U.S. Commercial Fishing Industry**
Pietro Parravano, Pacific Coast Federation of Fishermen's Associations

3:15 to 3:30 Coffee Break

3:30 to 4:30

PANEL 4. Trends and Future Issues in the Coastal States

Michael K. Orbach, Duke University, Chair

Building Capacity for Ocean Management: Recent Developments in U.S. West Coast States
Marc J. Hershman, School of Marine Affairs, University of Washington

Coastal States' Challenges
Sarah Cooksey, State of Delaware and Chair, Coastal States Organization

Development of a Comprehensive Ocean Policy for Florida
James F. Murley and Laura Cantral, Florida Governor's Ocean Committee

4:30 to 5:00

Summary and Conclusions

Michael K. Orback, Duke University

5:00 to 6:00 Reception

Appendix III: Workshop Participants

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