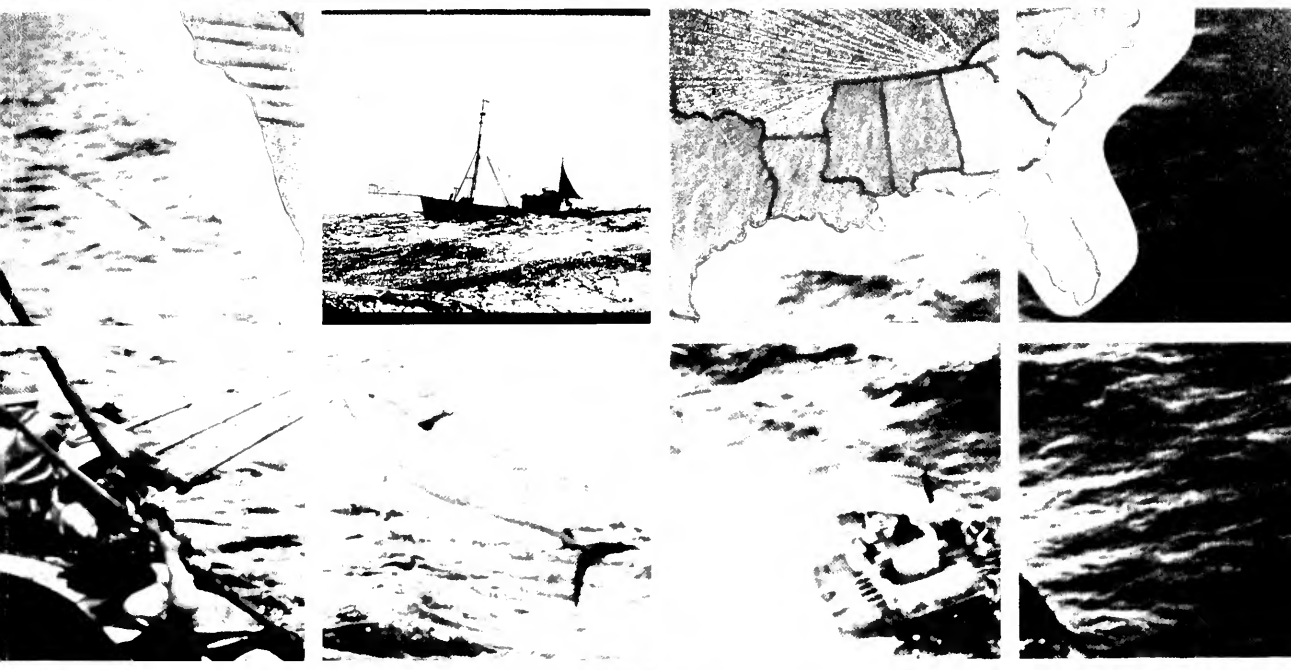


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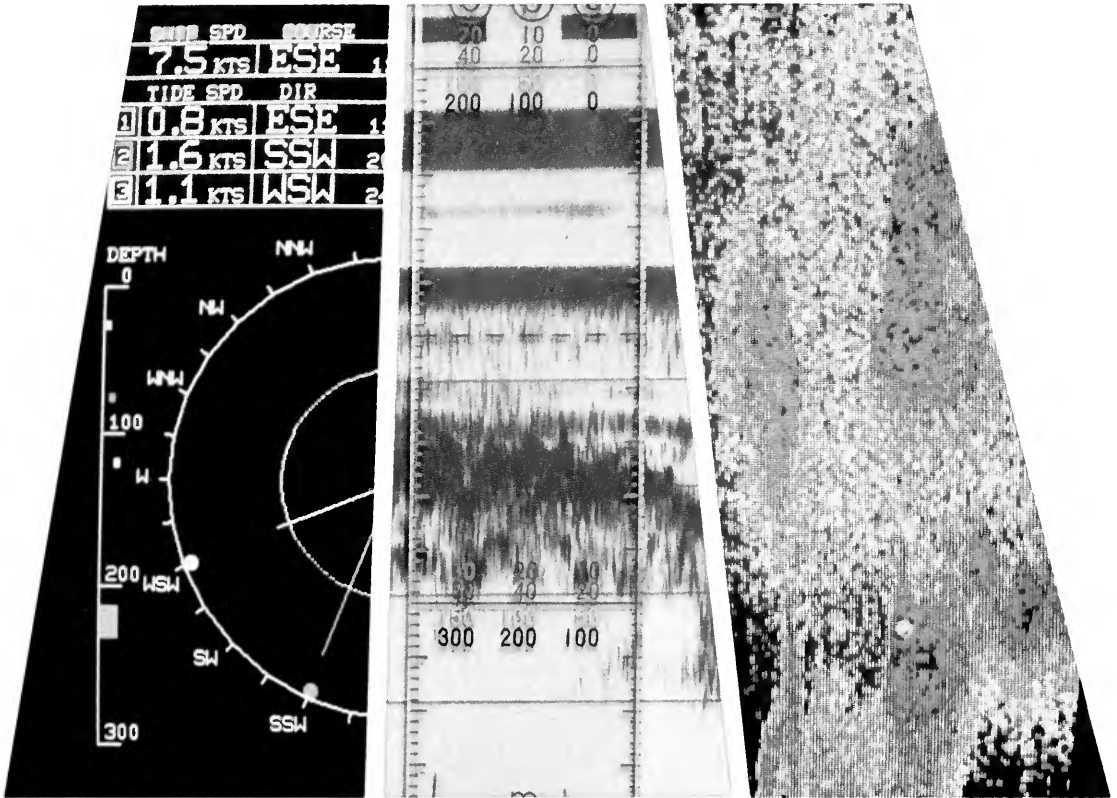
Volume 27, Number 4, Winter 1984/85



## THE EXCLUSIVE ECONOMIC ZONE



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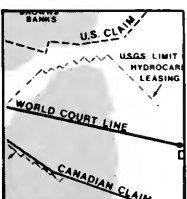
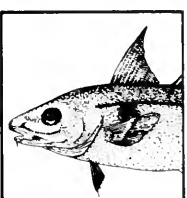




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200 Miles Offshore,  
Claiming Resources**

WASHINGTON, March 10 (Reuters) — President Reagan proclaimed a 200-mile-wide coastal economic zone today in which the United States will exercise exclusive rights over all resources. The proclamation stems from the Reagan Administration's refusal to sign the International Law of the Sea Treaty because of objections to provisions...



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Introduction:

# The Exclusive Economic Zone

*"The significance of the EEZ to the future of our country may well be greater than the 1803 Louisiana Purchase..."* From A Special Report to the President and the Congress by the National Advisory Committee on Oceans and Atmosphere (NACOA), May 1984.

When Napoleon sold the Louisiana Territory to the United States on April 30, 1803, it doubled the size of the country. Many critical questions were raised by the acquisition. The Constitution of our fledgling nation at that time made no provision for a transaction of that nature. But Thomas Jefferson, founder of the Democratic-Republican Party, moved by a tremendous scientific curiosity and looking forward to fruitful commercial exploitation, four months before the purchase had secretly requested that Congress appropriate funds for an exploratory expedition to be led by Meriwether Lewis and William Clark. By late 1803, they were on their way.

When President Reagan proclaimed an Exclusive Economic Zone on March 10, 1983, he established "sovereign rights" over resources and jurisdiction in an area that encompasses some 3.9 billion acres, significantly more than the 2.3 billion land acres of this nation and its territories. The exact size of the EEZ—the authors in this issue vary slightly in their calculations—depends on whether *certain* or *all* Pacific island territories are counted. Many critical questions have been raised by this acquisition. A number of the more important ones are addressed in this special issue, which is devoted to an examination of the principal options available to the United States in implementing its EEZ. But it is at this point that the analogy to the Louisiana Purchase ends. In the nearly two years since Reagan's Proclamation, there has been no executive decree to explore this vast, watery wilderness of which we know relatively little. For example, in terms of oil and gas resources, only 3 percent of the newly acquired area has been explored.

Jefferson's scientific curiosity about the area of the Louisiana Purchase is evident in his written instructions to Lewis, who was then secretary to the President: "The object of your mission is to explore the Missouri River, and such principal stream of it, as, by its course and communication with the water of the Pacific Ocean may offer the most direct and practicable water communication across the continent, for the purpose of commerce..."

"Your observations are to be taken with great pains and accuracy, to be entered distinctly and intelligibly for others as well as yourself to comprehend all the elements necessary, with the aid

of the usual tables to fix the latitude and longitude of the places at which they were taken, and are to be rendered to the War Office. . .

"Other objects worthy of notice will be: the soil and face of the country, its growth and vegetable productions, especially those not of the U.S.; the animals of the country generally, and especially those not known in the U.S.; the remains and accounts of any which may be deemed rare or extinct; the mineral productions of every kind; . . . ; volcanic appearances; climate as characterized by the thermometer, by the proportion of rainy, cloudy, and clear days, by lightning, hail, snow, ice, by the access and recess of frost, by the winds, prevailing at different seasons; the dates at which particular plants put forth or lose their flowers, or leaf; times of appearance of particular birds, reptiles, or insects."

## Announcements

*On the theory that two heads are better than one, I invited Professor Michael Champ to be co-editor of this special issue on the Exclusive Economic Zone. He provided a great deal of help in the organization of the issue and in the editing process. In addition to being an advisor to the Australian government on marine pollution matters, Professor Champ is in the Biology Department of American University in Washington, D.C., and a Science Advisor in the Office of Policy, Planning, and Evaluation at the U.S. Environmental Protection Agency. He also is a former Resident Scholar in the Ocean Assessments Division of the National Oceanic and Atmospheric Administration. Recently, he chaired the Oceans '84 symposium in our nation's capital on the Exclusive Economic Zone, a conference that was supported by the Marine Technology Society and the Institute of Electrical and Electronics Engineers, Council on Oceanic Engineering.*

*The Woods Hole Oceanographic Institution and the editors of Oceanus also would like to thank the Alfred P. Sloan Foundation for its generous support of this issue.*

—PRR

In NACOA's report to the President, cited at the beginning of this Introduction, there is a passionless appeal for expeditions in the Lewis and Clark tradition: "It seems reasonable that a vigorous national program of ocean exploration and research concerning the EEZ and its resources should be undertaken to provide a solid background of knowledge upon which to base appropriate future EEZ legislation." It seems *imperative*, to this writer, that exploration and research concerning the EEZ *must* be undertaken to *satisfy the scientific curiosity and needs of our nation*.

The oceans have never had a popular constituency. Fish and hydrocarbons don't vote and so are of little interest to politicians. It is the lobbying special interest groups (such as fishermen's associations and oil and gas consortiums) and Congressional legislators from coastal states that shape our national ocean policy. The new EEZ is an opportunity to make this system more equitable. To borrow an old idea from ocean philosophers, the area of the EEZ (extending from the edge of the 3-mile territorial sea out to 200 nautical miles seaward of the coastal baseline) is the common heritage of *all* Americans, not just those with vested interests or who live in coastal areas.

It is evident from the articles in this issue—Robert Knecht and Thomas Kitsos suggest a second Stratton Commission; and Lewis Alexander and Lynne Hanson propose regionalization of the EEZ—that something is missing from the deliberations to date on the Exclusive Economic Zone. We have not put our finger on the type of leadership needed to guide our nation in the tricky currents emanating from the combination of our refusal to become a party to the Law of the Sea (LOS) Convention and our desire to still conduct our maritime activities in a manner consistent with the majority of the LOS Convention provisions.

A second Stratton Commission could work if the chairman was someone of former Vice President Hubert Humphrey's caliber. (His dynamic leadership, coupled with his scientific curiosity, led to the success of the first Stratton Commission, the report of which—entitled *Our Nation and the Sea*—has had lasting influences on ocean affairs.) Another mechanism might be to establish a separate federal agency to handle EEZ affairs. Still a third idea would be to elect or appoint a governor for the area, although the former would presumably require a

change in the Constitution. Whatever the leadership structure, there is an overriding need to get on with the "10-year 'expedition' of research, exploration, and survey of our EEZ" proposed by NACOA.

The reader will certainly find a diversity of views in this issue of *Oceanus*. That is as it should be. Many of the articles stem from papers and debate at the Oceans '84 symposium on the Exclusive Economic Zone. For example, Martin Belsky, a professor of law at the University of Florida, argues against a regionalization of the EEZ because it might be interpreted by foreign nations as a zoning system that restricts navigation. He favors national over regional governance for the EEZ. Baruch Boxer, a professor at Rutgers, speaks to the need for a comprehensive program of marine research in the EEZ to monitor pollution. He fears that jurisdictional issues are dominating the formulation of ocean policy and states that marine pollution research must play an equal role in guiding ocean use.

It might seem to the reader of this issue that the United States has only three boundaries with other countries—Canada, Mexico, and the Soviet Union. In fact, the EEZ and the Magnuson Fishery Conservation and Management Act of 1976 put us in cartographic touch with some 20 other nations. Among them are Cuba, the Bahamas, the Dominican Republic, Venezuela, the British Virgin Islands, St. Christopher-Nevis-Anguilla (Britain), the Netherlands Antilles, the Federated States of Micronesia, the Marshall Islands, Japan, Tonga, Western Samoa, New Zealand (Cook Islands and Nive), Tokelau, and Kiribati.

Surely, it is equally as important to explore our own planet as to explore others. If we can walk on the barren moon, we should be able to take one small step on the bottom of the Mariana Trench, which is the deepest part of the ocean and within the U.S. EEZ. Do we always need to be prodded by the Soviets to set significant scientific goals? The exploration of the EEZ might just be the equal of NASA's now famous Apollo program. I close with this thought of Jefferson's, contained in a letter to William Mumford (1799): "*It is impossible for a man who takes a survey of what is already known not to see what an immensity in every branch of science yet remains to be discovered.*"

**Paul R. Ryan**  
**Editor, *Oceanus*,**  
**Woods Hole Oceanographic Institution**



Proclamation 5030 of March 10, 1983

# Exclusive Economic Zone of the United States of America

By the President of the United States of America

## A Proclamation

WHEREAS the Government of the United States of America desires to facilitate the wise development and use of the oceans consistent with international law;

WHEREAS international law recognizes that, in a zone beyond its territory and adjacent to its territorial sea, known as the Exclusive Economic Zone, a coastal State may assert certain sovereign rights over natural resources and related jurisdiction; and

WHEREAS the establishment of an exclusive Economic Zone by the United States will advance the development of ocean resources and promote the protection of the marine environment, while not affecting other lawful uses of the zone, including the freedoms of navigation and overflight, by other States;

NOW, THEREFORE, I, RONALD REAGAN, by the authority vested in me as President by the Constitution and laws of the United States of America, do hereby proclaim the sovereign rights and jurisdiction of the United States of America and confirm also the rights and freedoms of all States within an Exclusive Economic Zone, as described herein.

The Exclusive Economic Zone of the United States is a zone contiguous to the territorial sea, including zones contiguous to the territorial sea of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands (to the extent consistent with the Covenant and the United Nations Trusteeship Agreement), and United States overseas territories and possessions. The Exclusive Economic Zone extends to a distance 200 nautical miles from the baseline from which the breadth of the territorial sea is measured. In cases where the maritime boundary with a neighboring State remains to be determined, the boundary of the Exclusive Economic Zone shall be determined by the United States and other State concerned in accordance with equitable principles.

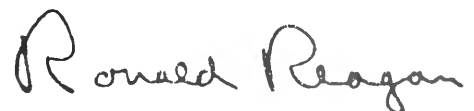
Within the Exclusive Economic Zone, the United States has, to the extent permitted by international law, (a) sovereign rights for the purpose of exploring, exploiting, conserving and managing natural resources, both living and non-living, of the seabed and subsoil and the superjacent waters and with regard to other activities for the economic exploitation and exploration of the zone, such as the production of energy from the water, currents and winds; and (b) jurisdiction with regard to the establishment and use of artificial islands, and installations and structures having economic purposes, and the protection and preservation of the marine environment.

This Proclamation does not change existing United States policies concerning the continental shelf, marine mammals and fisheries, including highly migratory species of tuna which are not subject to United States jurisdiction and require international agreements for effective management.

The United States will exercise these sovereign rights and jurisdiction in accordance with the rules of international law.

Without prejudice to the sovereign rights and jurisdiction of the United States, the Exclusive Economic Zone remains an area beyond the territory and territorial sea of the United States in which all States enjoy the high seas freedoms of navigation, overflight, the laying of submarine cables and pipelines, and other internationally lawful uses of the sea.

IN WITNESS WHEREOF, I have hereunto set my hand this tenth day of March, in the year of our Lord nineteen hundred and eighty-three, and of the Independence of the United States of America the two hundred and seventh.



Ronald Reagan

# Statement by the President On the Exclusive Economic Zone of the United States (March 10, 1983)

The United States has long been a leader in developing customary and conventional law of the sea. Our objectives have consistently been to provide a legal order that will, among other things, facilitate peaceful, international uses of the oceans and provide for equitable and effective management and conservation of marine resources. The United States also recognizes that all nations have an interest in these issues.

Last July I announced that the United States will not sign the United Nations Law of the Sea Convention that was opened for signature on December 10. We have taken this step because several major problems in the Convention's deep seabed mining provisions are contrary to the interests and principles of industrialized nations and would not help attain the aspirations of developing countries.

The United States does not stand alone in those concerns. Some important allies and friends have not signed the Convention. Even some signatory States have raised concerns about these problems.

However, the Convention also contains provisions with respect to traditional uses of the oceans which generally confirm existing maritime law and practice and fairly balance the interests of all States.

Today I am announcing three decisions to promote and protect the oceans interests of the United States in a manner consistent with those fair and balanced results in the Convention and international law.

First, the United States is prepared to accept and act in accordance with the balance of interests relating to traditional uses of the oceans—such as navigation and overflight. In this respect, the United States will recognize the rights of other States in the waters off their coasts, as reflected in the Convention, so long as the rights and freedoms of the United States and others under international law are recognized by such coastal States.

Second, the United States will exercise and assert its navigation and overflight rights and freedoms on a worldwide basis in a manner that is consistent with the balance of interests reflected in the Convention. The United States will not, however, acquiesce in unilateral acts of other States designed to restrict the rights and freedoms of the international community in navigation and overflight and other related high seas uses.

Third, I am proclaiming today an Exclusive Economic Zone in which the United States will exercise sovereign rights in living and non-living resources within 200 nautical miles of its coast. This will provide United States jurisdiction for mineral resources out to 200 nautical miles that are not on the continental shelf. Recently discovered deposits there could be an important future source of strategic minerals.

Within this Zone all nations will continue to enjoy the high seas rights and freedoms that are not resource-related, including the freedoms of navigation and overflight. My Proclamation does not change existing United States policies concerning the continental shelf, marine mammals and fisheries, including highly migratory species of tuna which are not subject to United States jurisdiction. The United States will continue efforts to achieve international agreements for the effective management of these species. The Proclamation also reinforces this government's policy of promoting the United States fishing industry.

While international law provides for a right of jurisdiction over marine scientific research within such a zone, the Proclamation does not assert this right. I have elected not to do so because of the United States interest in encouraging marine scientific research and avoiding any unnecessary burdens. The United States will nevertheless recognize the right of other coastal States to exercise jurisdiction over marine scientific research within 200 nautical miles of their coasts, if that jurisdiction is exercised reasonably in a manner consistent with international law.

The Exclusive Economic Zone established today will also enable the United States to take limited additional steps to protect the marine environment. In this connection, the United States will continue to work through the International Maritime Organization and other appropriate international organizations to develop uniform international measures for the protection of the marine environment while imposing no unreasonable burdens on commercial shipping.

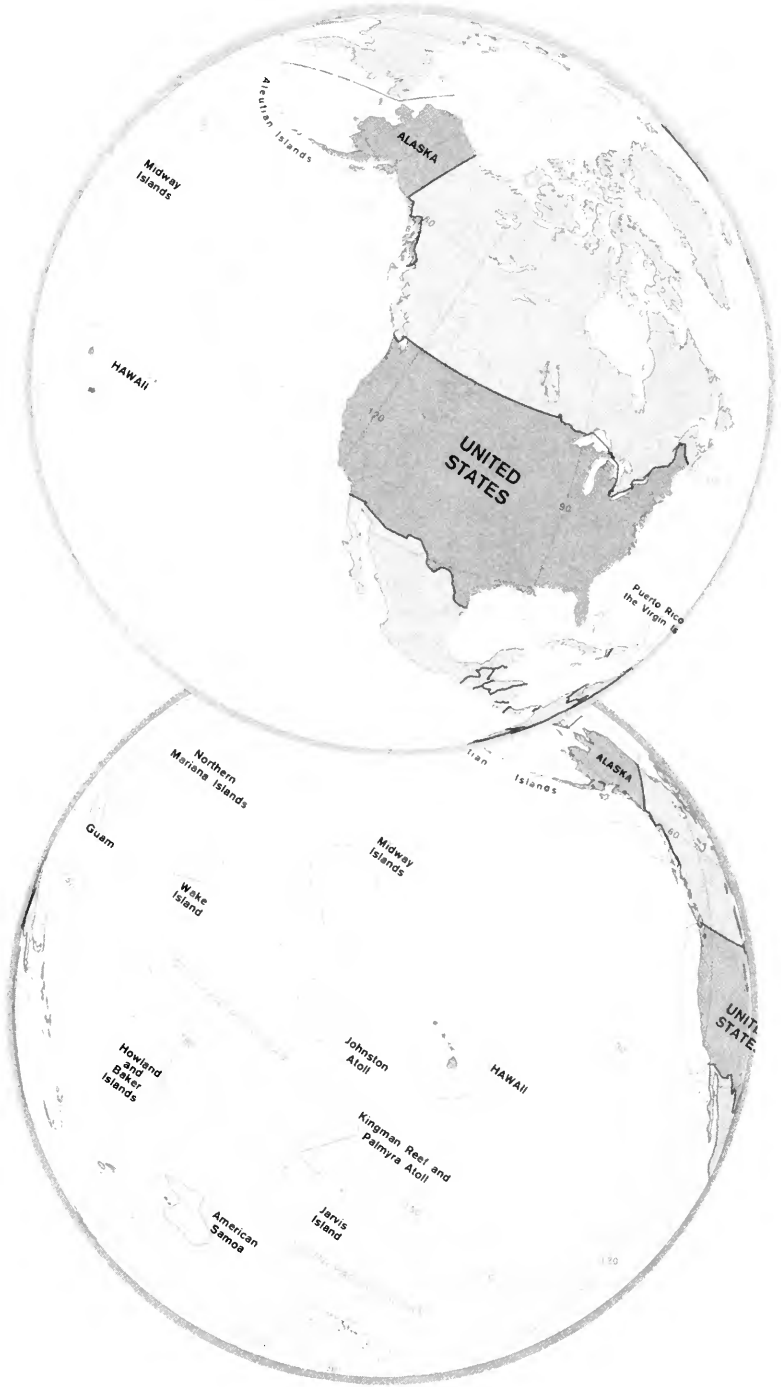
The policy decisions I am announcing today will not affect the application of existing United States law concerning the high seas or existing authorities of any United States government agency.

In addition to the above policy steps, the United States will continue to work with other countries to develop a regime, free of unnecessary political and economic restraints, for mining deep seabed minerals beyond national jurisdiction. Deep seabed mining remains a lawful exercise of the freedom of the high seas open to all nations. The United States will continue to allow its firms to explore for and, when market permits, exploit these resources.

The Administration looks forward to working with the Congress on legislation to implement these new policies.

# Regionalizing the U.S. EEZ

by Lewis M. Alexander and Lynne Carter Hanson



The U.S. Exclusive Economic Zone.

The United States has the largest Exclusive Economic Zone (EEZ) of any nation. It measures about 2.3 million square nautical miles—more than three-quarters the size of the U.S. land area. This sprawling 200-mile-wide belt includes the Arctic waters off northern Alaska, the coral reefs of Hawaii, and the fishing grounds of Georges Bank—a huge territory extremely diverse in ecology and resources.

Managing this enormous area is not a simple matter, considering the types and number of activities that would be affected, the levels of government responsible for carrying out management functions, and the nature and extent of scientific data needed for effective management. In the Exclusive Economic Zone, we encounter some of the same issues of federalism that exist for the U.S. land area. How do we, on the one hand, ensure that uniform rules and regulations prevail throughout the EEZ, when these are required, and at the same time allow, where appropriate, local and regional variations?

One method for coping with geographic variations in the EEZ would be to give coastal states greater offshore jurisdiction at the expense of the federally-controlled EEZ. The states would, presumably, be compelled to manage their portions of the EEZ within the framework of certain federally-mandated guidelines. But both Congress and the executive branch have tended to be wary of this approach, as evidenced by the “Tidelands” controversies some years ago (see box, page 12). One argument against this state-centered concept is the inequality of state access to the EEZ, as there are inland and coastal states. More than half the states have no access whatever. Historically, out to the three-mile limit coastal states have jurisdiction; beyond that, the federal government (and thus, all Americans) controls the territory to the 200-mile limit. Of the 23 states that do border the ocean, a few, such as Alaska, Hawaii, and California, have large EEZ areas. But the state of Connecticut is zone-locked, and New Hampshire, Rhode Island, Delaware, Mississippi, and Alabama have extremely short coastlines, leaving only 17 states that really could benefit from extending their jurisdictions out into the EEZ.

A possible compromise between federal and coastal-state management is regionalization of those activities that directly involve coastal states. This process already has been put into effect by the National Marine Fisheries Service (NMFS) of the National Oceanic and Atmospheric Administration (NOAA). Through the Magnuson Fisheries Conservation and Management Act (MFCMA),\* eight regional fisheries-management councils were established (New England, Mid-Atlantic, South Atlantic, Gulf of Mexico, Caribbean, Pacific, North Pacific, and Western Pacific).

There is considerable debate over the effectiveness of these councils. Much of the debate revolves around the operating characteristics of the

individual councils, however, rather than the regional concept itself or the division of the 200-mile zone into the eight sectors legislated in the MFCMA.

### Unity and Diversity in the EEZ

A wide variety of activities takes place in the EEZ beyond the limits of the three-mile territorial sea (see map page 15, box pages 16 and 17). Two aspects are important here: In what ways do the activities conflict with one another? Which activities exhibit sufficiently strong regional differences that they should be managed regionally?

It is necessary to distinguish among certain types of management. One is management of a fairly uniform system of activities, where regional units are established largely for the sake of efficiency, as is the case for the U.S. Navy, Coast Guard, and Army Corps of Engineers. In each of these organizations, the geographic units are basically tools for organizing fairly uniform responsibilities. The same response to events taking place in the EEZ—the same form of “management”—would presumably prevail within all areas of the EEZ for activities that are not strictly coastal issues.

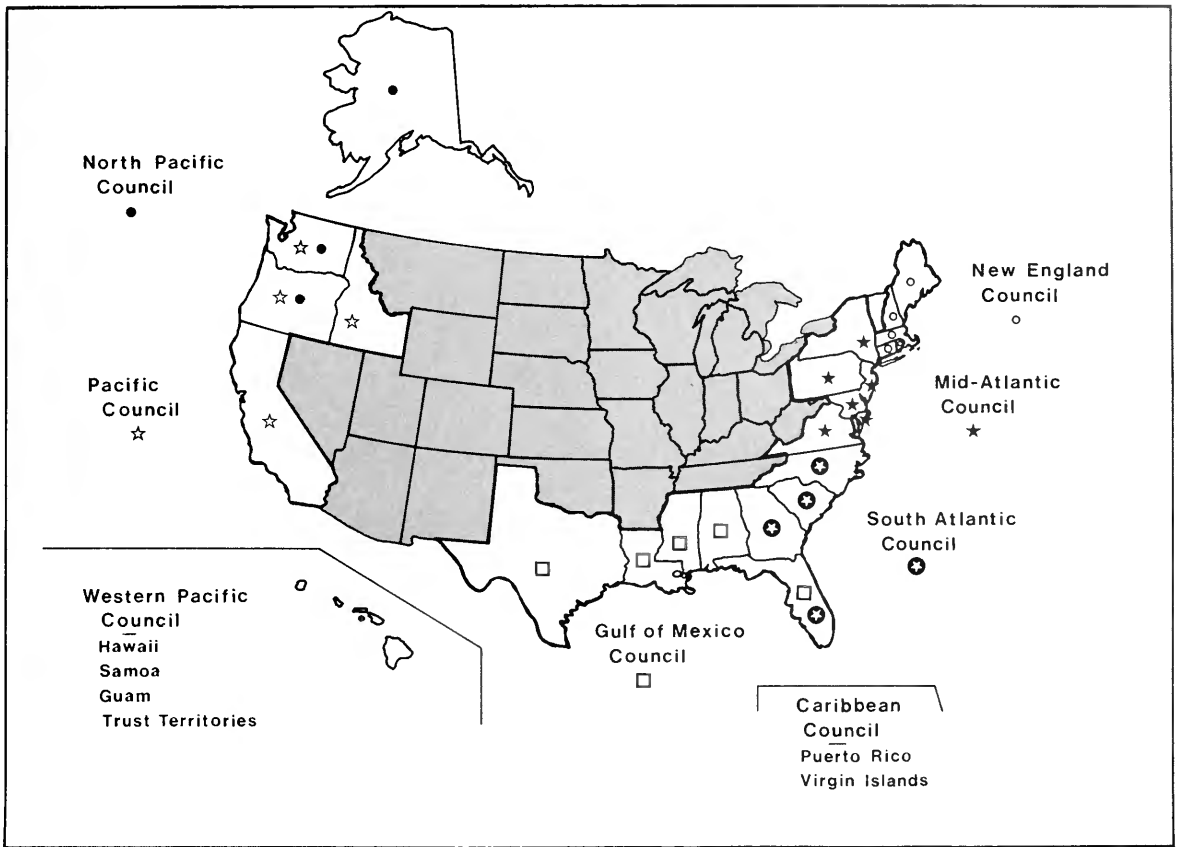
A second management style responds to regional differences—management is tailored to provide for these differences. Such is the case with the regional fisheries management councils and also might be true for managing ocean dumping or marine recreation in the EEZ. Where there is intense activity, as off the Middle Atlantic states, procedures transcending state jurisdictional limits might have to be adopted. Such procedures might not be needed in less heavily used areas, as off Oregon or northern California.

A third type of management is what we shall term “conflict avoidance.” This is very much a regional phenomenon. Think of the problems of conflicting uses the Coast Guard and other agencies must resolve in the stretch of EEZ between Norfolk, Virginia, and Cape Cod, Massachusetts, and compare them to the problems of conflict avoidance off Alaska: two very different regions with different, though equally pressing, use-conflicts to be resolved or avoided. Accommodation of conflicting uses in the EEZ beyond the limits of state jurisdiction is an issue that we feel has not been sufficiently addressed at the federal level.

### Regional Concept Issues

Geographers, planners, managers, and others have long employed regionalization. Geographers look for order in the immense variabilities of the Earth's surface; in this pursuit they establish conceptual regions—climatic, economic, demographic, and so forth—characterized by some common trait, such as little precipitation or high per-capita economic production. The regions' boundaries may be indistinct, as one characteristic shades into another. One advantage of the regional approach involves data management. How much more beneficial it often is to collect and assess data on New England

\*Magnuson Fisheries Conservation and Management Act (1976), 16 U.S.C. 1801.



The eight fisheries management councils established under the Magnuson Fisheries Conservation and Management Act might serve as a pattern for regional organization of the Exclusive Economic Zone.

or the Southeast, rather than relying on state-by-state information.

Planners and managers also are interested in characteristics that set one region apart from another. The regional concept may help balance inequalities, such as conditions of access to the sea and its resources. It also can help managers coordinate plans and programs with one another in areas that should be managed as complete ecosystems, a process relevant to coastal zone management programs in such "regions" as the Chesapeake and Delaware bays.

Let us note a few problems associated with regional management. If we establish regional units, will regional authorities have any real input in decision making, compared with state and federal officials? How many management units should there be, and where would lie the boundaries between these units? Additional funding would be required for new organizational bodies. How will the benefits and costs associated with regional activities be equitably allocated? It is easy to make sweeping recommendations for regional action, without facing the new and perhaps unwarranted problems which such action may entail.

### Management Units for the EEZ

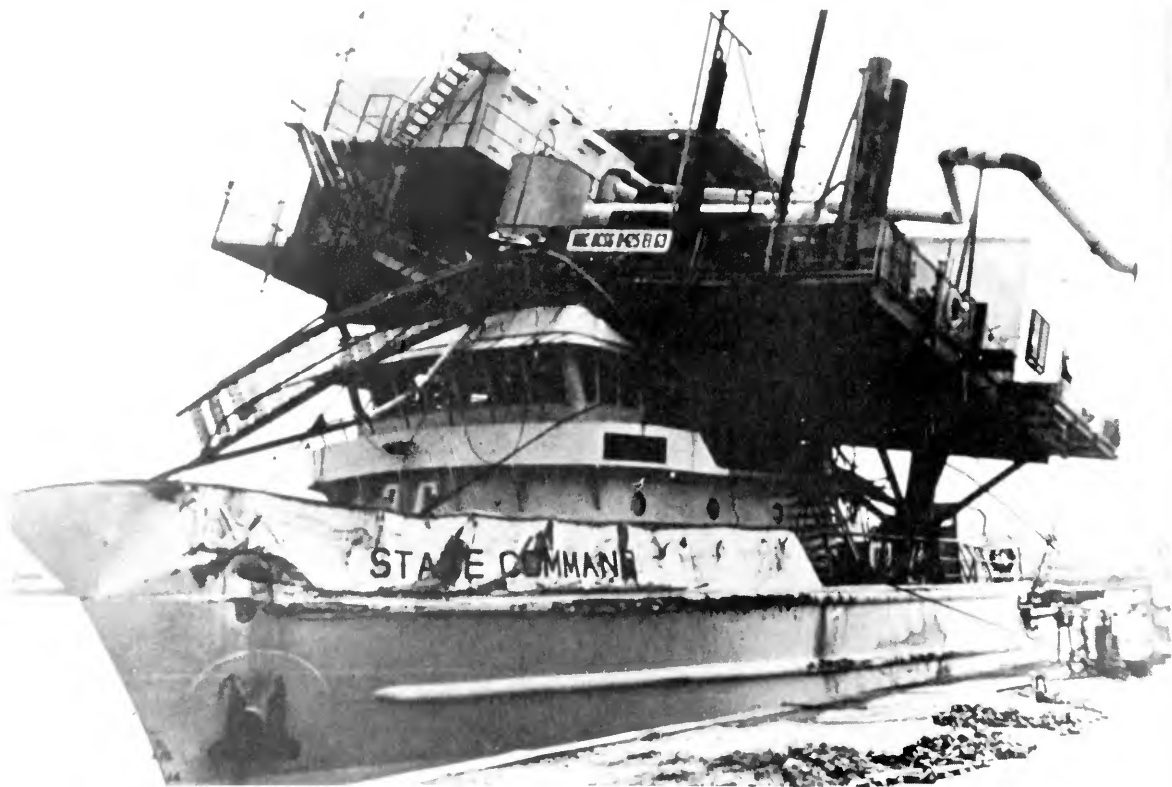
For the time being, we suggest that the geographic extent of EEZ management units be the same as

those assigned to the eight regional fisheries-management councils, to expedite implementation and to take advantage of already well-established regional divisions. This may cause difficulties for some federal agencies, such as the Coast Guard and the Environmental Protection Agency (which are quite concerned with activities in the EEZ), but treating the Economic Zone in terms of these eight regions could become a long-term goal for these agencies.

Having considered the geographic character of the EEZ regional management units, the next question is: Which EEZ activities have sufficient regional variation to warrant separate management bodies? (See Table 1.) Passing over commercial fisheries, we suggest that ocean dumping should be a regionally-oriented activity carried out within the

Table 1. Activities that lend themselves to regionalization because of their area-specific natures:

● Fisheries
● Ocean dumping
● Marine recreation
● Multiple resource use
● Data management
● Pollution control
● Construction of offshore facilities
● Navigational aids
● Super ports



*Use conflict can get physical: an oil rig decapitated by a fishing vessel.*

overall federal guidelines. There should be opportunity for regional as well as state input into decisions affecting sludge sites, disposal of dredge spoils beyond states' jurisdictional boundaries, disposal of unused ammunition, military hardware, and so forth. Also, at-sea incineration seems to be a regional issue (Table 2).

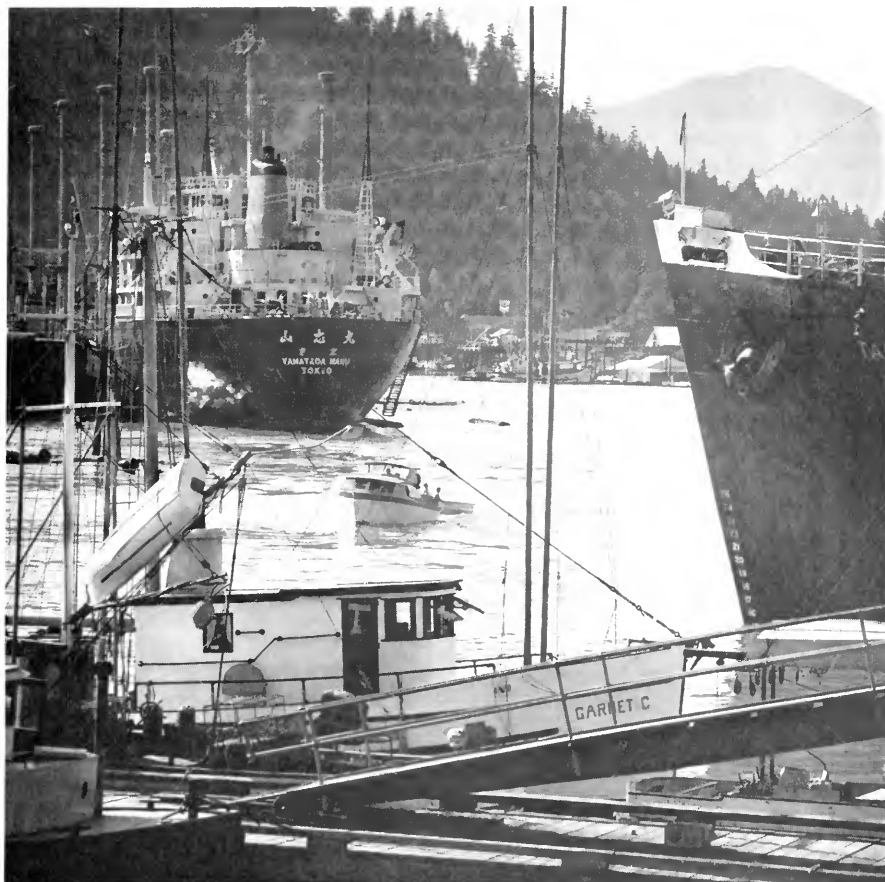
Use of the EEZ for recreation is a regionally-oriented activity, particularly in relatively congested areas, such as southeastern New England and the New York Bight. In these areas, problems of pleasure boating, sport fishing, scuba diving, and other recreational activities are prominent in the

Table 2. Responsibilities in the U.S. EEZ: Should they be borne by the states, the federal government, or by regional organizations? A plus sign indicates a positive ability by that level of organization; a minus sign indicates a negative level of ability in that area.

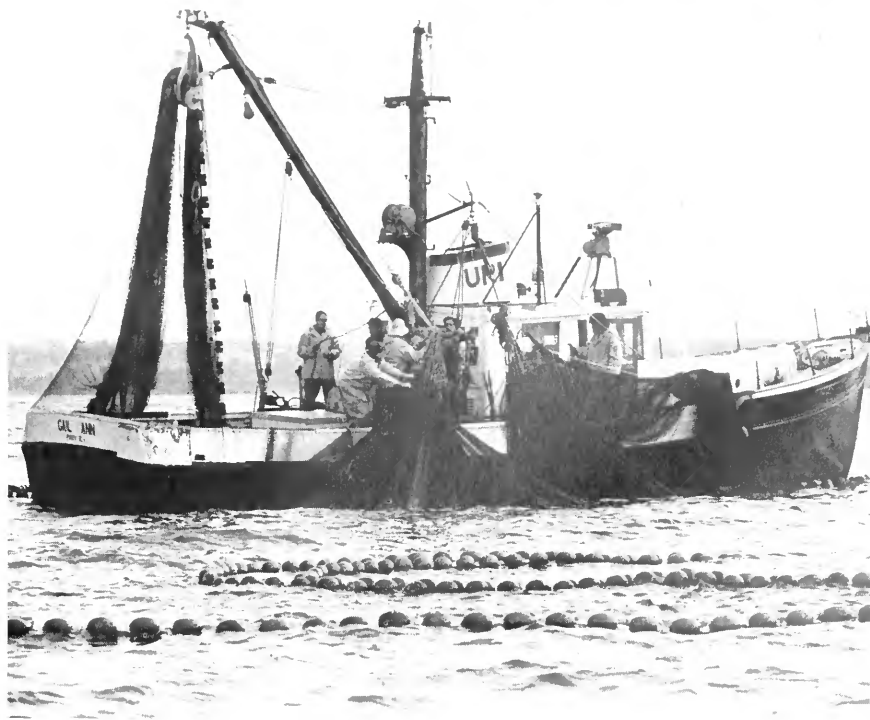
Issue	State	Federal	Regional
1. Communication efficiency	-	-	+
2. Resolution of inequalities	-	+	+
3. Recognize regional differences	-	-	+
4. Encourage public participation	+	-	+
5. Collect comparable data	-	+	+
6. Implement recommendations (i.e., enact legislation)	-	+	-
7. Encourage conflict avoidance (i.e., compromise)	+	-	+

landward portions of the EEZ. Regional management groups could coordinate the work of individual states, and assume some responsibilities for areas seaward of state jurisdictional units.

Finally, we recommend that some thought be given to regional management of the seabed, again particularly in heavily-used areas beyond the limits of state jurisdiction. With new technologies and new economic opportunities, a whole host of innovative uses is gradually evolving for the shallower parts of the continental shelf—underwater restaurants, oil storage facilities, aquaculture sites, marine parks, and perhaps, some day, underwater power plants. One often hears the term "sea use planning." Before long, the United States may need both planning and standard setting (such as the establishment of discharge limits for



*A busy day in the port of Wrangell, Alaska. As ocean use grows, conflicts between recreation, fishing, oil and gas exploration, and trade are likely to increase, requiring an ocean management system both reasonably consistent and responsive to the needs of the ocean users. (Photo by Martin Litton, Photo Researchers, PR)*



*Working the nets aboard the University of Rhode Island fishing vessel, Gail Ann. (From Hanson and Alexander, Resource Use and Use Conflicts in the Exclusive Economic Zone)*

## Tidelands Controversy

Until the 1930s, both the U.S. federal and state governments assumed that the territorial sea was under state jurisdiction as opposed to federal control. Submerged lands and their natural resources belonged to the states.

By 1937, the Roosevelt Administration had begun a campaign to replace state with federal authority in relation to submerged lands and offshore oil and gas. Much of the initial interest came from the desire for oil and gas revenues on the part of the federal government, but a wide variety of interest groups quickly became involved in what was called the "Tidelands Controversy." World War II intervened, delaying decision on this issue.

In 1947, in *United States v. California*, the Supreme Court decided that the states do not own the submerged lands of the territorial sea and that

the federal government has full authority over these resources. The same decision was held in the *United States v. Texas* and the *United States v. Louisiana* cases, both in 1950.

By the 1952 Presidential campaign, the issue of state versus federal control of offshore lands and resources was important. Dwight Eisenhower strongly supported state ownership while Adlai Stevenson was strongly opposed. The issue was finally resolved when President Eisenhower signed the Submerged Lands Act of 1953. In that act, the coastal states retained most, if not all, of the authority they had enjoyed prior to the debate.

For more information see: E. R. Bartley, 1953. *The Tidelands Oil Controversy*. Austin: University of Texas Press. 1953.

offshore oil and gas operations), as well as enforcement for seabed use in certain parts of the EEZ.

Our final regional management category for the EEZ is conflict avoidance among users. One can easily reel off potential conflicts, such as between recreational and commercial vessels or fishermen, between petroleum installations on the shelf and the interests of environmental groups, and between the military, which blocks off certain EEZ areas for its own requirements, and other users of the EEZ. But merely listing the potentialities does not get down to the heart of the issue. In what specific areas, and in what specific forms, are conflicts occurring or likely to occur? By what means will choices be made? Who keeps records of existing or potential conflicts? What are the costs of accommodation? These are concrete issues facing us as we make more and more use of our EEZ. (See Table 2, page 10.)

What we suggest is the creation of eight regional "conflict-avoidance" councils, composed of representatives of the various federal agencies concerned, representatives of the coastal states of the region, and—as in the case of the fisheries councils—selected persons from the private sector. The councils would be largely advisory in nature, at least in their initial stage, and each would be responsible for developing plans to accommodate conflicting interests in its region of the EEZ and for recommending standards (consistent with federal regulations) for such things as vessel discharge limits. In time, the councils' responsibilities might be expanded to include investigatory activities when use-conflicts outside the jurisdiction of any single agency either occur or appear imminent.

What would be the Washington base for these councils? Who would coordinate their activities and provide funding? Any one of a number of agencies could assume the task—

Transportation, Interior, perhaps NOAA through its Sea Grant Program. We like the idea of an interagency EEZ management commission or council, under whose aegis the regional councils could be placed. But we are not, especially considering the present political climate, arguing governmental reorganizations and expansions. Our goal is to point out the regional nature of many EEZ management problems, and to suggest that regionalization, in one form or another, may be a viable way out of the federal/state management dilemma in the Exclusive Economic Zone.

Lewis M. Alexander, formerly Geographer of the U.S. State Department, is Professor of Geography and Marine Affairs at the University of Rhode Island, as well as Director of the University's Center for Ocean Management Studies (COMS). Lynne Carter Hanson is executive Director of COMS.

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# Multiple-Use Management in the EEZ

by Robert W. Knecht  
and Thomas R. Kitsos

It has been more than a year and a half since the President established the Exclusive Economic Zone (EEZ) for the United States. Although Proclamation No. 5030 of 10 March 1983 practically doubled U.S. jurisdiction (from some 2.3 billion land acres to about 4 billion acres in total), it certainly has not seemed a sexy public policy issue to the media or the public. To date, it has been largely a matter of interest to a small core of people inside the Washington, D.C., beltway. In other words, the EEZ doesn't play in Peoria.

Yet, the EEZ Proclamation remains an important and challenging step taken by the U.S. government, one that will require imaginative and innovative management solutions to multiple-use problems.

## Like a Spider's Web

Oceans policy covers a broad range of interests and activities. It involves a complex web of issues that vary over different areas and among different activities within each area. In the past, the basic issues of oceans policy have boiled down to three core questions. First, what rules will govern a particular activity; second, who will establish these rules; and third, who will enforce them? Now, a fourth question is necessary: In what zone in the ocean is the activity being conducted? (See map page 15)

These four core questions, then, underlie the debate concerning fisheries, navigation, ocean mining, marine pollution, oil and gas development, environmental protection, and the panoply of other issues that must be addressed in the EEZ.

Clearly, the Proclamation establishing the EEZ was principally done for international purposes, primarily to tell other nations how we interpret international law and what we believe we can legitimately claim. Nevertheless, with respect to the domestic implications of the EEZ Proclamation, it seems that we must have one central objective. Specifically, we must strive to establish recognized rules of conduct over the Exclusive Economic Zone. As in other areas of human activity that involve government jurisdiction, we must seek those very elusive goals of predictability, fairness, efficiency, and effectiveness.

The EEZ Proclamation clearly places within U.S. jurisdiction resources lying beyond the edge of the continental shelf but within 200 nautical miles of

the coast, which were not subject to U.S. jurisdiction under earlier claims. It proclaims "sovereign rights" over all resources (except tuna) within 200 nautical miles, establishing legal "ownership." It also claims jurisdiction over new ocean uses (energy production, for example) and appears to provide more authority for environmental regulation and enforcement over non-U.S. citizens operating within the EEZ.

## Multiple-Use Management Issues

Within 200 nautical miles of our baseline, many people may want to carry out different activities. Given that the spatial area (except for the 3-nautical-mile territorial sea) falls within federal jurisdiction, it is the government's responsibility to figure out how to coordinate all the activities of those different people. Our second and third core questions, therefore, appear to be at least superficially easy. It is the federal government which should establish and enforce the rules for activities in the EEZ.

However, the matter is complex. Should the federal government, for example, establish regional management units for the purpose of EEZ management? This is the main thesis of Lewis Alexander and Lynne Carter Hanson's article entitled "Regionalizing EEZ Management" (page 7).

They suggest that eight regional management units be established, corresponding to the regional fisheries management councils that were created by the Magnuson Fishery Conservation and Management Act (MFCMA) of 1976. These councils have significant conflict-resolution authority and experience and thus seem to be well-suited for at least some EEZ-related tasks.

There are other decision-making problems associated with the federal government, however. Generally, these involve difficult issues associated with American federalism, the centralization of authority, and intragovernmental coordination.

For example, although nominally a 200 mile zone, the U.S. EEZ in fact is 197 nautical miles in width, with the three-mile territorial sea remaining, under the Submerged Lands Act of 1953, within the jurisdiction of the adjacent coastal states. The Coastal Zone Management Act (CZMA) of 1972 provides states having approved management programs with certain controls over federal activities that occur in the coastal zone. Federal activities that occur outside of the coastal zone but within the EEZ that "directly affect" the coastal zone may or may

**EMPLOYEE OF U.S.  
DIES IN GUATEMALA**

**Worked for Aid Program — 3  
Others Are Also Killed by  
Government Soldiers**

GUATEMALA, March 10 (UPI) — Four people, including a Guatemalan working here for the United States Agency for International Development, have been slain by Government troops, the army announced today.

Army officials said in a statement that the killings would be investigated by a military court. The four were detained earlier this month near Peten, 150 miles northeast of Guatemala City, according to military communiques Wednesday. Investigators concluded the four—Abel Ortiz Jacinto, Obispo Santos, Patricia Ortiz Maldonado and Carolina Ortiz—were on a mission to train guerrillas, the communique said.

**Under Contract With Embassy**  
Mr. Ortiz was described by the army as an employee of a United States aid program specializing in bilingual education. An American Embassy spokesman acknowledged Mr. Ortiz was under contract with the embassy, but declined further comment.

The communique said soldiers shot the four to death while they were trying to escape but did not specify when or where the killings took place. It said the commander of the patrol that killed them had been ordered to report to an army court "to determine responsibility for this act," an indication officials questioned his contention the four were killed while trying to escape.

Under Guatemala's special anti-terrorist laws, suspected subversives are tried in secret military courts and do not have the right to a defense lawyer of their choice.

An army firing squad last Thursday executed six men, three convicted of terrorism and three of kidnapping and rape, despite a Vatican appeal for clemency. Pope John Paul II visited Guatemala Sunday.

**U.S. Expresses Concern**

WASHINGTON, March 10 — The State Department said tonight that the United States had expressed its concern to the Guatemalan Government over "this tragic case" and had asked it to insure the safety of employees of the United States working in that country. The department said it was preparing to discuss any possible cutoff of United States aid to Guatemala since the Guatemalans were being given time to respond to the United States representations.

"We have been in constant contact with Guatemalan officials to make sure that they make a full investigation of the events surrounding the disappearances and deaths of Mr. Ortiz, a Guatemalan contract employee of the United States Agency for International Development in that country, and his three Guatemalan companions," the department said.

It added that "we are also seeking assurances from the Guatemalan government that any and all investigations carried out in this case will be fair and impartial."

**Reagan Sets a Zone  
200 Miles Offshore,  
Claiming Resources**

WASHINGTON, March 10 (UPI) — President Reagan proclaimed a 200-mile-wide coastal economic zone today in which the United States will exercise exclusive rights over all resources.

The proclamation stems from the Reagan Administration's refusal to sign the international Law of the Sea Treaty because of objections to provisions governing deep-sea mining. The proclamation affects more than four million square nautical miles of ocean around the continental United States and Pacific islands.

It grants the United States sole right to mine valuable minerals and drill for oil and gas in this area. The proclamation also claims sovereignty rights over fisheries.

A State Department official noted that a 200-mile fisheries management zone already existed and said the new proclamation would not affect present fishing by foreigners.

**Rights Claimed Since '45**  
The United States has claimed sovereignty rights over the continental shelf since 1945. The proclamation would extend this area where it stops short of 200 miles off the coast.

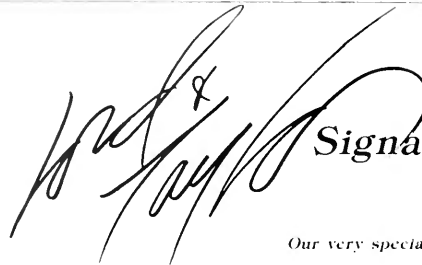
The official who briefed reporters said the administration believed that the proclamation was consistent with international law as reflected in the sea law treaty.

He said that the United States had consulted broadly with other countries on its action and that the response had been "quite moderate" over all, with countries that opposed the United States position on the sea-law treaty expressing most concern.

Third world countries that saw a threat to the market for minerals in their own lands strongly supported the treaty's seabed mining provisions.

**New Plea on Soviet Jews**

MADRID, March 10 (Reuters) — The Interparliamentary Conference on Soviet Jewry, made up of members of national parliaments of Western Europe, asked American and other delegates to the European Security Conference today to speak up for Soviet Jews "we are expelled," the group said in a statement, at the workshop of the situation facing Soviet Jews since the conference was convened in November 1980.

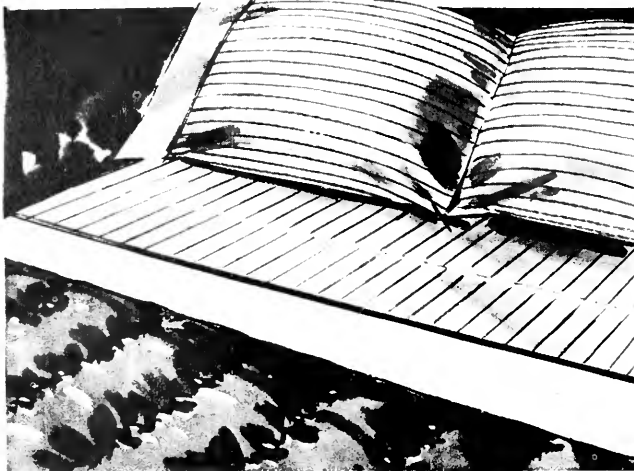


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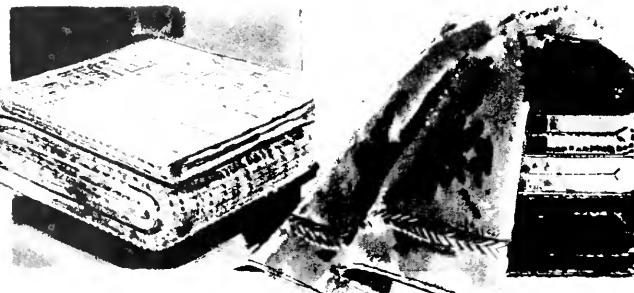


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Queen reg. 32.00, 21.99  
King reg. 40.00, 26.99  
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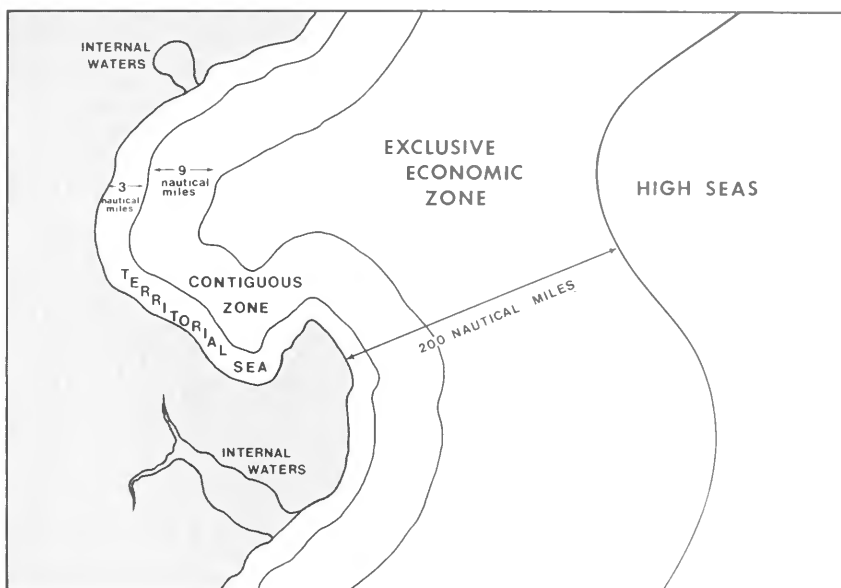
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The Exclusive Economic Zone has not evoked great media or public interest. The day after President Reagan laid claim to jurisdiction over this enormous area, The New York Times ran this article by a foreign news service on one of its inside pages. (Copyright 1983 by The New York Times Company. Reprinted by permission.)

International law recognizes five different water areas in relation to a country's shoreline—internal waters, the territorial sea, the contiguous zone, the Exclusive Economic Zone, and the high seas. The irregular nature of the boundaries and the difficulty of determining one's location at sea greatly complicate enforcement efforts. Shown are U.S. claims; those of other nations, particularly in regard to the territorial sea and the contiguous zone, vary widely. Map not drawn to scale.



not be subject to CZMA authority. The water surrounding this issue has been muddled by a January, 1984, Supreme Court decision\* that ostensibly (but not definitively) dealt only with offshore oil and gas development. Despite certain heated exchanges within the 98th Congress, no legislative resolution of this issue was reached. The fact is that intragovernmental control over the EEZ is not nearly as simple as one might assume.

With respect to the first core question—What rules will govern a particular activity?—it has been suggested that the Proclamation offers a splendid opportunity to review the status of U.S. domestic ocean management. In fact, for the first time, the nation has a uniform 200-nautical-mile jurisdiction that includes “sovereign rights” over nearly all resources. This has been contrasted to varying geographical and functional jurisdictions associated with nearly a dozen different laws and management philosophies. It is natural that many will argue that the establishment of the EEZ should lead to a comprehensive oceans management policy for the purpose of effectively carrying out the national interest. The need for a comprehensive oceans policy is, of course, a theme that has been heard for many years from a number of different sources.

Administratively and politically, comprehensive ocean management implies a centralized decision-making authority for various activities within a general geographical area using a unified set of objectives. This centralized authority

notion is in contrast to the more decentralized proposition put forward by Alexander and Hanson in their article. But some have noted that there is a very narrow political constituency for a comprehensive EEZ strategy, and thus, little likelihood that true centralization of authority will be forthcoming. Essentially, it has been argued that oceans policy, like any other area of the political system, is pluralistic in nature, with groups vying for rules and processes that directly benefit their interests. This system is likely to continue at the national level with respect to multiple-use management proposals in the EEZ.

It is interesting, we think, that none of the papers submitted at the recent Oceans '84 symposium on the EEZ advocated more decentralization of authority beyond the regional level. Yet, if the United States were ever to move toward an expansion of its territorial sea, it is likely that efforts would be made to amend the Submerged Lands Act to give individual coastal states resource jurisdiction out to the edge of the new juridical line. Actually, the expansion of the territorial sea would not be necessary to expand coastal state jurisdiction over some or all of the resources of the EEZ. It is not yet clear whether this item will be on the agenda of some future Congress.

Assuming that full decentralization is not likely and that the federal government will continue to play the major role in multiple-use management in the EEZ, intragovernmental coordination becomes a key issue. Some mechanisms must be established to avoid the potential for internecine warfare among federal agencies. The early warning signs of EEZ jurisdictional battles with respect to the Gorda Ridge lease area between the Interior Department and the National Oceanic and Atmospheric Administration (NOAA) [with both organizations seeking primary responsibility for scientific research and resource exploitation, see Broadus and Bowen, *Oceanus*, Vol

\* *Secretary of the Interior v. California*, 52 U.S.L.W. 4063. Justice O'Connor, writing for a five vote majority, held that federal oil and gas lease sales conducted under the Outer Continental Shelf Lands Act are not subject to the “consistency” requirements of the CZMA. The reasoning used by the court to reach this decision has thrown a cloud over the applicability of the CZMA to other federal activities.

## The History of

In 1494, in the Treaty of Tordesillas, Spain and Portugal divided the oceans of the Southern Hemisphere, with the Pope's blessing. Later, England followed suit, claiming dominion over large sections of the ocean and the resources (at that time limited to fish) within it. These early claims proved difficult to enforce, and provoked disagreement with states that did not recognize them.

In 1609, Hugo Grotius, a Dutch lawyer working for the Dutch East Indies Trading Company, published an essay that revolutionized international attitudes toward the seas. Called *Mare Liberum*, the essay maintained that the seas were the communal property of all peoples, and could not be claimed by one. The fish within the seas were infinite in number and, being wild creatures, were no one's property, and so also could not belong to any one nation. Finally, the seas could not be spoiled, and so did not require protection. Thus, he maintained, the seas should be free for navigation and use by all. Grotius's freedom of the seas viewpoint, though influential, was not universally accepted; for example, in

1632, the English lawyer John Selden published a reply, *Mare Clausum*, maintaining that it was indeed legitimate to claim portions of the seas contiguous to one's coastline.

Over time, nations gradually agreed that a country had dominion over waters guarded by the cannon in its forts, which at the time were held to have a range of about three nautical miles. By extension of this principle to coastline not guarded by forts, most nations gradually came to recognize a territorial sea of three miles width along their entire coast.

But in the last 40 years expanded territorial claims again have become rampant. In 1945, President Truman laid claim to all resources on the continental shelf off U.S. coasts. This proclamation (generally known as the Truman Proclamation) prompted claims by a number of Latin American nations to sovereignty over the ocean up to 200 miles from their coastlines. The debate began again.

27(3): 26-31] should give all interested parties some reason for concern. Clear lines of responsibility can, and should, be established among federal agencies for multiple-use management decisions affecting the EEZ.

### A Cautionary Note

Many observers argue for extraordinary caution in addressing the domestic aspects of the EEZ. These



Controlling marine pollution is but one of the tasks facing the United States in the EEZ. (Photo courtesy of the National Marine Fisheries Service.)

are people concerned with the international aspects of U.S. actions vis-a-vis the Law of the Sea (LOS). They become agitated about the possibility that overly ambitious actions could jeopardize efforts to hold the line on navigational freedoms within the EEZ areas of all nations. They feel that the United States should act in an exemplary fashion in this regard and scrupulously guard against taking any domestic action that appears to add controls in the U.S. EEZ above those explicitly allowed by the LOS Convention. Clearly, any effort to revise the present structure of U.S. domestic law affecting uses and resources in our EEZ will have to be done carefully and with full appreciation of the implications for our international posture.

In terms of the domestic implications of the EEZ proclamation, these observers call on us to learn from the Truman Proclamation of 1945. With the advantage of hindsight, we now see that the 1945 Proclamation\* encouraged other nations to take similar (but less well-justified) actions leading eventually to the need for the Third U.N. Conference on the Law of the Sea. There is now an increasingly strong opinion among many observers that the United States should go slow in giving domestic effect to the EEZ Proclamation. The 1953 Submerged Lands Act (and the companion Outer Continental Shelf Lands Act) followed the Truman Proclamation by eight years without apparent serious consequence. And the issues today, both domestic and international, are undoubtedly more complex.

\* The Truman Proclamation asserted U.S. jurisdiction over resources located on the continental shelf.

# the Territorial Sea

In 1967, Malta's Ambassador to the United Nations suggested a conference to devise a new law of the seas, and evoked Grotius's ghost by calling the oceans the "common heritage of mankind." In the negotiations that eventually produced the U.N. Convention on the Law of the Sea, the idea of a common heritage was used to argue that minerals recovered from under the high seas should be used to the benefit of all nations, and not just those technologically capable of exploiting them. Disputes over the deep-ocean mining provisions proved impossible to resolve, and eventually provoked the U.S. refusal to sign the treaty.

Despite such irreconcilable differences, the negotiators were able to reach consensus on the extent of the territorial sea, setting up a three-tiered system to protect economic and environmental interests on the one hand, and military and navigational concerns on the other. The system rests on a 12-nautical-mile territorial

sea, a 12-nautical-mile contiguous zone, extending from the edge of the territorial sea out to 24 nautical miles from the coast, and the 200-nautical-mile Exclusive Economic Zone (EEZ). Within the contiguous zone coastal nations are allowed to enforce laws and regulations governing customs, immigration, and sanitation, and thus have significantly more power than in the EEZ, but less than in the territorial sea.

To protect navigational rights, the treaty allows free passage through international straits and rests primary responsibility for the actions of a vessel with its home (flag) nation.

The EEZ itself is, as Bernard Oxman points out (see page 52), a delicately constituted creature. It was designed to give coastal nations control of the resources in and under their coastal waters, and to allow them some control over marine contamination, without abridging the rights of free passage for trade and military purposes. It is a curious exercise to try and imagine Grotius's reaction to these many boundaries drawn upon the sea, or to guess his stand on seabed mineral resources.—FLL

## Conclusion

Most of the discussion of multiple-use of the oceans today tends to focus on the question of conflict—or the lack thereof—in the functioning of ocean governance. Restated, the question appears to be: Is the present system, however that may be characterized, working or not? And if there are conflicts between users and uses, how best can they be addressed? We have touched briefly on the major core questions and concepts that will help guide us in the future when dealing with these issues. Essentially, will authority over the uses of the EEZ be highly centralized, regionalized, or decentralized? Within the federal government, will inter-agency jurisdictions be clearly established or subject to volatile and highly charged *ad hoc* battles?

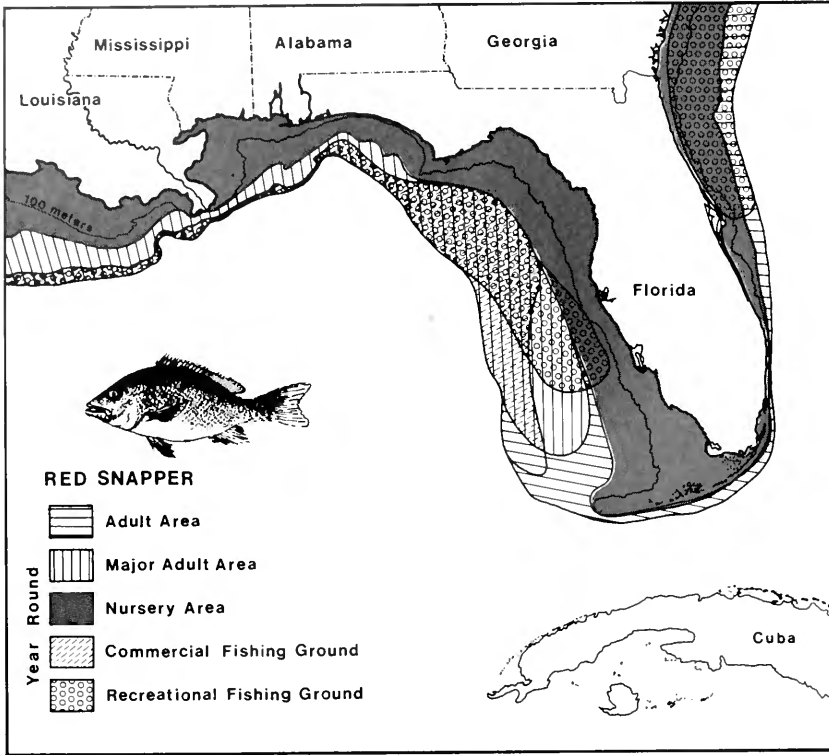
There are no good answers to these questions yet, but one aspect seems clear. The best available information on the resources of the EEZ is absolutely essential. Charles Ehler and Daniel Basta, Chiefs, respectively, of the Ocean Assessments Division and the Strategic Assessment Branch of NOAA's National Ocean Service, speaking at the Oceans '84 Conference, pointed out the important work that has been done by NOAA's Oceans Assessment Division since 1979. The division has been collecting the best information available on selected characteristics of important regions within the EEZ and conducting comprehensive, strategic assessments useful for reducing potential conflicts. One can only encourage this work. At the same time, we must recognize that our knowledge of the EEZ is still in its infancy. For example, it was not until 1960 that scientists first understood the dimensions of the mid-ocean ridge that stretches for 72,000 kilometers along the sea

floor. And it was not until 1979 that they got a first-hand look at the venting of high-temperature hydrothermal fluids along this ridge (see *Oceanus*, Vol. 27, No. 3). Now we must expand this scientific exploration to include areas within the EEZ.

Finally, the papers presented in September at the Oceans '84 EEZ Symposium helped us move toward what we believe is the key issue. Should Congress establish priorities or guidelines for the resolution of existing and new ocean conflicts in the



Whale watching on Stellwagen Bank, off Provincetown, Cape Cod: a popular recreational use of the EEZ. (Photo by Tim Dietz, New England Aquarium)



Since 1979, the National Oceanic and Atmospheric Administration's Ocean Assessments Division has been working to characterize the resources of the EEZ.

EEZ? Under what circumstances should Congress take on this task? During the 98th Congress, legislation to establish a National Oceans Policy Commission was passed by the House of Representatives to address, among other concerns, these EEZ-related issues. No action was taken, however, in the Senate. Perhaps the time has come for a Stratton Commission II\* to deal with these difficult and complex questions.

*Formerly a Senior Fellow in the Marine Policy and Ocean Management Program at the Woods Hole Oceanographic Institution, Robert W. Knecht is presently a Senior Lecturer at the University of California at Santa Barbara. Thomas R. Kitson is a senior staff member of the Committee on Merchant Marine and Fisheries, U.S. House of Representatives.*

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\* The original Stratton Commission, established by Congress in 1966, was representative of diverse interests and areas of the country; it was charged with examining the nation's stake in the oceans, reviewing current and planned maritime activities, formulating a long-term plan for marine affairs, and recommending the form of government organization best suited to support this plan. This was the first official attempt to define a national oceans policy, and was responsible for many present ocean programs.

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# A Strategy to Avoid Conflicts

by Martin H. Belsky

On 10 December 1982, nearly 120 countries signed the proposed United Nations Convention on the Law of the Sea, commonly known as the Law of the Sea Treaty.\* Part Five of that Convention provides for an "Exclusive Economic Zone" (EEZ) extending 200 nautical miles seaward from the coast. Within that zone, coastal nations have "sovereign power" to exploit and manage all natural resources, plus "jurisdiction" to govern these activities.

The United States refused to sign the treaty largely because of concerns about deep seabed mining provisions. The United States does, however, accept those provisions consistent with American interests and hopes to establish firm rules of international law that would bind other nations to those provisions. One such set of provisions deals with the establishment of EEZs.

Therefore on 10 March 1983, President Reagan issued a Proclamation establishing a 200-nautical-mile Exclusive Economic Zone for the United States. He gave as his basis for the unilateral declaration:

*... international law recognizes that, in a zone beyond its territory and adjacent to its territorial sea, known as the Exclusive Economic Zone, a coastal state may assert sovereign rights over natural resources and related jurisdiction ... (EEZ Proclamation)*

How to implement the U.S. EEZ Proclamation has been a source of debate ever since its issuance. Some argue that our government should "seize the opportunity" of the new American awareness of the oceans and develop a comprehensive oceans policy. Others are concerned that additional unilateral U.S. action could interfere with our attempts to preserve, as part of customary international law, the EEZ provisions in the Law of the Sea Convention.

## The Need for a U.S. Oceans Policy

Biliana Cicin-Sain and Robert W. Knecht, both in the Political Science Department at the University of California at Santa Barbara, recently argued at the Oceans '84 Conference in favor of seizing the opportunity of the EEZ Proclamation to establish a new, comprehensive U.S. oceans regime. For many other nations, the establishment of an Exclusive Economic Zone marked the beginning of serious interest in the management of ocean activities and the exploitation of ocean resources. In the United States, however, national attention has focused on the oceans ever since the 1950s, when federal

statutes and programs began to promote marine science, engineering, and technology.

More recently, new federal statutes have established significant programs for management of commercial and recreational fisheries, exploitation of offshore mineral resources, control of marine pollution, control of navigation, regulation of marine recreation, protection of environmentally sensitive areas, and planning and regulation of the multiple uses of the coastal zone.

The U.S. marine regulatory and policy framework has grown rapidly but haphazardly. Congress has responded in an *ad hoc* manner to different crises and to concerns raised by divergent constituencies by enacting a number of specialized laws. As Cicin-Sain and Knecht put it, "While it appears that each of these laws is serving more or less well in its intended purposes, there is serious question whether, in toto, they provide a sufficiently adequate over-all framework for the management of closely interconnected offshore resources and uses."

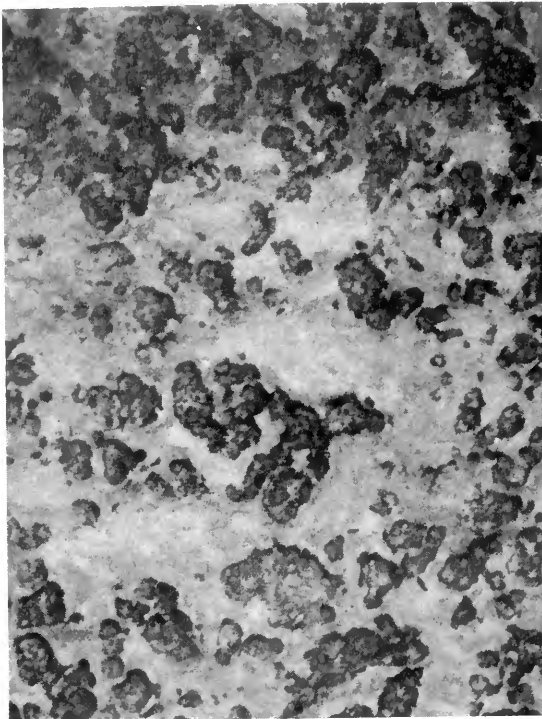
Under the present U.S. system of ocean management, no one is responsible for examining the cumulative effect of the various statutes and programs. Few opportunities exist for examining the ramifications of decisions in one sector on another or for trade-offs to be made among the conflicting objectives of different programs. The result is that oceans policy is characterized by undue and excessive conflicts that often wind up in the courts. Even when these conflicts are resolved (after extensive delays), again it is on an *ad hoc* basis and there is little opportunity for advanced planning for important ocean issues.

Cicin-Sain and Knecht argued that the implementation of the EEZ Proclamation offers an opportunity for reassessing the strategy underlying our present ocean-governance regime. In contrast to present marine laws, which generally are single purpose, the Proclamation declares sovereignty over almost all resources (with the exception of tuna, which are highly migratory) and jurisdiction over almost all activities in an all-encompassing geographic area. The creation of the EEZ allows a legislatively-mandated, multiple-use approach to marine resource management.

## Risks of Statutory Implementation

Despite the need for an improved ocean-governance regime, however, there would be some substantial risks to U.S. national interests if implementation of the President's Proclamation were used as the basis for new, comprehensive oceans legislation. With the possible exception of the migratory tuna provisions, the Law of the Sea (LOS) Treaty articles that deal with activities and responsibilities in the EEZ are generally consistent with U.S. interests. The President and other

\* The treaty takes effect one year after 60 signatories have ratified it.



*Manganese nodules are one of the deep-sea mineral deposits that provoked the U.S. refusal to sign the Law of the Sea Treaty. (ANGUS photograph courtesy of Frank Manheim, USGS)*

government officials have publicly expressed satisfaction with these provisions and have expressed their desire to have the provisions accepted as international law, binding on all nations. To do this, the United States must conform its interpretation and implementation of the EEZ to the LOS Treaty's EEZ provisions.

### **The Basis of International Law**

International law is established either by international agreement or by the custom and practice of nations (customary international law). Since the United States has refused to sign the Law of the Sea Treaty, in establishing an EEZ it must make its legal argument on the basis that the treaty provisions on the EEZ have become part of customary international law; the nations of the world have agreed to the EEZ provisions, not as part of a binding treaty, but rather through their deliberations on the treaty and the consensus of nations that these new rights, powers, and obligations are now part of international customary law. In effect, the international community has agreed that the customary law of the sea will include the EEZ rules. With or without a treaty, future state practice has been promised.

This theory of international law is dependent on a real consensus. That consensus, in turn, is

built on the provisions of the Law of the Sea Treaty. Thus, it is in the United States' best interest to conform its EEZ as closely as possible to the EEZ provisions in the treaty. Implementing legislation runs the risk of creating inconsistencies between the U.S. EEZ and the treaty provisions. This would weaken the premise that all the rights, powers, and obligations in the treaty are part of customary international law and thus reduce the ability of the United States to dispute claims that run counter to its interests. The risks involved in further unilateral U.S. action are significant.

### **Freedom of Navigation**

At the Oceans '84 Conference, John N. Moore, Professor of Law at the University of Virginia, and Bernard H. Oxman, Professor of Law at the University of Miami, argued that important U.S. national security and commercial interests hinge on preserving the careful balance that the Law of the Sea Treaty provides for the protection of navigation. Most of the United States' alliances are inter-oceanic; its economy depends on ocean-related transportation; some of its future mineral resources may come from the oceans; and its military strategy relies on sea power to complement its land-based and air-based forces.

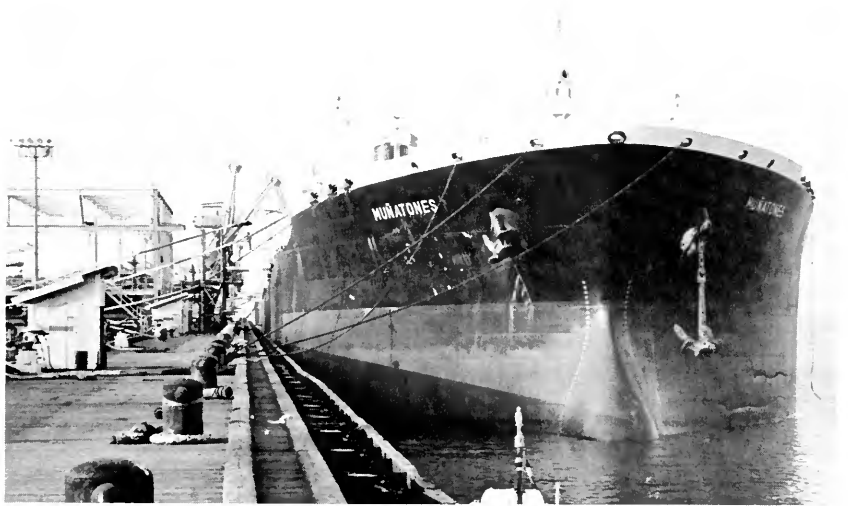
Some inconsistencies between the U.S. EEZ Proclamation and the LOS Treaty already exist. The Proclamation, for example, provides for protection and preservation of the "marine environment" in the EEZ. The United States worked diligently and successfully to defeat any treaty provisions that would give a nation unlimited power over vessels (especially military vessels) under the guise of protection of the environment. But the Proclamation appears to make navigational freedoms subject to U.S. sovereignty. This could lead other nations to make similar sovereign rights claims that would limit the freedom of navigation of vessels.

Another illustration of the threat of domestic legislation to the careful balance set up in the Law of the Sea Treaty is found in the Soviet Union's Proclamation establishing its EEZ. That declaration, which was published 29 February 1984 and took effect the next day, provides that the rights of individuals to conduct activities in the EEZ, and the right of navigation in that zone, are subject to the decrees, laws, and other rules of the Soviet Union, as well as to the provisions of the LOS Treaty, which the Soviet Union has signed, but not yet ratified.

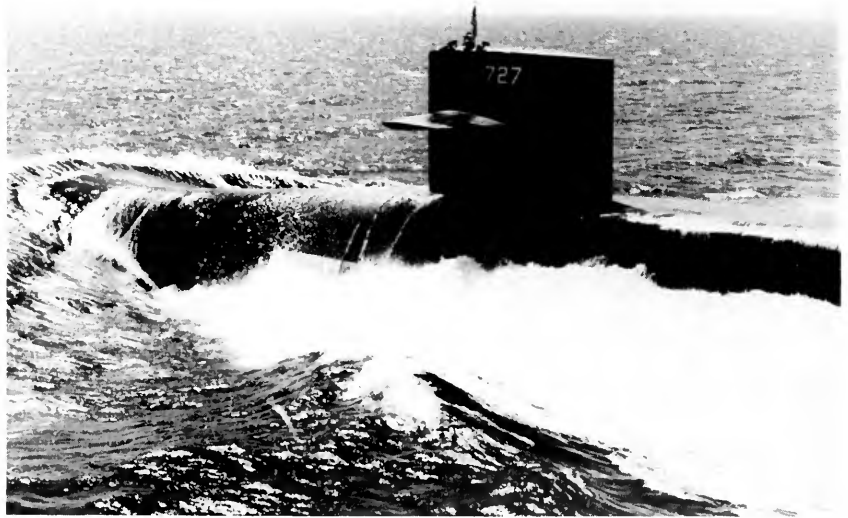
The proclamations by the United States and the Soviet Union illustrate the problems inherent in further unilateral action. We must do all that is possible to have the Law of the Sea Treaty provisions pass into customary international law. In this "struggle for law," it is essential that we strictly adhere to the treaty's EEZ provisions and conform the President's Proclamation to those provisions. If nations see the major powers limiting activities, outside of the wording of the treaty, the careful consensus as to the binding nature of those treaty provisions could be lost.



*The safeguards to freedom of navigation in the EEZ provisions of the Law of the Sea Treaty are vital to the U.S. economy and national security. Here an oil tanker loads up at Kharg Island, Iran. (Photo by Ray Ellis, PR)*



*Among other provisions, the Law of the Sea Treaty guarantees free passage of submerged submarines through international straits, a right not guaranteed by other international treaties. At right, the Trident missile submarine USS Michigan at sea. (Photo courtesy of the U.S. navy)*



### **A Strategy**

The need for consistency between U.S. EEZ laws and policies and the Law of the Sea Treaty can be reconciled with the desire to use the Proclamation as a means to reduce inconsistencies and conflicts in our nation's ocean management, but we must be cautious. Comprehensive legislation to implement the Proclamation, or even a comprehensive set of amendments to existing national statutes, must be avoided. Even if intended only to "clarify" U.S. interpretation of the scope and effect of the international customary rules relating to the EEZ, it could set a bad precedent for similar unilateral (and perhaps inconsistent) legislation by other nations.

Moreover, because of the nature of the political process, it is likely that provisions would be included in legislation in response to pressure

from special interest groups. These provisions might be inconsistent with what we are trying to establish as customary international law.

A better strategy would be to adopt a "wait and see" approach. The United States should work as closely as possible with other nations to develop national policies consistent with the treaty's EEZ provisions.

Similarly, the United States should work closely with other nations to vigorously protest and discourage claims that are inconsistent with the treaty provisions. Perhaps an international or multinational watchdog group could be established to protest any inconsistent or inappropriate action in regard to national proclamations and legislation.

One way to promote consistency is for the United States to agree to compulsory and binding

third-party settlement of disputes between nations as to the meaning and effect of the Law of the Sea Treaty's EEZ-related provisions. This would show our commitment to these provisions and our willingness to have the provisions bind us (and protect us and other nations). The best method to implement this policy would be national legislation committing us to the settlement procedures detailed in the Law of the Sea Treaty with any nation that agrees to apply those procedures with us.

The "wait and see" approach is not necessarily in conflict with the desires of many to use the President's EEZ Proclamation as a basis for resolving the problems of managing the oceans. Mechanisms to resolve conflicts among different ocean users and state and federal regulatory agencies do not threaten consistency; they promote it. With a clear U.S. position on ocean activities, the other nations of the world would find it easier to deal with us and our laws. Thus, legislation that does not affect the substance of present ocean-related laws, nor jurisdiction over ocean activities, could be developed to force more inter-agency coordination and to establish, as under the treaty provisions, compulsory settlement of disputes between users of the ocean. Even establishing new management councils to set cross-resource priorities, as suggested by Cicin-Sain and Knecht, would not necessarily lead to damaging precedents of inconsistent U.S. EEZ actions. But, as with our implementation of the EEZ Proclamation generally, we must be cautious.

New mechanisms to govern our EEZ should not be established on a regional basis, but only on a national basis, as regional governance might be applied (or simply interpreted) as a zoning system that could limit navigational freedoms, and might produce similar but more restrictive systems by other governments. And any new legislative action should not be allowed to change the scope and nature of our laws, and thus encourage other nations also to act unilaterally.

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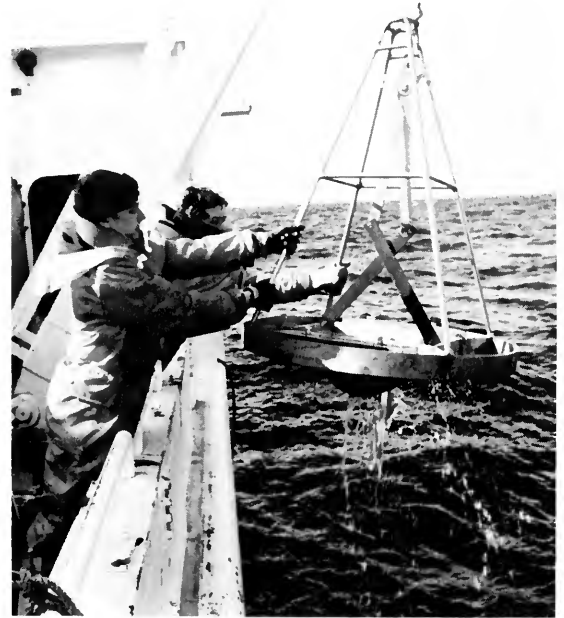
# Marine Pollution Research Needs in the EEZ

by Baruch Boxer

Recent discussions on U.S. oceans policy in the Exclusive Economic Zone (EEZ) have focused almost entirely on legal and economic issues arising from the need to balance variously perceived domestic needs and international obligations. The recent Gulf of Maine boundary dispute with Canada over the Georges Bank fishery (settled 12 October 1984 by the World Court at The Hague) is a good example of this. It is to be expected that there will be conflicting opinions on the nature of U.S. rights and responsibilities in the EEZ, given the unabashedly political tone of the President's March, 1983, Proclamation and statement on the 200-nautical-mile zone. This emphasis on principle, however, unfortunately has diverted attention from important questions concerning the role of scientific research in fostering balanced attainment of domestic and international policy goals. This is especially true of marine pollution research, an area that has been virtually ignored in studies of EEZ options.

The EEZ declaration was more than a statement of U.S. intentions regarding the United Nations Convention on the Law of the Sea (hereafter called the LOS Treaty). It also served as an official statement on oceans policy. In the words of James L. Malone, special ambassador to the treaty negotiations, "by establishing an EEZ and clearly setting forth the principles upon which U.S. national oceans policy will be based, the United States has reassured the international community and restored U.S. leadership in the development of international oceans law." This linkage of policy and law through the simple act of proclamation implies that in the U.S. view, legal fiat is a sufficient basis for defining ocean policy. There is little, if any, recognition of research as a tool for mediating political objectives and environmental realities. The present uncertainty over what to do with the EEZ testifies to this, especially as conflicts mount over appropriate management strategies for resource development.

The wisdom of using the EEZ Proclamation as a mechanism for U.S. rejection of multilateral control over resource development and as a statement of support for the principle of free enterprise is still a matter for debate. Regardless of one's philosophical position, however, it is likely that key decisions on resource use and strategies for managing this use are bound to reflect short-run political factors. To date, there has been only



*Marine pollution research is essential to wise decision-making in the EEZ. Here Woods Hole Oceanographic Institution personnel monitor the effects of oil drilling on the ecology of Georges Bank. (Photo by George Hampson, WHOI)*

fragmentary scientific debate on the best means of balancing economic, conservation, health, and environmental considerations.

Research is concentrated on technical questions related to specific resource exploitation programs, whether in fisheries, hard minerals, oil and gas, or ocean energy. Marine pollution research, by contrast, must reflect the social and political values that define its methods and objectives. This makes determining its role difficult. Yet failure to consider the relevance to EEZ decisions of existing research protocols developed in response to domestic regulatory needs would be shortsighted. This is especially important as domestic and international policy choices are linked in many ways that are only beginning to be recognized.

The literature that discusses EEZ demarcation and exploitation for the United States and other countries generally fails to address the place of pollution research in defining



*Application of present ocean management laws to the EEZ is problematic. Most such laws (like the Clean Water Act) were enacted before the establishment of the EEZ and are so worded as to apply only within territorial waters and the contiguous zone. Extending such laws to the EEZ may be impeded by conflicting language in international treaties. (Illustration by ZAPP)*

development paths that accommodate competing conservation and development factions while supporting marine environmental protection goals. A possible exception is work relating to fisheries, where reciprocity concerns necessitate application of scientific findings in studies of the jurisdictional consequences of EEZ delimitation.

### Background

It is not surprising that the place of marine pollution research in EEZ planning has not been more clearly articulated. Since the late 1960s, when marine environmental concerns began to take shape in early deliberations of LOS Treaty and at the Stockholm Conference on the Human Environment, there has been a noticeable gap between well-intentioned pronouncements on environmental and conservation goals and realistic assessments of the knowledge base as it might be applied to achievement of these goals.

Some of the earliest writings on the environment and the Law of the Sea acknowledge the difficulties of achieving international marine environmental protection objectives in the face of governments' desires to exploit ocean space and resources. Still, it was felt that nations ultimately would have to acknowledge the need for "minimum international pollution control and living resource conservation requirements" within their national jurisdictions, simply to protect their own interests. Even if internationally sanctioned pollution-control and conservation requirements

were impossible to meet, it was assumed that countries would accept the economic logic of preventive measures to control pollution, thereby maintaining renewability of living resources.

Arguments in the early 1970s, for or against international or national supervision and control of pollution in the EEZ, also were predicated on the assumption that cooperative scientific research would lead to the development of standards that could serve as a common point of reference for bilateral and multilateral negotiations (see D.M. Johnston, ed. 1981. *The Environmental Law of the Sea*. Berlin: Erich Schmidt Verlag.) Expectations of agreement on standards went unfulfilled, however, mainly because the lawyer/diplomats who considered the issues failed to appreciate the difficulties of moving from scientific understanding to determination of absolute standards—standards against which threats to human or environmental health could be measured.

During the last decade, international discussions on the marine environment have followed divergent paths. Legal scholars assume that science can ultimately provide firm factual ground for international decision-making. Scientists, however, have come to realize how difficult it is even to frame the proper questions, much less gain understandings that can support regulatory objectives.

Thus, legal thinking on prevention and control of marine pollution evolved to focus on issues associated with five main sources of pollution: vessels, dumping, land-based activities,



By not signing the Law of the Sea Treaty, the United States excluded itself from the environmental protection provisions of the treaty. U.S. actions are instead bound by earlier treaties that may not reflect the existence of an EEZ, and unilateral U.S. actions in violation of these treaties may risk retaliatory actions. (Illustration by ZAPP)

seabed activities, and mining. There has been parallel development of legal work on the problem of "living-resource" conservation, a subject that has taken on even greater significance in light of the rapid global trend toward national enclosure of ocean space. This discrepancy at the international level, between legal and scientific thinking and between a concern for pollution sources as opposed to living-resource conservation, has important implications for U.S. EEZ planning.

### Choices and Dilemmas

Questions concerning the place of marine environmental research in EEZ planning can be thought about in two ways: What is the relation between basic research objectives and management needs for particular development goals (for example, energy, minerals, fisheries)? And, are domestic U.S. concepts of research, monitoring, and environmental assessment adequate for dealing with direct and indirect international impacts of the U.S. EEZ Proclamation (including transboundary and vessel-source pollution, consistency with prevailing dumping standards, oil spill compensation obligations)?

Another important consideration is the effect of the EEZ Proclamation on the role of U.S. federal agencies (National Oceanic and Atmospheric Administration, Environmental Protection Agency, Interior Department, Army Corps of Engineers, and so on) in their dealings with U.S. coastal states (see Belsky, page 19). Will the effectiveness of states'

jurisdictions over their territorial seas change as a result of the extension of federal control to the 200-nautical-mile limit? Will federal agencies' research functions pertaining to the EEZ remain the same (as in the case of ocean dumping research where, because the United States is a party to the London Dumping Convention, judicial interpretations of federal responsibilities may require greater consistency with other countries' practices in such controversial areas as seabed emplacement of radioactive wastes)? The Reagan Administration assumes that the U.S. EEZ declaration will assure stability and harmony in the use of ocean space because it underlines the importance of customary law and practice in such noncontroversial areas as navigation and rights of transit. Yet there are implicit obligations for protection and preservation of the marine environment that have not been adequately considered from either legal or scientific perspectives.

Questions can be raised, for instance, as to the adequacy of existing research in planning for EEZ mineral development. The problem pertains not only to the matter of determining what is meant by environmental impacts or "acceptable" environmental impacts. More generally, it reflects an inability to organize research so that questions on related economic and ecological concerns can be mutually addressed. Preparation of environmental impact statements as a precondition for lease sales usually leads to a compilation of

standard categories of information that may bear only peripherally on scientific concerns most crucial to economic feasibility decisions. A related issue is the need at an early stage to define more carefully a role for environmental research that can help determine the best balance between scientific inquiry for its own sake and work on technical engineering problems directly related to mineral recovery.\*

This reflects a continuing dilemma in the United States over distinctions between environmental research and environmental monitoring in guiding regulatory policy so that it can accommodate both conservation and development goals. In virtually every area of potential EEZ exploitation now under discussion, there is much uncertainty over the relative weight to be assigned to research as opposed to monitoring activities.

In some areas, such as marine waste disposal, where research has responded primarily to legislative mandates seeking clarification of such vague notions as "unreasonable degradation," there is still much confusion. J. O'Connor and R. L. Swanson, for example, observed that "probably most waste discharge and dumping criteria for coastal waters could be challenged . . . because we have no quantitative, socially-agreed definition of how much pollution or how much impact is too much." There are still considerable knowledge gaps for our much-studied coastal waters. New approaches to clarification of monitoring and research roles are essential, especially if environmental and economic constraints in planning resource exploitation in poorly-studied EEZ open-ocean areas, such as those surrounding Pacific islands or Alaska, are to be properly evaluated.

Another major concern when thinking about marine pollution research in EEZ planning has to do with changes in federal/state relations associated with the EEZ. Except for some limited work on federal jurisdiction over fisheries in coastal states' territorial waters (for example, Gulf of Maine), little thought has been given to the effects of the establishment of the EEZ on state and federal pollution control and environmental management responsibilities. This is especially true of conflicting state and federal interpretations of standard-enforcing rules when domestic standards are tied to international treaty obligations.

The problem has different facets: Where and how can marine pollution research serve to clarify connections between what are perceived as important domestic issues (New York/New Jersey waste disposal controversies, disposal of nuclear waste, enforcement of vessel-source pollution control laws, and so forth), and the international political impacts of unilateral U.S. EEZ activities? In other words, what are the international implications

of justifying U.S. positions in multilateral discussions on the basis of domestic regulatory mechanisms, backed by domestic research, that are employed in the U.S. EEZ? Also, if the international legal implications of a restrictive condition in U.S. law have not been explored, can conflicts arise between domestic legal requirements and U.S. obligations to international conventions?

There are inconsistencies between domestic law and international practice. D. C. Slade, of the National Advisory Committee on Oceans and Atmosphere (NACOA), points out how the ambiguity of the Clean Water Act's "sheen rule" might lead to a number of problems. The act prohibits discharge of oil by vessels "into or upon the navigable waters of the United States, adjoining shorelines, or into or upon the waters of the contiguous zone; or, in connection with activities . . . which may affect natural resources belonging to, appertaining to, or under the exclusive management authority of the United States in such quantities as may be harmful as determined by the President . . ." Harmful discharges are defined as "caus[ing] a film or sheen upon or discoloration of the surface of the water or adjoining shorelines or caus[ing] a sludge or emulsion to be deposited beneath the surface of the water or upon adjoining shorelines."

Foreign-flag vessels are currently taken to be in violation of the "sheen rule" only within U.S. "navigable waters and the contiguous zone." The EPA has not yet promulgated regulations governing activities of these vessels beyond the contiguous zone. Still, U.S. jurisdiction over foreign ships is governed by "international agreement to which the United States is a party," namely, the 1973 International Convention for the Prevention of Pollution by Ships (as modified by its 1978 Protocol). Thus, even though a foreign vessel may leave a "sheen" in the U.S. EEZ, it theoretically would not be violating the Clean Water Act, because technically it would not be subject to U.S. jurisdiction. The United States, in this case, would be ill-advised to extend a more restrictive domestic law to govern activities of foreign ships operating in the U.S. EEZ without specific international agreement. By so doing, it would invite retaliatory restrictive actions by other coastal states against U.S. vessels operating in other EEZs.

In addition to specific inconsistencies between domestic regulations and international obligations, NACOA points out a number of cases where the substance and intent of some ocean-related U.S. statutes need modification as a result of the establishment of the U.S. EEZ. In some cases, U.S. laws are predicated on the assumption of U.S. accession to the Law of the Sea treaty. The Magnuson Fishery Conservation and Management Act (MFCMA) of 1976 is a case in point. It unequivocally supports U.S. efforts to ". . . obtain an internationally acceptable treaty, at the Third United Nations Conference on the Law of the Sea."

A number of conflicts also may arise from assumptions implicit in U.S. laws relative to continental shelf definition, as in the case of the 1972 Marine Protection, Research, and Sanctuaries

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\* See U.S. Department of the Interior. 1984. *Symposium Proceedings: A National Program for the Assessment and Development of the Mineral Resources of the United States Exclusive Economic Zone*. U.S. Geological Survey Circular 929.

Act. Here, designation of marine sanctuaries outside U.S. territorial waters is to be governed by jurisdictional definitions provided by the 1958 Geneva Convention on the Continental Shelf, and the Secretary of State is directed to negotiate bilateral agreements. The Geneva Convention defines the continental shelf as "the seabed and subsoil outside the territorial sea to a depth of 200 meters, or, beyond the limit, to where the depth of adjacent waters admits of exploitation."

This definition raises questions as to whether jurisdictions similarly defined in the 1953 Outer Continental Shelf Lands Act and other U.S. laws might be in conflict with current international understanding based on the United Nations Convention on the Law of the Sea. Article 76 of the convention defines the continental shelf as "comprising the seabed and subsoil of the submarine areas that extend beyond [a nation's] territorial sea throughout the natural prolongation of its land territory to the outer edge of the continental margin, or to a distance of 200 miles from the territorial sea baseline if the margin does not extend to that distance."

The issue of seabed emplacement of radioactive wastes is a case in point. In discussions at the February 1984 Consultative Meeting of Contracting Parties to the London Dumping Convention (LDC), it was agreed that future decisions on the technological feasibility of seabed disposal of radioactive waste would be based on the results of ongoing research. This position was pursued by some parties to counter others' views that seabed emplacement should under no circumstances be considered because it interferes with the inherent "rights of others." In the near future it is unlikely that there will be successful translation of research findings into regulatory mechanisms since this will depend on agreement among signatories as to the most efficacious research approach.

The official U.S. stance on the LDC appears to be a rejection of an enforcement concept based simply on prohibition of scheduled (toxic) waste materials as they affect the marine environment. However, the role of the United States as a signatory party to the LDC continually demands U.S. involvement in ongoing review of the place of research in international policymaking on dumping questions. This is especially true because of the range of conflicting views on the rights of nation-states in other states' EEZs.

Finally, except for issues such as dumping and fisheries with legal frameworks in place to support technical discussions on connections between research and regulation questions, there are still few opportunities for comparative assessment of coastal nations' approaches to environmental research as part of their EEZ resource-development activities.

## Effective Research Role Needed

The question of the place and function of marine pollution research in EEZ planning is part of a much larger and more challenging issue: the extent to which marine research can effectively guide ocean use and development. In the EEZ case, however, emphasis on jurisdictional concerns has diverted attention from a number of important matters that inevitably link domestic and international dimensions of ocean management. Certainly EPA, NOAA, the Army Corps of Engineers, and the Department of Interior have successfully pursued environmental research responsive to domestic needs. In the United States, however, our focus has been largely on technical matters pertaining to development of specific resources. But the thickets in the jungle of ocean management options are becoming more difficult to penetrate. Self-satisfying declarations of principle cannot be magically transformed into workable policies. We must struggle to delineate a more effective role for marine pollution research in this venture.

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# Non-Living EEZ Resources:

by Michael A. Champ,  
William P. Dillon,  
and David G. Howell

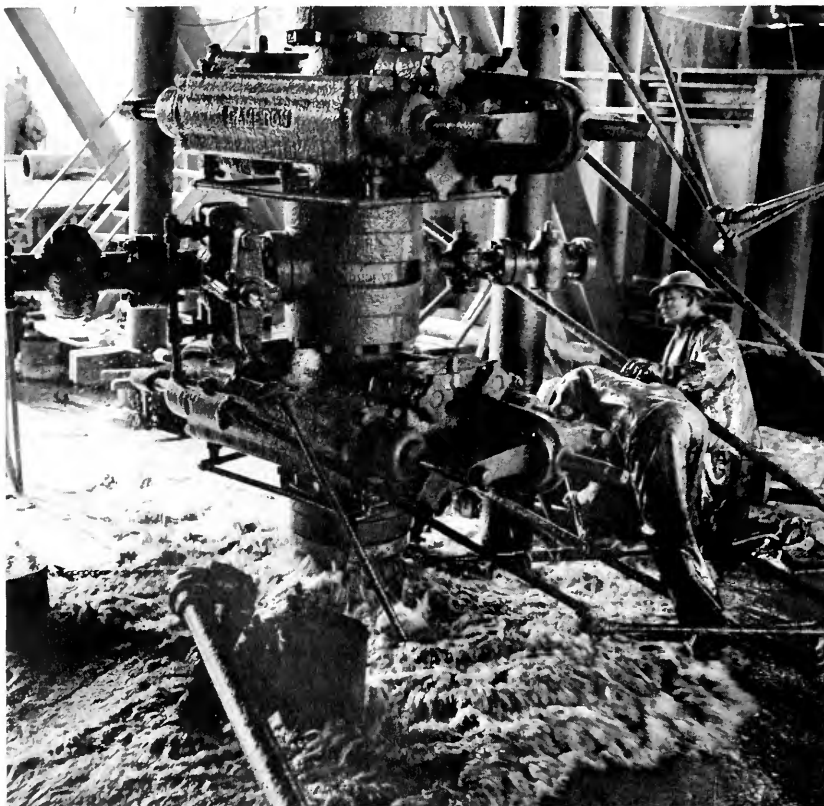
The oil crises of 1973 and 1979 demonstrated that dependency on imports for a critical or strategic material could change a superpower's position very quickly. Those of us who arose at 4 a.m. to line up at service stations for 10 gallons (the limit) of gasoline in order to drive to work every day will never forget the experience.

Despite conservation efforts that began in the 1970s, in 1984, every man, woman and child in America required approximately 40,000 pounds of new minerals. In a lifetime, each American will need a half ton each of lead and zinc, 2 tons of aluminum, and 45 tons of iron and steel. The principal argument used by the United States to reject the United Nations Law of the Sea Treaty was that the deep seabed mining provisions could jeopardize the ability of a superpower to obtain critical, strategic minerals. Our dependence on imported minerals is

shown in Table 1.

The importance of these minerals in times of peace and war is well established. Manganese is fundamental to the production of virtually all steels and most cast iron. Cobalt is a critical hardener of steel and superalloys used in cutting tools and jet engine parts. Nickel, principally used in alloys to resist corrosion, is important in aircraft and shipbuilding. These minerals form the basis of many developing technologies in the areas of defense, energy, and our space programs.

The United States in the early 1970s was unchallenged in the field of deep-submergence technology. Since then, France, England, West Germany, Japan, and Canada have passed us in the area of deep-sea mineral exploration. The French brought together highly regarded engineers and scientists on cruises organized for the assessment of



*In the future, oil is likely to be extracted from wells drilled in much deeper water. Here drilling proceeds in relatively shallow water in the Gulf of Mexico. (Photo by Fritz Henle, PR)*



# Minerals, Oil and Gas



*Ferromanganese crusts (inset) coat basaltic rocks on the sides of volcanic islands and submerged volcanoes in the Central Pacific. These crusts are rich in cobalt and other metals. Modern basalts at the edge of Pago Pago harbor (foreground) are similar to the rocks underneath these crusts. In the background, the R/V S.P. Lee on a cruise to investigate such crusts. (Photo by Frank Manheim, USGS)*

potential commercial mineral deposits. The French also added mining engineers and economic geologists to their research teams. They even acquired the first commercially available Seabeam sonar mapping system (developed by the U.S. Navy) from General Instruments in Massachusetts, putting it on their best research ship, the *Jean Charcot*, 3 years ahead of the United States.

Canada invited American scientists to help formulate its national minerals program, holding a major symposium in 1983 to carry out the planning effort. The program was in the field that summer. Japan, being almost fully dependent on foreign sources of mineral supplies, early realized the significance of this dependency and began immediately to coordinate its research and planning activities as a major cooperative effort with Japanese and American industry.

The United States marine non-living resource effort has been generally diffused, because of the myriad of issues and agencies involved in funding deep-sea research and exploration for minerals, oil, and gas. Recently, however, there has been a high level of coordination and cooperation in this area. The National Oceanic and Atmospheric

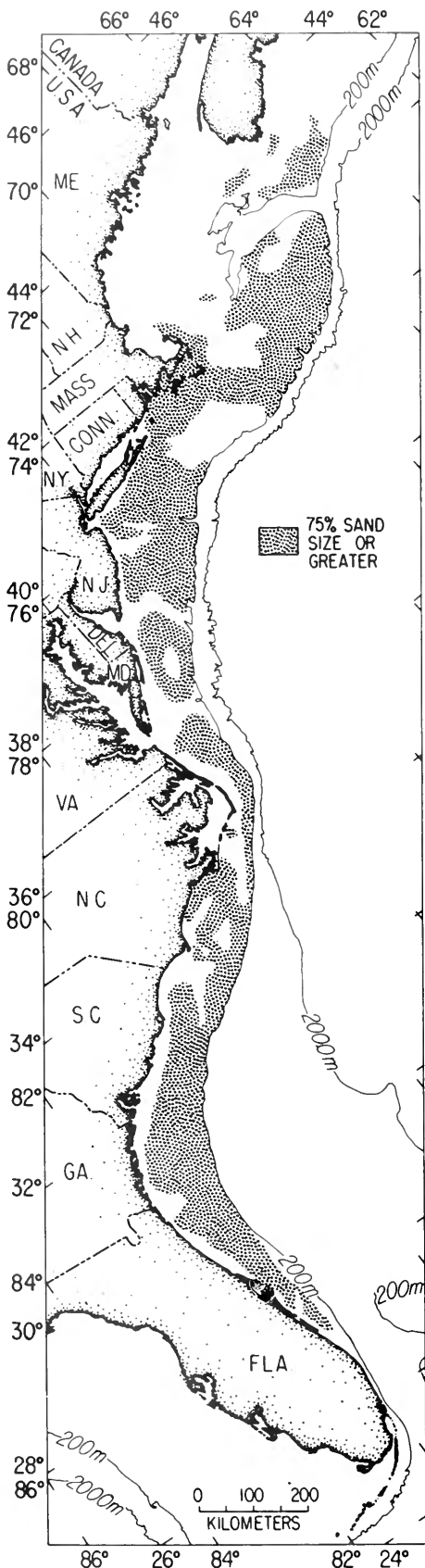
Administration (NOAA) and the U.S. Geological Survey (USGS) are planning a second conference on this topic for May and June of 1985 with hopes that it will become an annual event. It is hoped that other agencies and industries (particularly the oil and gas industry) will join this or future conferences to develop a national multiple-use EEZ perspective.

**Table 1. U.S. reliance on imports for some minerals that could be recovered from the oceans:\***

Manganese	99%
Cobalt	95%
Platinum group metals**	90%
Chromium	76%
Nickel	75%
Zinc	65%
Silver	61%
Iron Ore	37%
Vanadium	26%
Copper	19%
Gold	19%
Sulfur	15%

\* 1983 statistics [1984 statistics not available]. Source: Bureau of Mines.

\*\* Includes platinum, palladium, rhodium, iridium, osmium, and ruthenium. Only platinum is likely to be recovered from the seafloor.



### Hard-Mineral Resources

Six major hard-mineral resources have been identified in the U.S. EEZ: 1) sand and gravel, 2) placers, 3) phosphorites, 4) manganese nodules, 5) cobalt-ferromanganese crusts, and 6) polymetallic sulfides.

### Sand and Gravel

Worldwide offshore mining of sand and gravel currently exceeds offshore production of all *nonfuel* minerals in both volume and value. The United States uses about a billion tons of sand and gravel each year for construction alone, primarily from onshore sources. Additional sand is used for glass manufacturing, beach nourishment, road sand, and sand blasting. However, except for operations in New York Bight, and off northern Alaska, the United States mines little sand or gravel from the ocean.

Offshore sand dredging in the United States began in the early 1950s on the East Coast for beach nourishment. In the future, as U.S. onshore sand and gravel supplies become limited as the result of land use restrictions and environmental or economic concerns, the enormous offshore sources on the continental margins of the EEZ will become important and economically viable. Sand and gravel resources on the continental margins of the U.S. EEZ have been estimated by the Interior Department to be 29 billion cubic meters on the Pacific coast, 19 billion cubic meters off Hawaii, 830 billion cubic meters along the Atlantic coast, and very large off Alaska.

Sand and gravel mining will soon be very attractive to coastal cities that have port facilities because transportation costs by rail or truck have increased steadily. In Hawaii, white sand is limited (and superior to the typical black sand for construction), and a large deposit has been located about 35 kilometers off the Island of Oahu. In Puerto Rico, where large amounts of sand have been removed from beaches for use in construction, new offshore resources have been found.

### Placer Deposits

The first placer\* mining in the United States occurred on the beaches of Nome, Alaska, in the early 1900s by gold miners who arrived too late to claim stream or creek beds. On the Pacific continental margins, (not including Alaska), gold and heavy mineral sand deposits have been estimated to be about 2.06 billion cubic meters, occurring in reworked Pleistocene gravels, relict (former) beaches, or buried river channels. In Alaska, no estimates are available, but the placer deposits are thought to be extremely

\* A placer deposit is an accumulation of mineral grains concentrated by sedimentary processes, commonly in ancient beaches or stream beds. The grains are derived from the breakdown of solid rock by weathering, and they may contain gold, titanium minerals, and other important elements.

*Sand resources along the Atlantic Coast are quite large. Sediments in the speckled areas are comprised of at least 75 percent sand. (From Manheim and Hess, 1981)*

large. Along the Atlantic coast, newly discovered placer deposits containing titanium minerals and other valuable minerals promise future resources.

### **Phosphorite**

About 52 million tons of phosphorite (used as a fertilizer) is mined on land in the United States annually. It has been estimated that reserves will last for about 20 years. It may then be economical to tap the enormous resources within the EEZ.

Environmental and land use constraints may make it desirable to tap the EEZ deposits even sooner. These include deposits on the Blake Plateau estimated to contain more than 2 billion tons, nearshore deposits off South Carolina and Georgia, and new finds off North Carolina that may be even larger than deposits on the Blake Plateau. In the Pacific, phosphorite has been recovered from several seamounts associated with cobalt-rich ferromanganese oxides. No estimates are available on the quantity of these resources.

### **Manganese Nodules**

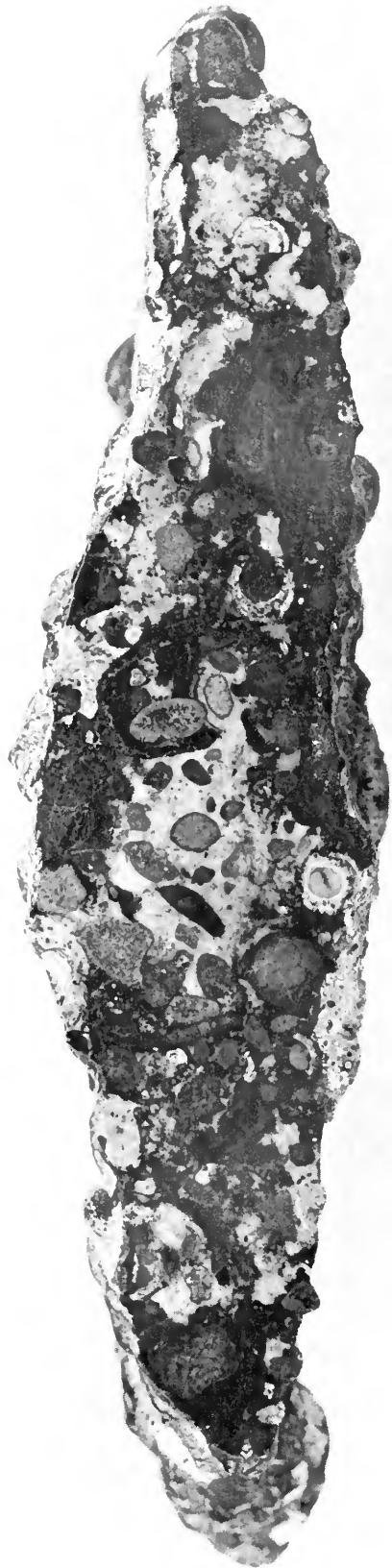
Manganese nodules (more precisely termed ferromanganese nodules) are rich in nickel, copper, and cobalt and have been found within the United States EEZ off the east (Blake Plateau) and west coasts, Hawaii, and the Pacific Island territories. However, within the EEZ, they are not as rich in valuable metals as in the Central Pacific. Manganese nodules from the U.S. EEZ were first collected in 1885 on the Blake Plateau off the Georgia and South Carolina coasts. There the nodules grade into slabs and crusts.

In July of 1970, Deepsea Ventures, working on the Blake Plateau, completed the first at-sea tests of and environmental effects studies on manganese mining. In later tests, platinum was found in the nodules at concentrations of 0.1 to 0.5 grams per ton. These concentrations added to economic interest in Blake Plateau nodules, which had already been requested for lease by Reynolds Metals.

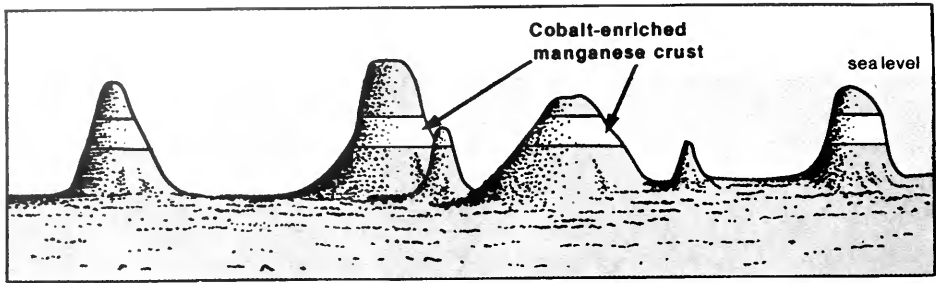
### **Cobalt-Ferromanganese Crusts**

Recently, especially high concentrations of cobalt have been found in ferromanganese nodules, crusts, and slabs on the sides of several seamounts in the EEZ of the Central Pacific. Recovery of these crusts, located on irregular steep-sided seamounts (submarine volcanoes), poses as yet unresolved engineering and mining problems.

The manganese oxide crusts have the highest concentration of cobalt (up to 2.5 percent) at water depths of 800 to 2,500 meters. Crust thicknesses of more than 2 centimeters may yield accessible concentrations of about 16 kilograms of ore per square meter of crustal surface. Therefore, the economic return in cobalt, nickel, manganese, copper, and molybdenum from these crusts could be much greater than from manganese nodules at deep water sites. It has been estimated that a single



*A phosphorite. Such rocks are rich in phosphate, which is used in fertilizers and many other products. The rock shown is 32 centimeters long. (Photo by Frank Manheim, USGS)*



Cobalt-rich manganese crusts occur on the flanks of volcanic islands and seamounts. (Drawing courtesy of USGS)

seamount could yield up to 4 million tons of ore. Approximately 100 of these seamounts exist in the EEZ of the Hawaiian Islands and Line Islands alone. The potential cobalt resources are far larger than any known source on land.

### Polymetallic Sulfides

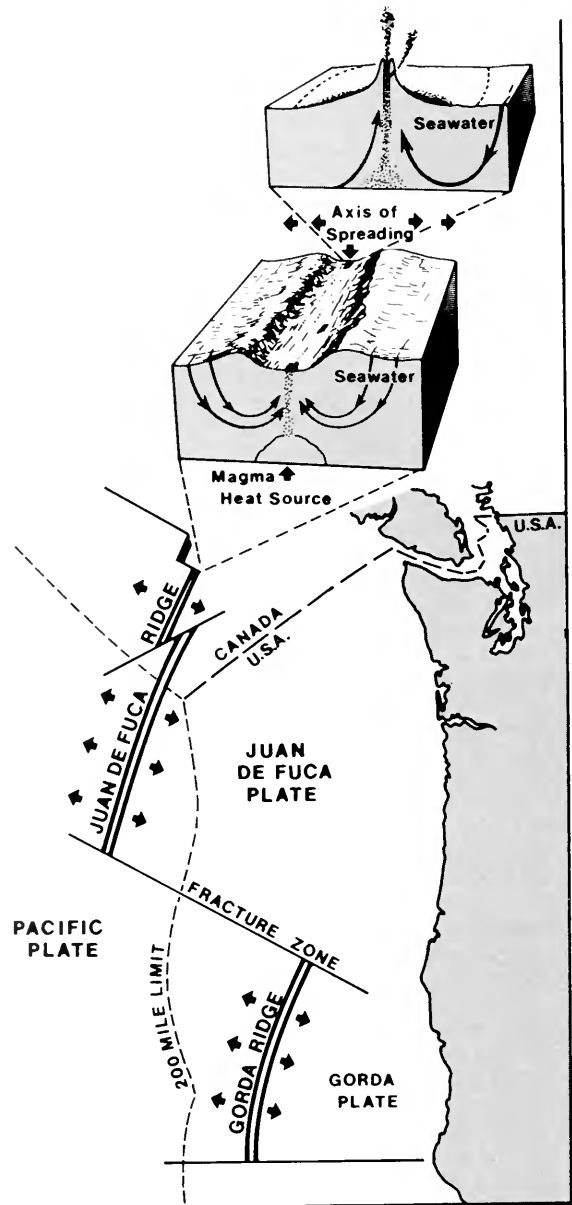
Polymetallic sulfides have been recovered from the sea floor of several areas in the eastern Pacific. Similar sulfides are also found in many onshore areas, such as Canada, Cyprus, India, Italy, the Philippines, the Soviet Union, and Turkey. Such sulfides are rich in copper, zinc, and silver. The discovery in 1979 of hydrothermal vents on the East Pacific Rise at 21 degrees North in the mouth of the Gulf of California supported the hypothesis that polymetallic sulfide deposits were formed as a result of sea-floor volcanism.

Studies using the submersible *Alvin*, operated by the Woods Hole Oceanographic Institution for the U.S. Navy, found active hydrothermal vents with fluid temperatures exceeding 350 degrees Celsius. These vents are commonly called "black smokers" because the plumes contain enough sulfide to be black in color. The sulfide mineralization is produced when deeply circulating very hot seawater leaches heavy metals and sulfur from rocks below the sea floor. On coming in contact with the cold ocean water, the metals and sulfur precipitate, producing deposits containing iron, copper, and zinc sulfides; silver; and anhydrite (calcium sulfate). Similar deposits have been discovered at the Galápagos Rift, the Guaymas basin within the Gulf of California, the Juan de Fuca Ridge (which extends into the EEZ of Canada), and on the East Pacific Rise at 11 degrees North and 20 degrees South.

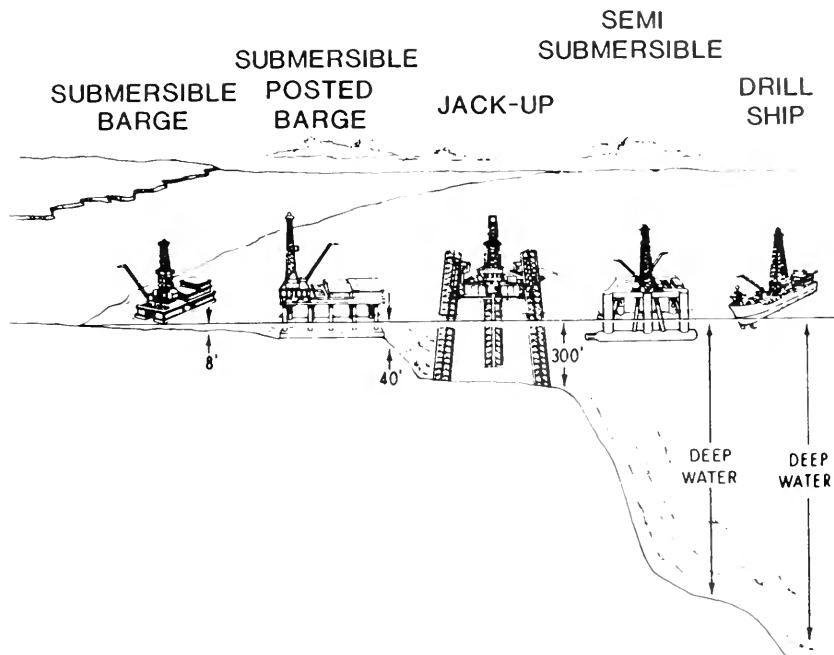
### Oil and Gas Resources

Production of offshore oil and gas from the U.S. EEZ is presently valued at \$26 billion annually. By comparison, fisheries landings are about \$2.5 billion annually. In terms of strategic importance, offshore oil production in 1983 accounted for about 11 percent of total U.S. production, while offshore gas production accounted for about 24 percent. Ninety percent of the oil and almost 100 percent of the natural gas produced in federal waters in recent years has come from the Gulf of Mexico. The U.S. Geological Survey has estimated that between 26 and 41 percent of the oil and between 25 and 30 percent of the gas in U.S. undiscovered resources lie offshore.

In the 1970s, great expectations arose from



Polymetallic sulfides are formed at mid-ocean ridges, where seawater heated by magma leaches minerals from the seafloor. Such sulfide deposits have been found on the Juan de Fuca ridge within the EEZ of Canada, but have not yet been encountered on the Gorda Ridge.



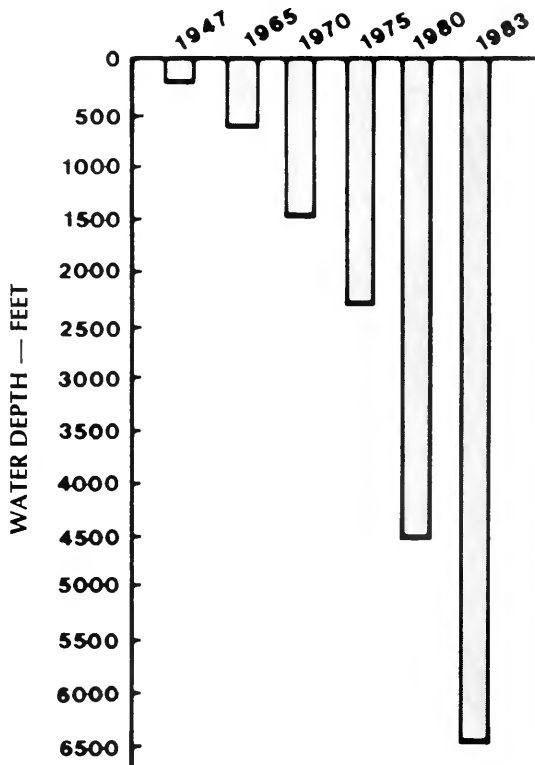
Different types of mobile drilling rigs are used in different water depths.

both federal and industrial estimates of oil and gas reserves on the outer continental shelf of the North Atlantic. But subsequently more than 45 wells have been drilled on the U.S. East Coast; all came up dry, although four produced flows of natural gas and one produced flows of gas and oil. The trend is toward deeper drilling depths. New emphasis is being placed on exploration at greater depths in both the Gulf of Mexico and the northern regions. As drilling has moved to deeper waters, the platform design has changed significantly, particularly in the Arctic.

### Environmental Data Requirements

The petroleum industry has demonstrated clearly its willingness to develop offshore oil and gas reserves. The industry has favorably responded to the charges of the Stratton Commission report: "... it will be difficult but essential to establish a reasonable dividing line between what industry should do for itself under profit motivation and what government should do to assist. In most instances, programs that benefit only a specific industry more properly should be carried out by that industry. ..." Similar concerns will apply to minerals development in the future.

Both industry and the government have a major concern—that EEZ environmental data bases be created and maintained for the prediction of short- and long-term environmental trends, and of oceanographic and meteorological conditions. The stability of seafloor sediments and possible distribution of pollutants by sedimentary processes must be understood. The development of these data, along with development of the assessment technology and predictive capability, are required for any resource development project in the EEZ. Without this type of data and assessment capability, EEZ offshore structures and operations will always be in jeopardy.



Achievable drilling depths have steadily increased; exhaustion of resources on land is likely to demand further improvements in offshore drilling technology.

### Resources for the Future

No doubt, petroleum will be the most valuable product of the EEZ in the near future. The western Gulf of Mexico already has produced large amounts of petroleum and production is moving toward



Deeper drilling implies greater danger. The Ocean Ranger, a 37-story-tall behemoth, was considered unsinkable. When it went under in 100-mile-per-hour winds off the coast of Newfoundland, 84 people died. (Photo courtesy of UPI/Bettmann Archive)

deeper water where similar geological structures hold great promise. The rest of the EEZ is a frontier area for petroleum.

Trends toward controlling land use near cities that limit extraction of sand and gravel almost certainly will force such mining to offshore areas. Phosphorite is well known in the offshore area; its exploitation will be dictated by the time when onshore resources become inadequate (perhaps tens of years).

Significant concentrations of heavy minerals of economic value are present in shelf sands. Whether these are present in economic quantities is only just becoming known, but preliminary data suggest that they are. Combined mining efforts, in which various heavy minerals as well as sand and gravel are extracted together, look promising.

Ferromanganese crusts and nodules are known to be present in large quantities on the sea floor; they probably could be mined fairly easily. When such mining will begin depends on economic factors and development of additional uses for the nodules.

The polymetallic sulfides discovered in the last decade at sea-floor spreading centers may ultimately be exploitable resources of zinc, silver, and copper.

Valuable resources exist in the U.S. EEZ. Some (phosphorite, ferromanganese nodules, sand and gravel) are well known and exploitation awaits only detailed analyses of their deposits and the proper economic conditions. Some (placer deposits and petroleum) require considerably more

exploration before development. To make these resources available we must begin now to study their occurrence and the logical constraints to their exploitation.

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The views expressed in this article are those of the authors and not necessarily those of the U.S. Government.

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# The Coastal Fishing Industry and the EEZ

by William G. Gordon  
and Richard E. Gutting, Jr.

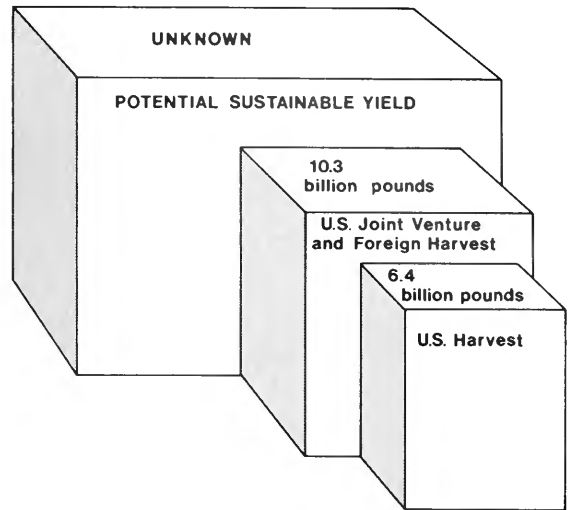
On 10 March, 1983, President Reagan proclaimed the establishment of a 200-mile Exclusive Economic Zone (EEZ) for the United States. The Proclamation and accompanying statement contain two points of importance to coastal fisheries. First, the United States will exercise "sovereign rights" over the living resources within 200 nautical miles of our coasts. Second, one purpose of the Proclamation is to "reinforce the government's policy of promoting the United States fishing industry."

By itself, the Proclamation does not appear to materially change U.S. jurisdiction over its coastal fisheries as set forth in the Magnuson Fishery Conservation and Management Act (MFCMA) of 1976. This act had declared that the United States has "exclusive fishery management authority" over all fish (except tuna) within the Fishery Conservation Zone, a zone essentially identical to the EEZ. The President's action does provide, however, an opportunity for Congress to reexamine our approach to developing these fisheries.

Leaders of the U.S. fishing industry consistently express the industry's desire to fully use the fishery resources within our new 200-mile zone; how the United States chooses to implement the President's Proclamation could provide the key to this development. The basic issue is whether our industry will be given the opportunity to grow in a manner that promotes efficiency and brings long-term prosperity, or whether we will allow this opportunity to be traded off to satisfy other political interests.

## A Healthy Harvest

Our nation's coastal fisheries are an important source of nutrition and recreation, and contribute significantly to our economy, health, and quality of life. They are enormous, yielding about 10 billion pounds of food each year, or nearly 50 pounds for each person in the United States. Added to this amount is another 750 million pounds caught each year by recreational fishermen. Counting all subsidiary effects, our coastal fisheries contribute more than \$23 billion to the economy each year and provide employment for more than a million people.



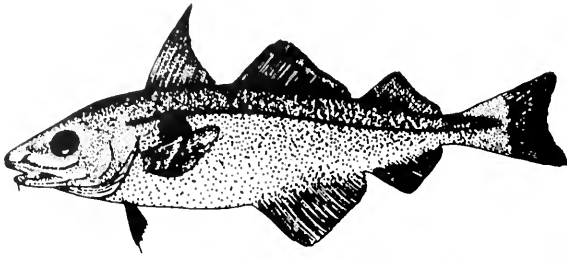
*Fifteen percent of the world's fish and shellfish are found within the U.S. EEZ. Although American fishermen take the majority of the catch, there is significant room for expansion.*

No other country has such abundance and diversity of fish and shellfish off its coasts; fully 15 percent of the world's living resources are contained within the U.S. EEZ. But the United States ranks only fourth\* among the fishing nations of the world. Indeed, less than half the potential yield from U.S. fisheries is harvested and processed by U.S. fishermen and processors. The remainder is harvested by U.S. fishermen but sold to foreign processors, harvested by the fishing fleets of more than a dozen countries, or is left unused.

In 1976, through the MFCMA, the United States declared "exclusive fishery management authority" over its coastal fisheries and established "optimum yield"\*\*\* as the primary goal of fishery management and development. Only that portion

\* The first 12 fishing nations (in order) are: Japan, the Soviet Union, China, the United States, Chile, Peru, Norway, India, South Korea, Indonesia, Denmark, and Thailand.

\*\* Under the MFCMA, *optimum yield* is defined as the amount of fish "which will provide the greatest overall benefit to the Nation," and as the "*maximum sustainable yield* . . . as modified by any relevant economic, social, or ecological factor" [emphasis added].



Haddock.

of the optimum yield not needed by the American industry was to be made available to foreign fishing fleets. This preference to American fishermen for access to the resources, along with other provisions regarding the regulation of foreign fleets, was intended to spur rapid expansion of the U.S. fishing industry, provide jobs, and reduce the U.S. balance of trade deficit in fishery products. The act also emphasized that a national program was necessary to develop fisheries that were not being used by our industry.

U.S. fishermen began to benefit almost immediately. Foreign fishing was reduced to help several stocks of fish\* recover and American vessels began fishing for species that had been of interest only to the foreign fleets. This diversification was prompted in part from the existence of more fishing vessels in some fisheries than the resource and the economic situation could support, and from drastic reductions in traditional stocks. It would not have occurred, however, unless new markets had opened up for American fishermen. These markets were found offshore in new fishing arrangements known as "over-the-side" sales or "joint venture fishing." Under these arrangements, American fishermen catch the fish and deliver them to foreign processing vessels while still on the fishing grounds. Although these at-sea arrangements were new to the United States at the time the MFCMA was enacted, they had been common off the coasts of other countries for many years.

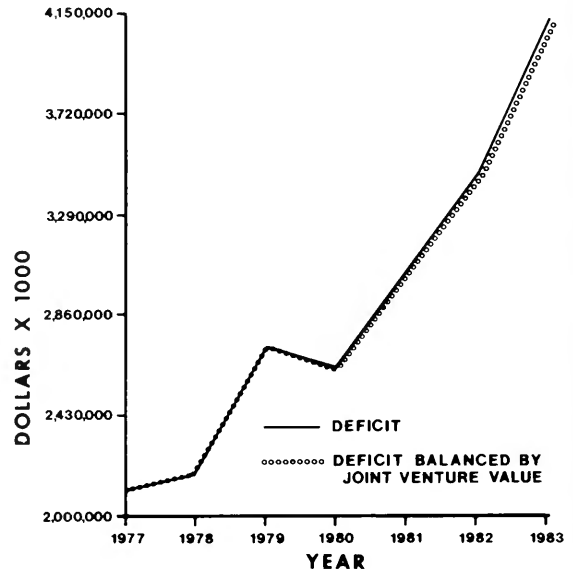
Joint fishing operations involving U.S. fishermen began in the Pacific in the summer of 1978, when the Soviet Union purchased about 2 million pounds of Pacific hake. Growth came rapidly; in 1983, over-the-side deliveries reached 959 million pounds, worth \$51 million. Vessels from eight nations\*\* conducted at-sea operations with American fishermen in both the Atlantic and Pacific fisheries. These arrangements have proved, on an interim basis, to be a major boon to building and maintaining the U.S. fishing fleets needed to replace the foreign fleets.

The willingness of foreign vessels to buy from American fishermen has not been matched by

a similar willingness to buy new U.S.-processed products. Instead, the home countries of the foreign fleets continued to guard their domestic markets against American products. In Japan, for example, the U.S. industry continued to face protective tariffs and quotas as well as informal discrimination—such as intimations of poor quality in U.S. products—that provided substantial advantages to Japanese producers. In another instance, Spain discouraged market access by withholding import licenses or making them difficult to obtain. Similarly, the European Economic Community (EEC) used reference prices and high product tariffs to keep imports into member countries at a minimum. The development of overseas markets also has been impeded by the relatively high cost of U.S. production and the extraordinary strength of the U.S. dollar. As a result, the processing sector of the American fishing industry lagged behind the expansion of our fishing fleet. This trend is apparent from U.S. fishery statistics, which show a growing trade deficit despite increasing sales to foreign processing vessels in the same period.

These trends have prompted Congress to amend the MFCMA several times. The initial growth of "joint venture" fishing in 1978, for example, led to an amendment which made it clear that preference in access to fishery resources was to be given to both American harvesters and processors over the foreign fleets—resulting in the reduction of foreign processing offshore.

In 1980, Congress recognized that as long as foreign nations were permitted to continue a high level of fishing in the U.S. zone while U.S. fish exporters were denied access to important foreign markets, the United States would be unable to achieve full development. In response, the Act was



Joint ventures between U.S. fishermen and foreign processing ships have barely dented the growing U.S. fisheries trade deficit.

\* Haddock and cod off New England, mackerel along the Atlantic seaboard, and ocean perch and Pacific hake off the Pacific Northwest.

\*\* Japan, South Korea, the Soviet Union, Italy, Spain, Portugal, Taiwan, and East Germany.





*Hauling salmon off the coast of Washington. (Photo by Josephus Daniels, PR)*

amended again. This time a “reduction formula” was devised which provided that as U.S. fishing increased, the level of foreign fishing would be reduced by an even greater increment. This formula was a compromise between those interests that sought to impose strict exclusion of foreign fishing and those interests that viewed mandatory reductions as contrary to the principle of full utilization endorsed at the Law of the Sea Conference. The formula, however, was so complicated that it essentially was never implemented.

Far more important was the 1980 codification of the so-called “fish and chips” policy, which linked the right of foreign fleets to fish in U.S. fisheries to the purchase of U.S. fish products. The fish and chips policy prescribes eight criteria for making allocation decisions, including such factors as whether the nation has tariff or non-tariff barriers to restrict importation of U.S. fish or fish products, the level of cooperation with the United States, and so on. Clearly, under this policy, market access was to be the touchstone of the federal government’s decisions to allocate surplus fish to the foreign fleets. Nevertheless, while foreign companies often will buy fish from American fishermen in their effort to secure allocations, they continue to resist importing U.S.-processed products.

### **Foreign Relationships**

The President’s EEZ Proclamation raises the issue

of whether the relationship between the United States and the foreign fishing fleets should be altered.

At the present time, the federal government allocates “surplus” fish to several different countries on a year-to-year basis. The process is exceedingly complex and time consuming. Last year, for example, allocations were made to 11 nations,\* of which six fished,\*\* and—as noted earlier—eight different countries were permitted to buy fish directly from American fishermen. Some 19 different allocation decisions were reviewed or made by numerous officials in the Departments of Commerce and State.

At the heart of all this activity is the fish and chips policy, but the future effectiveness of this approach to opening overseas markets is uncertain. In recent years, the number of foreign countries involved has increased, threatening to make the process even more complex.

The system also is becoming more and more political as growing numbers of lobbyists and applicants argue over fewer and fewer fish. Major disruptions of the allocation process have been prompted by such unrelated issues as the public’s concern over whales and the Soviet Union’s

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\* Bulgaria, West Germany, Italy, the Netherlands, Faroe Islands, East Germany, Japan, Portugal, South Korea, Spain, and Taiwan.

\*\* West Germany, Italy, East Germany, Japan, South Korea, and Spain.

invasion of Afghanistan. These factors are weakening the industry's ability to plan for future growth and the federal government's ability to insist that foreign nations extend economic benefits to the U.S. fishing industry in exchange for the right to operate in U.S. coastal fisheries.

The President's EEZ Proclamation may help to counter these forces. Prior to the Proclamation some nations had disputed the right of the United States to impose economic conditions, arguing that we only had the right to scientifically manage and conserve fishery resources. The Proclamation makes it clear that the federal government views the access of foreign nations to our fisheries to be a privilege that is to be earned, and not a right. Since the Proclamation, agreements with several foreign nations have incorporated this principle. Along similar lines, Senators Robert Packwood (R.-Ore.) and Slade Gorton (R.-Wash.) sponsored an amendment to the Magnuson Act that would deny allocations to foreign nations as a matter of right. Similar proposals were made last year by Senator Ted Stevens (R.-Alaska) and Congressman John Breaux (D.-La.).

Congress is also working on ways to improve the government's implementation of the fish and chips policy. The changes in the MFCMA proposed by Senators Packwood and Gorton link allocations to the purchase of U.S.-processed fishery products on a species-specific basis.\* In other words, if a foreign nation wants an allocation of pollock, it must buy U.S.-processed pollock products. Representative Don Young (R.-Alaska) also has proposed to eliminate the government's authority to take factors unrelated to the fishing industry into account when allocations of fish are made to foreign fleets.

Not everyone is convinced that the fish and chips approach to opening foreign markets will work in the future. Senator Stevens, for example, advocates a scheduled phaseout of foreign fishing.

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\* **Editor's Note:** On 10 October 1984, the Congress passed an amendment to the MFCMA clarifying that the United States is not required by law to allocate the total allowable level of foreign fishing, and requiring an evaluation of what a particular nation is doing to improve U.S. access to its markets for the particular species for which an allocation is sought. On 8 November 1984, President Reagan signed the bill.

In his view, the very existence of allocations inhibits the ability of our fishermen and processors to replace the foreign fleets. He points out that there is a possibility that U.S. fishermen will be denied increases in allocations for Pacific ocean perch in the Gulf of Alaska this year, while foreign fleets are permitted to continue their harvest.

This inequity stems from a large foreign allocation and an underestimation of the needs of U.S. fishermen delivering fish to foreign processing vessels. With the elimination of allocations, problems such as this would become nonexistent. Senator Stevens' basic argument for a phaseout, however, is that an elimination of the foreign fleets would provide the incentive needed to overseas buyers to purchase U.S. products in order to fulfill the demands of their existing markets.

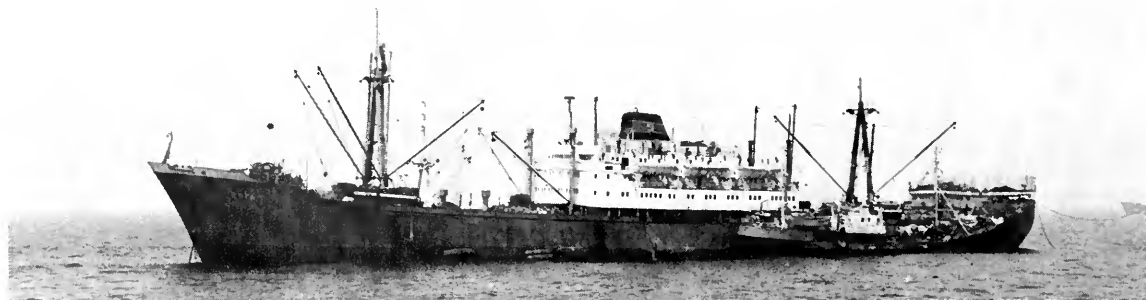
Senator Stevens argues that we need to send foreign nations a clear signal of our commitment to full domestic utilization of these resources. Foreign nations must be made aware that their fishing in our waters will soon be a thing of the past. A phaseout over a specified number of years, he argues, would send this signal, and would encourage foreign companies to invest in cooperative ventures with U.S. harvesters and processors. These cooperative arrangements would guarantee foreign companies access to the fisheries resources and all of the resulting privileges of U.S. harvesters and processors mandated under the MFCMA.

### Private Versus Public Property

The President's EEZ Proclamation also raises another issue. Under the legal framework established by the Magnuson Act, the federal government has more of a public trust rather than an ownership relationship over coastal fishery resources. Under this philosophy, fish are viewed as common property available on a first-come, first-served basis to all Americans.

This open access to fisheries has led to rapid fleet expansion in those fisheries with products in high demand. Regulations necessary to conserve those fisheries have curbed the opportunities of individual vessels to maintain production levels. As a result, vessel productivity has dropped sharply in some fisheries and output costs have escalated.

The New England otter trawl fleet,\* for



A fishing vessel tied up to a Soviet factory ship. (Photo courtesy of the National Marine Fisheries Service)

example, grew from about 600 vessels in 1977 to nearly 1,000 vessels in 1982. Fleet landings increased, but not enough to warrant the increased number of vessels. Productivity declined and costs shot up. Between 1977 and 1982, the catch per unit of effort for the fleet dropped 15 percent. The effects of the decline, combined with rising input costs, resulted in a doubling of the cost to the fishermen per pound of fish caught. Prices received by fishermen barely rose enough to cover the increased costs, and there was no real improvement in the fleet's profitability.

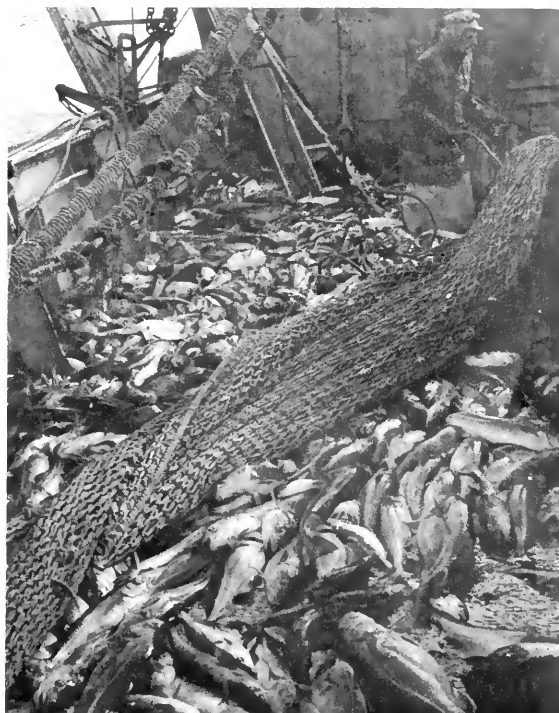
One implication of the reference to sovereign rights in the President's Proclamation is ownership. This implication raises the issue of whether or not the federal government should vest itself with property rights over fisheries and rent or sell opportunities to fish to private industry. Legislation would be needed before such a change were made. Such a change, however, would mark a radical departure from the way fisheries are presently managed and developed.

Indeed, the legislation that has been proposed to implement the Proclamation goes out of its way to say that "Nothing in this Act is, nor shall be deemed to be, a basis for any royalty, fee, tax or other assessment of revenue, for fishing by United States flag vessels." But is this the best policy? Some argue that actions such as this should be taken to increase the economic return from our coastal fisheries.

A few state fishery agencies and regional fishery management councils have attempted to make fisheries more efficient by limiting the number of vessels. For a number of reasons, these "limited entry" programs have not been universally accepted. The licensing procedures used often appear very mechanistic and unresponsive to the interests of the resource users.

Some argue that a more acceptable way of controlling entry into our fisheries would be to allocate resource shares directly among the participants, perhaps via an auction. In this way, the resource shareholders, individually or collectively, could decide on the best harvesting system to take their share of the resource. As opposed to the first-come, first-served chaos of today, under a resource share approach it would be in the interests of the shareholders to apply fishing effort judiciously so as to insure perpetuation of the resource and the greatest long-term net economic gain. Proponents also point out that along with establishing a system to allocate resource shares, it is equally important that the shareholders be able to follow fishing strategies and marketing plans with a minimum of outside interference.

Proponents of this approach say that there is an urgent need to put some type of resource sharing plan into place to protect the gains made by domestic fishermen since the Magnuson Act was enacted. If this is not done, they argue, we will



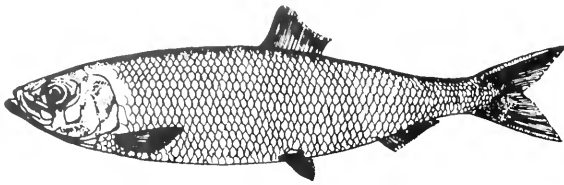
*A West German fishing boat with a load of cod on Georges Bank. (Photo courtesy of the National Marine Fisheries Service)*

see one fishery after another become overcapitalized with resulting adverse social and economic consequences.

What can happen without a share system is illustrated by the halibut fishery, which is managed on a first-come, first-served basis. To conserve the resource, fishery managers have had to drastically reduce the fishing season. What exists today is a mad scramble of intensive effort over a short period of time. This results in a massive infusion of fresh halibut into the market in a very short period of time. Under a share system, halibut fishermen would be able to exercise their personal judgment, based on resource, weather, and market conditions, to determine when to fish. The season could be spread over time with substantial reduction in conflict. Added to this would be reduced government involvement and regulations. Similar examples could be drawn from the Atlantic coast clam, scallop, and haddock fisheries.

Those opposed to resource sharing programs argue that they would be counterproductive, unfair, and too complicated to operate. The American commercial fishing industry, they argue, has economic problems that would be aggravated by share systems requiring payments or assessments for the opportunity to fish. Fishermen, they argue, make their contributions to society through the taxes they pay. They produce food products of high quality and domestic importance, generate substantial employment, and contribute to the international economic strength of the United States. They should not be required to pay

\* A method of fishing that involves towing a net along the ocean bottom.



Herring.

for the fish which are the common property of all Americans.

### Clear Policy Needed

The American fishing industry has made substantial progress. Significant investments have been made, and new markets have opened up. The additional investment needed to develop these fisheries to their full potential, however, is massive and the direction of future market growth is unclear. Foreign governments are becoming increasingly resistant to further trade concessions and the political struggle over access to our fisheries has intensified. Several of our more traditional fisheries are overcrowded. Many people in government and industry believe we have come to a crossroads and need a clear and consistent policy to guide and foster future development.

The President's EEZ Proclamation said that our coastal fisheries belong exclusively to the citizens of the United States. It did not say what the United States intended to do with them. It does, however, give us an opportunity to fashion the national policies needed to insure that the American people obtain the maximum benefits from these resources. We believe that an enormous economic opportunity is waiting offshore for our domestic fishing industry and our nation. Whether or not we fully realize this potential depends on our courage to grasp it.

*William G. Gordon is Assistant Administrator for Fisheries of the National Oceanic and Atmospheric Administration, Washington, D.C. Richard E. Cutting, Jr., is Vice-President for Government Relations of the National Fisheries Institute, Washington, D.C.*

The views presented in this article are those of the authors and not necessarily of their respective organizations.



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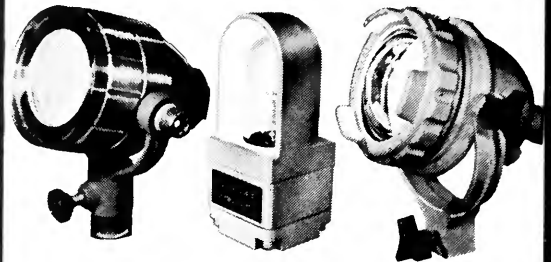
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# U.S. EEZ Relations With Canada and Mexico

by Robert E. Bowen  
and Timothy M. Hennessey

One of the more pressing concerns facing the United States in the aftermath of the Exclusive Economic Zone (EEZ) Proclamation is the establishment of mutually agreed upon boundaries with Canada and Mexico. In setting these boundaries, differences in views over the legal status of the United Nations Convention on the Law of the Sea (hereafter referred to as the LOS Treaty), in interpretation of customary international law, and in resource management approaches, are likely to cause confusion and conflict between the United States and its neighbors.

Boundary settlement is important to EEZ jurisdiction for one rather straightforward reason. If the comprehensive resource jurisdiction established by the EEZ claim is to lead to more comprehensive management of coastal marine resources, it is necessary to be able to precisely characterize the nature of those resources. Since substantial resources are located in areas of boundary dispute, one could argue that a determination of such boundaries is a prerequisite to the rational evaluation of various proposed EEZ management strategies.

The development of alternative jurisdictional regimes for the regulation of transboundary resources and other ocean uses also has caused conflict between the United States and its neighbors. One can identify three major concerns: 1) management of resources that are transboundary in nature (for example, the northern anchovy fishery exploited by the United States and Mexico, the Atlantic herring fishery exploited by the United States and Canada); 2) resources exploited by the citizens of one country within areas of jurisdiction claimed by another nation (for example, the exploitation of tuna by American vessels within the Mexican EEZ, or the Mexican exploitation of squid off the coast of New England); and, 3) nonresource activities that require a mutually agreed upon regulatory regime (such as the management of vessel pollution or the regulation of marine scientific research).

One source of conflict rests in the historic differences in marine policies followed by the three countries. Interpretation of ambiguous Law of the Sea Treaty language will be influenced both by historic preferences and by an emerging body of individual national practice. A complicating factor is that, while Mexico and Canada have signed the LOS Convention, the United States has not.

Indeed, this trilateral situation is an unusual one. These three nations are strongly allied—politically and economically—and both Mexico and Canada share extensive boundaries with the United States. Yet, each approaches LOS issues from a



Among the resources affected by disputes with Canada and Mexico are important fishing grounds. Here a worker in Alaska prepares king salmon for freezing. (Photo by Steve McCutcheon, PR)

different perspective, attempting to maximize a different set of interests. Further, all three countries historically have been active and influential participants in the development of an international law of the sea. Canada and Mexico are longstanding proponents of strong coastal nation jurisdiction. The United States has voiced an often contradictory set of policy preferences, but has generally favored limitations on coastal nation sovereignty and jurisdiction.

## EEZ and the LOS

The concept of an EEZ was introduced early in the bargaining at the Third United Nations Conference on the Law of the Sea. One of its earliest manifestations came in the form of a working paper\* prepared by a group of nine coastal nations, including both Canada and Mexico. Upon submission of that document, the Canadian representative stated:

*"The point of departure of the sponsors, and those with whom [we have] collaborated, [is] that the existing law of the sea [is] incomplete, inadequate, and anachronistic.*

*It is the firm conviction of the sponsors of the working paper that the law of the future must be based on new and imaginative concepts, such as the economic zone,*

\* A/CONF.62/L.4.

the patrimonial sea, and the common heritage of mankind, while at the same time retaining those principles which [are] relevant to today's world."

Central to Canadian policy was the need to be able to adequately protect, in their terms, the coastal environment:

*"The Exclusive Economic Zone is not just a question of resources. It also include[s] the rights and duties of the coastal [nations] to protect the marine environment and control scientific research. It is not merely a matter of bargaining between rights over resources and navigation rights. The coastal [nation] should have the right to utilize and preserve resources adjacent to its coasts, since the survival or development of its people depends on those resources and because it [is] in the best position to regulate their rational exploitation."*

Indeed, the former Canadian Prime Minister, Pierre Trudeau, stated that the principle of "clean seas"\* is "as vital a principle for the world of today as the principle of free seas had been for the world of yesterday."

The Mexican position, while supportive of Canada, derived from a rather different set of interests. These were articulated by President Luis Echeverria Alvarez in July of 1974:

*"The new Law of the Sea, now in preparation, [is] one more indication that the Third World ha[s] ceased to be the passive object of international relations, and ha[s] now become an active participant. The concept of an economic zone up to 200 miles in breadth, which would doubtless form the nucleus of the future Law of the Sea, [is] a natural consequence or corollary of the development philosophy, which reinforce[s] the ideals and expectations of the Third World."*

The early response by the United States to discussions of the EEZ was, at best, lukewarm. In his comments following the introduction of the working paper, John Stevenson, representing the United States, stated:

*"... [my] delegation [can] not negotiate (on the question of establishing an EEZ) in the face of conceptual arguments that any particular idea [is] incompatible with the essential character of the zone. One of the most serious restraints in the history of the Law of the Sea on the expansion of coastal [nation] jurisdiction over resources ha[s] been the concern that jurisdiction would, with time, become territorial in character. Although the proponents of the economic zone have argued that it could be constructed with sufficient safeguards to prevent such a result, Document A/CONF.62/L.4 tend[s] to confirm some of [my] delegation's serious misgivings... Accordingly, [my] delegation [is] unable to express even tentative acceptance of the document as a basis of negotiation."*

It is possible, then, to offer a general characterization of the approaches of the United States, Canada, and Mexico to the establishment and jurisdiction of the Exclusive Economic Zone. All three have now established an EEZ, yet each has different expectations and policy goals. These

differences have contributed to several boundary and management conflicts and will likely be at the base of future ones as well.

## U.S./Canadian Relations

An important boundary problem for the United States and Canada involves the area of the Beaufort Sea (Figure 1). The disputed area may contain large reserves of oil and gas. Canada claims that the 141st meridian of west longitude, established in 1825, is a seaward extension of its border and has issued permits for hydrocarbon rights to that line.

The United States argues that the boundary is not the meridian but, rather, runs northeast along a line equidistant between the U.S. and Canadian coasts. This dispute has not been settled and, given the economic potential of the disputed area, agreement may be difficult to achieve.

Areas of conflict over both boundary settlement and resource management include Georges Bank and the Northwest Passage. The dispute over Georges Bank, where fish and possibly petroleum resources are at issue, was to be settled in 1979 by a combined boundary treaty and fishing agreement. But heavy opposition to the agreement by the U.S. fishing industry held up ratification of the agreement in the Senate. It was then decided to submit the dispute to the International Court of Justice for adjudication. The United States claimed all of Georges Bank, arguing that it is a natural prolongation of the continental shelf.

Canada, initially using the principle of equidistance, claimed approximately a fourth of the bank. Later Canada increased its claim to a third of the bank based on the principle of equitable equidistance. In October of 1984, the court released its decision granting approximately 80 percent of the bank to the United States and the remainder to Canada (see map page 45). The court did not fully support either country's argument, basing its

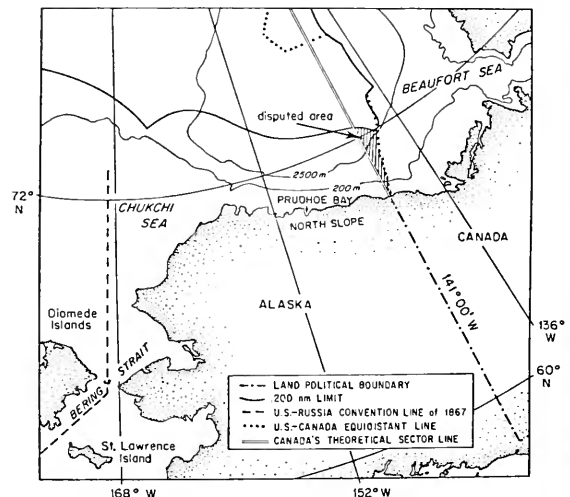


Figure 1. The resolution of the U.S.-Canadian boundary in the Beaufort Sea may affect jurisdiction over significant oil and gas reserves.

\* Canada and some other nations have pushed strongly for minimum pollution discharges into the ocean.

decision on other geographic considerations. Setting the Georges Bank boundary, however, has done little to lessen the potential for management conflicts in the region.

For example, major scallop beds are located in both the U.S. and Canadian sectors and productive harvesting areas may vary in location from season to season. Such limitations clearly could lead to antagonism and future boundary conflicts. Further, it is anticipated that conflict will continue to exist over such transboundary stocks as haddock, cod, flounder, herring, and squid. One obvious solution to these dilemma would be joint fisheries management, but given the depth of historic differences, it is unlikely that such bilateral cooperation will be forthcoming.

The United States has important strategic interest in the Northwest Passage (Figure 2a and 2b). Beyond the potential for military uses, the passage is a prime route for the transport of oil from Prudhoe Bay in Alaska to East Coast markets. Canada considers the waters within the Arctic Archipelago, including the waters of the Northwest Passage, to be the internal waters of Canada, and claims its jurisdiction is made clear by a series of its legislative and administrative acts, the most recent of which is the Arctic Waters Pollution Prevention Act of 1970. Moreover, Canada has asserted that ships enroute through the passage are subject to the conditions of Article 234 of the LOS Convention, the so-called Ice Covered Area Provision, which specifies extensive rights to adopt and enforce regulation for the prevention, reduction, and control of marine pollution from vessels in such areas.

The United States does not recognize the territorial claims advocated by Canada, is not a signatory to the LOS Treaty, and has consistently proclaimed the applicability of traditional ocean law and high seas principles to the Northwest Passage. These conflicting interpretations are significant and make the future availability of the passage for shipping problematic.

### U.S./Mexican Marine Relations

The setting of marine boundaries with Mexico has been a longstanding problem between the United States and Mexico. In 1935, Mexico made claim to a 3-league (9-mile) territorial sea, basing its arguments on the 1848 Treaty of Guadalupe-Hidalgo signed with the United States. The U.S. strongly disputed the claim, countering that the broadest internationally accepted territorial sea was 3 nautical miles. The Gulf of California also has been an area of historic dispute. In 1968, Mexico extended its territorial sea baseline south, to a point midway down the gulf where boundary lines were drawn connecting several islands. Once again, the United States strongly protested, stating that the Mexican claim was contrary to accepted international practice (Figure 3). The United States also protested the Mexican declaration of an EEZ in 1976, stating that such a move was premature given the status of negotiations at the Third U.N. Conference on the Law of the Sea.

One current concern relates to the delimitation of baselines in the Gulf of Mexico. The



Figure 2a. The Manhattan, a vast tanker that pounded her way through the Northwest Passage in both directions in the hope of opening a new route for Alaskan oil in 1969. She was accompanied by the Canadian icebreaker John A. Macdonald. Again and again the icebreaker was called upon to free the tanker from the ice, but the Manhattan eventually made it through to Point Barrow, Alaska. The project was financed by four U.S. oil companies who put up \$40 million to test the feasibility of tanker transportation through the ice channels. (Photo courtesy of Exxon Corporation.)

baselines from which the Mexican EEZ is measured are drawn, in some instances, from islands off the coast of the Yucatan Peninsula. These claims, according to the Mexican government, were made in accordance with the relevant articles of the LOS Treaty. A provisional agreement on the issue was reached by U.S. and Mexican negotiators in 1976, embodied in an Exchange of Notes (24 November 1976), and confirmed in a treaty signed in 1978.

However, during the process of treaty ratification, questions were raised by the U.S. Senate concerning the justification of using the islands as baseline points. Particular concern was raised by petroleum geologists, who argued that the agreement may place substantial oil and gas reserves under the sole jurisdiction of Mexico. In response, it was even suggested that Mexico should measure its EEZ from the continental coastline, and that the remaining open area (and its oil and gas reserves) be split equally between the two countries. While Senate ratification of the treaty is still outstanding, informal agreement on this issue may have been reached recently, but details are not yet publicly available.

U.S./Mexican fisheries relations have been contentious for the better part of this century. The legal status of highly migratory stocks, such as tuna, is one of the major concerns. The United States has

## Implications of the U.S./

On 12 October 1984, the International Court of Justice settled the dispute between Canada and the United States on the location of the boundary line across Georges Bank. This 20-year-old dispute (see *Oceanus*, Vol. 20, No. 3, 1977), in which the U.S. claimed 100 percent of Georges Bank while the Canadians claimed 35 percent, involves one of the world's richest fishing grounds for cod, flounder, haddock, and scallops.

The dispute began in the mid-1960s over the issuance of oil-exploration permits. In 1964, Canada issued oil-exploration permits on the eastern portion of Georges Bank. The U.S. State Department was diplomatically informed of these in 1966, and issued a reservation in 1968 and a formal protest to the Canadian government in 1969. The area formerly in dispute is approximately 15,000 square nautical miles of ocean (see map). Estimates of the energy resources of the entire bank vary widely, but the U.S. Geological Survey has estimated that the bank could contain 1.5 billion barrels of oil and 12.2 trillion cubic feet of natural gas.

The dispute intensified in 1977, when both countries expanded their fisheries jurisdiction to 200 nautical miles from 12. Both the United States and Canada wanted to exclude foreign fishing vessels from Georges Bank. In 1973, foreign fishing vessels (that is, other than those of the United States and Canada) caught approximately 80 percent of fish landed from Georges Bank (the Soviet Union, 42 percent and East European Countries, 30 percent) while the United States and Canada only landed 11 and 9 percent, respectively. The United States has fished the entire bank for more than 150 years. Canadian vessels generally have fished in this area only since World War II but the fishery has become quite important in that time. The Canadian Government has estimated that exclusion of Canadian fishermen will cost \$80 to \$100 million a year and as many as 3,600 jobs in the Maritime Provinces.

The hope for an oil discovery on Georges Bank (encouraged by the natural gas field discovered in 1979 in the nearby Canadian Scotian Basin) and the fishery issues are the factors that brought the dispute to a head. U.S. oil companies have, to date, drilled eight wells in the southern, undisputed section of the bank, but all have been dry.

### The Court Decision

The two countries agreed in 1981 to have the International Court of Justice at The Hague, Netherlands, settle the dispute. They requested that five judges hear the case

(instead of the normal 15). The judges came entirely from Western democracies (Italy, France, West Germany, the United States, and Canada). They voted four to one, with the French judge dissenting, for a final decision that can be regarded as a compromise. The judges rejected arguments based on historic ties, economic interests, geological units, or ecological regional units, and based their decision largely on a modified equidistant procedure. Canada contended that the boundary should be drawn equidistant from adjacent national territories. The United States argued "special circumstances" which included arguments based on the geographical prolongation of the United States into the ocean. The Court's final decision gave about a half of the disputed area to each country. This gave Canada about a sixth of Georges Bank (see map).

### Aftermath

New England fishermen were deeply disappointed with the decision because the northern region of the bank, granted to Canada, is an area rich in scallops and one of only two spawning grounds for haddock on the bank. The Fisheries Council of Canada estimated that, even though the new Canadian section is a highly productive scallop region, the area will not support the existing scallop fleet.

During the last eight years, the Canadian scallop fishery has declined because of overfishing. In 1976, Canadians landed approximately 90 percent of the scallops caught on Georges Bank; in 1977, they landed approximately 73 percent; more recently their catch has been at the 50 percent level. The court decision may lower it even more. Most of the Canadian catch for the last several years has been exported to the United States and has been a major source of revenue for the eastern provinces.

In the United States, the loss of a key fishing ground is expected to reduce the U.S. seafood harvest and drive up consumer prices. The real effects are very difficult to estimate. For example, cod and haddock migrate north in winter and will be available to the Canadians; in summer, they migrate south and will be available only to U.S. fishermen. Therefore, stock size and management practices will play a more important role in the number of fish caught by either country than will the boundary line. Also, if one particular fishery is reduced or unavailable, vessels can sometimes be refitted to go after another. Thus it is quite difficult to project real figures on the cost of the boundary decision to either the U.S. or Canadian fisheries.



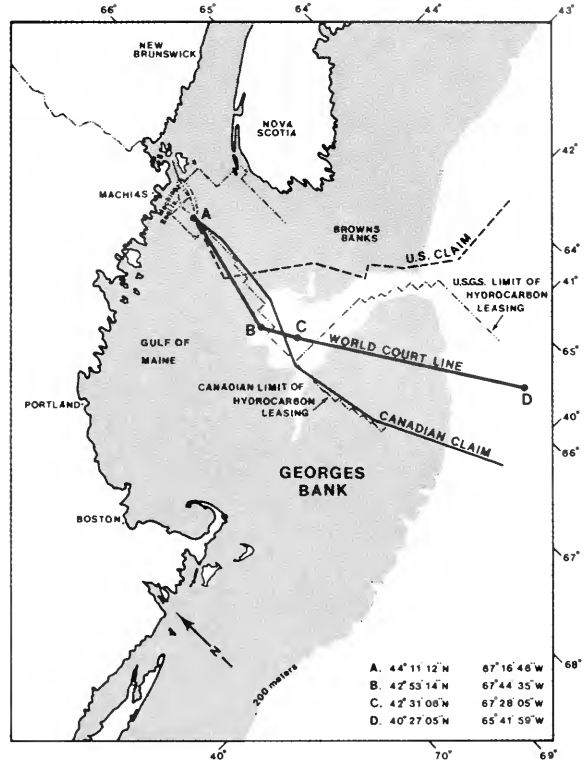
# Canada Boundary Decision

## Undermining the Future

Because the court issued a relative compromise decision, basically granting each country *half* of the disputed area, the Georges Bank decision may have some impact on Bernard Oxman's third option of compulsory dispute settlement (see page 52), although his proposal does not include compulsory settlement of maritime boundary disputes. This type of compromise in the future may be reached politically instead of through the expensive (\$12 million Canadian dollars plus \$7 million U.S. dollars) process of an international court case lasting several years.

The World Court was unable to make a decision favoring either side, because both countries' positions had merit. The court's decision, however, may foster the development of boundary settlements by political means, rather than by governments taking their chances in court, where win, lose, or draw may be the only options. The World Court decision may do a disservice to the dispute settlement process, because many governments may decide not to resolve their boundary disputes in court. Either way, the United States and Canada must settle three other boundary disputes: 1) the Dixon Entrance (line) between Alaska and British Columbia; 2) the Juan de Fuca Strait boundary between Washington State and Vancouver Island; and 3) the boundary in the Beaufort Sea between the Yukon and Alaska. There are 300 other such boundary disputes around the world, and more are expected to arise as a result of national interpretations of the U.N. Convention of the Law of the Sea (UNCLOS).

—Michael A. Champ



*The World Court's decision pleased few in either nation. Fishermen's rights to follow fish were restricted, and fisheries management plans will have to be coordinated. The dispute turned on both disagreement over fishing rights and conflicting claims to the oil believed to exist under the bank (note oil leasing limits).*

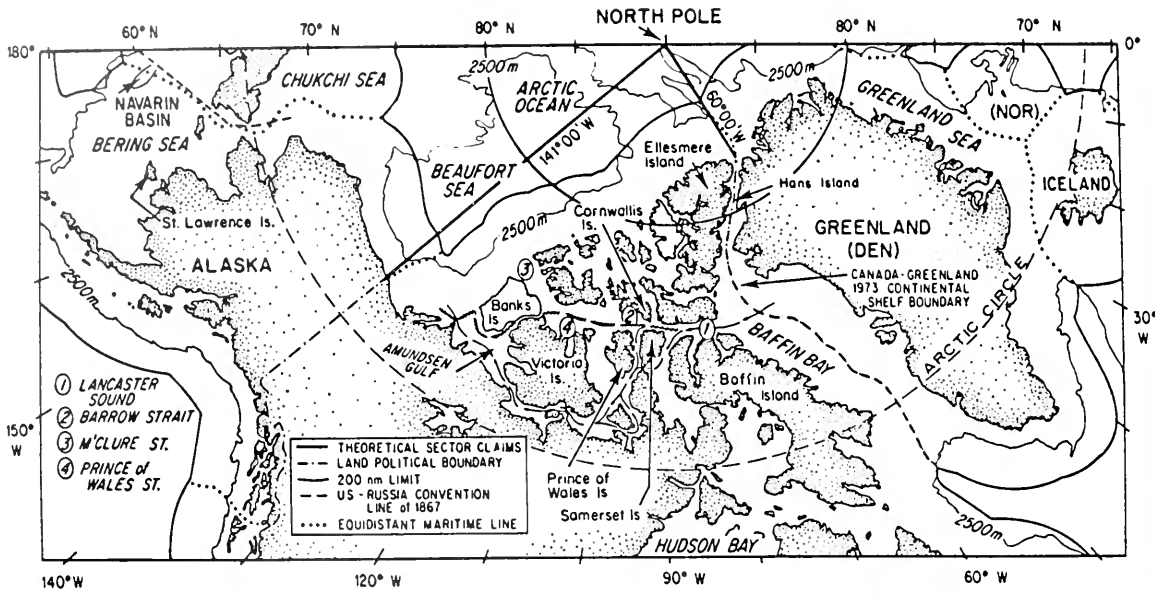
The views expressed are those of the author and not the U.S. Environmental Protection Agency.

consistently argued that migratory species, such as tuna, should be managed by competent regional organizations rather than by individual coastal nations. The management of eastern tropical Pacific tuna has been carried out by the Inter-American Tropical Tuna Association (IATTA). However, in 1978, largely as a result of feelings of inadequate consideration and unfair treatment, Mexico withdrew its IATTA membership.

Mexico has since interpreted the LOS treaty as granting coastal nations sovereign rights over such stocks and has instituted a system of licensing fees for foreign vessels. The United States refusal to recognize that claim has led to seizures and fines of U.S. tuna vessels and a U.S. boycott of Mexican tuna products. Informal talks between U.S. business interests and Mexican officials have yet to produce tangible results.

However, one recent development may help to direct future relations; that is, the signing of the Eastern Pacific Ocean Tuna Fishing Agreement. This agreement, also known as the San Jose Treaty, would create an international authority to license and regulate entry for tuna fishing over a substantial portion of the eastern Pacific. The treaty is not a management tool, although it has been suggested that the treaty council will work closely with the IATTA so that conservation and management recommendations are included in the license granting process. The United States, Costa Rica, Panama, Guatemala, and Honduras have signed the treaty, which will enter into force when ratified by five nations.

A second concern is the exploitation of the northern anchovy fishery in the California Bight—an area ranging from Point Conception in California to



**NORTHWEST PASSAGE & CANADA'S THEORETICAL SECTOR LINES**  
 - - - - - route of the S.S. Manhattan (1969)  
 - - - - - other routes taken

Figure 2b. The Northwest Passage is another area of dispute. The United States regards free passage from Alaska to the East Coast as important for the full utilization of Alaskan oil. Canada worries about possible environmental effects of oil spills on the Arctic environment.

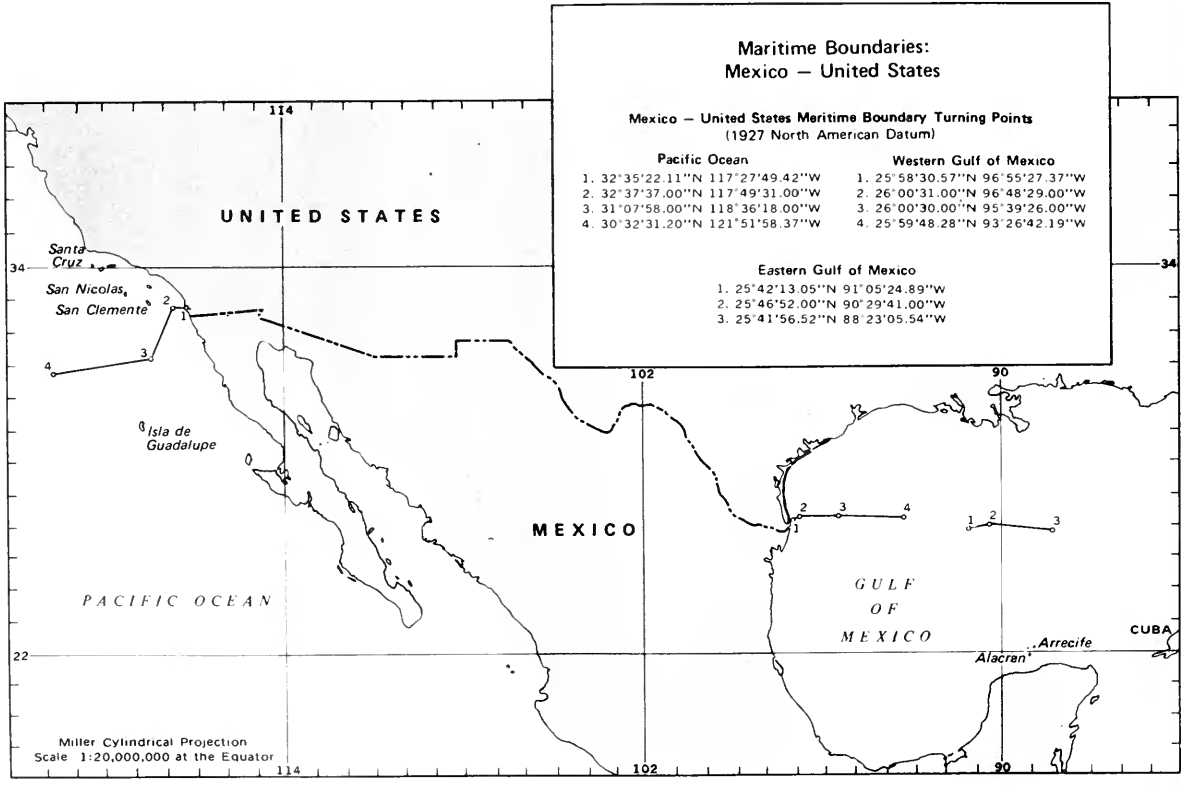


Figure 3. To the south, border disputes turn primarily on several Mexican claims drawn from offshore islands, and affect both petroleum and fisheries resources. Among the more noticeable differences are disagreement over the management of anchovy stocks off the coast of southern California and northern Mexico, and Mexican claims, not recognized by the United States, to ownership of tuna. (Map source: U.S. State Department)

Punta Eugenia in Baja California. The stock moves across the U.S./Mexican border and is exploited by both American and Mexican fisherman during different stages in its migratory cycle.

American fishing is managed by a plan developed by the Pacific Fishery Management Council. However, many scientists argue that the anticipated unregulated expansion of Mexican efforts when the stock is in Mexican waters could dramatically reduce future stock size. Indeed, because the anchovy is such an integral part of the food chain several scientists have suggested that the ecology of the entire California Bight could be substantially altered. There are at present no plans to jointly manage the exploitation of northern anchovy.

Two general conclusions emerge from these situations. Perhaps the most important concerns the dominant role that national perspectives and attitudes play in the negotiation of marine resource issues between the United States and adjacent countries. Both Canada and Mexico view bilateral marine relations within a broader, more inclusive context than does the United States—both link these negotiations with questions of economic and political dependency. Thus, symbolism of the negotiating positions has a substantially greater value for them than for the United States. This suggests that the process of fixing a broadly defined coastal resource zone should necessarily incorporate discussions of the interrelationship of the previously discussed issues, as well as a more consistent

approach to the delimitation of mutually agreed upon marine boundaries.

A second, related conclusion is that United States could consider a regional mediation or arbitration mechanism to help resolve boundary problems. It seems unlikely that the more significant of these boundary disputes will be resolved quickly. The Georges Bank dispute has persisted, in one form or another, for decades. Moreover, the cost of preparing cases for adjudication by the International Court of Justice is prohibitively high, particularly given the number of disputes in which the United States is involved. As a non-signatory to the Law of the Sea treaty, the United States will not have access to the dispute settlement mechanisms therein described. Therefore, one option available to the United States is to develop a general and informal dispute settlement process for itself and its neighbors. The United States, Canada, and Mexico are allied countries with strong common interests in bilateral cooperation. The opportunity to work together in the areas of marine resource management and boundary dispute settlement is one that should be thoroughly explored.

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# Marine Ecology

## AT THE MARINE BIOLOGICAL LABORATORY

June 18 — August 26, 1985

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Peter W. Frank, Oregon (Director). Faculty: James T. Carlton, Williams College — Mystic Seaport; Eugene Gallagher, University of Massachusetts — Boston.

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**DEADLINE: APPLICATION March 1, 1985**

# Transboundary Fishery Stocks in the EEZ

by David A. Colson

When the United States enacted the Magnuson Fishery Conservation and Management Act (MFCMA) in April, 1976, establishing a 200-nautical-mile fishery conservation zone, effective 1 March 1977, it claimed one of the richest prizes of the Exclusive Economic Zone (EEZ)—the right to conserve and to manage the fishery resources within the zone. The political impetus for this was the desire to rid those waters of large foreign fishing fleets that were devastating the fish stocks.

The 1976 Act has succeeded. The U.S. Fishery Conservation Zone, now embodied in the Exclusive Economic Zone, is well established. What foreign fishing that does occur within it, does so under U.S. control. But in the intervening years we have found that the establishment of the jurisdiction was not, in and of itself, a panacea. Problems remain. One of the major ones is that of transboundary stocks.

A stock is a community of fish or shellfish that, under normal circumstances, is capable of maintaining itself without influxes of the same species from other communities. The concept is fundamental to fisheries science and management. On the one hand, each stock should be managed as a unit, because fishing a stock in part of its range will affect the abundance of that stock throughout its range. On the other hand, separate stocks of the same species may be managed independently, because fishing one stock will not affect the abundance of the other stock.

A transboundary stock is one of these communities of fish or shellfish that does not respect the jurisdictional boundaries drawn on charts. Some stocks off the U.S. coast spend only part of their lives within the 200-mile zone, and thus under the controls established by U.S. fisheries laws. Such fish may spend part of their lives in the waters off neighboring coasts, or they may range into waters beyond the jurisdiction of any country.

Given these facts, cooperation and coordination of our fisheries interests with other countries are still needed, because the action of the fishermen from those countries outside U.S. jurisdiction can affect the abundance of fish available within the U.S. EEZ. In other words, in the case of transboundary stocks, the coastal nation does not have all the control it may have thought it would have when it established its 200-nautical-mile jurisdiction.

In the management of transboundary stocks, two different problems arise. The first arises when one regulates fishermen or the fishery for the stock within the EEZ, but finds that no similar controls are placed upon those fishing that stock beyond the zone. Such fishing activity frustrates conservation and management goals and makes it difficult to attain the cooperation of fishermen to abide by

regulatory controls. The second problem arises when a transboundary stock becomes the subject of two different management regimes—mutually frustrating each other's goals.

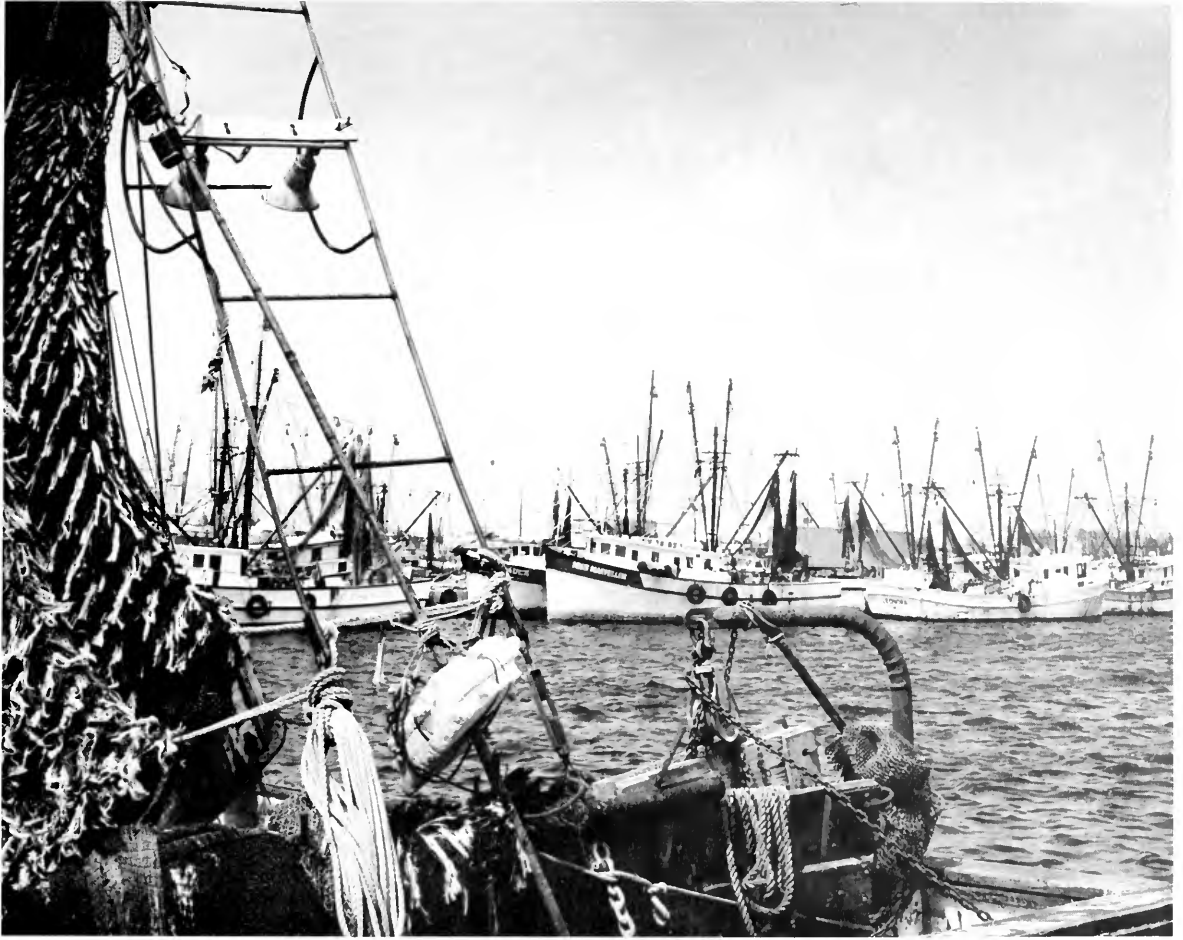
A few examples of the difficulties inherent in the management of transboundary stocks:

**Shrimp in the Western Gulf of Mexico:** With the passage of the Magnuson Fishery Conservation and Management Act, significant adjustments were required in the fishing patterns of the shrimp fishing industry in the Gulf of Mexico. For many years, the industry had ranged the coastal waters of the Gulf, including those of Mexico, without significant restrictions. With the establishment of our own 200-nautical-mile zone, the United States was compelled to recognize Mexico's jurisdiction over shrimp fishing off the Mexican coast. The United States was able to negotiate a phase-out of the U.S. shrimp fishery off the Mexican coast, which allowed for some gradual adjustment to the new reality. But today, no U.S. vessel fishes lawfully in Mexican waters for shrimp.

In the last few years, the shrimp of the Gulf of Mexico have been made the subject of a great deal of scientific study. While shrimp stocks are still not fully understood, we know that there is a significant migration of shrimp from United States to Mexican waters, and possibly vice versa. U.S. management strategy calls for area closures to protect juvenile shrimp. This makes good sense if the shrimp stay in U.S. waters and, therefore, can be caught in those waters when fully grown. But if the only result of this regulation is to allow the shrimp to escape U.S. fishermen and be caught by Mexican fishermen, some question may be raised as to the advisability, from the U.S. perspective, of the management goal.

Just how this problem is to be dealt with in the Gulf shrimp fishery remains to be seen. Two factors likely will play a role. One of these is fisheries science. To make judgments about the effects of fishing on transboundary stocks, one needs a data base from which to work. That base is just beginning to be developed. The second factor is the perceptions of fishermen, which in many cases do not correspond to the views of scientists. The politicians, fish managers, and negotiators must take both viewpoints into account if a transboundary stock is to be managed effectively.

**Pacific Salmon:** Pacific salmon present a classic transboundary stock problem. The salmon, which hatch in the rivers along the west coast of North America, spend most of their life cycle in the high seas. As they near the end of their lives, they return to the rivers from whence they came. It is at this stage that they become subject to major commercial



*Shrimp boats in port. U.S. fishermen are now excluded from fishing for shrimp in Mexican waters, but recent evidence suggests that U.S. protection of juvenile shrimp is primarily helping Mexican shrimpers. (Photo by Maurice E. Landre, PR)*

fisheries. Some salmon which spawn in the rivers of the United States are caught by Canadian fishermen off the coast of Canada before those fish come within U.S. jurisdiction. The opposite also occurs—that is, some salmon of Canadian origin are caught by U.S. fishermen in U.S. waters before reaching Canadian jurisdiction. Plus, there is a problem with transboundary rivers, such as the Yukon, that run through the territory of both countries.

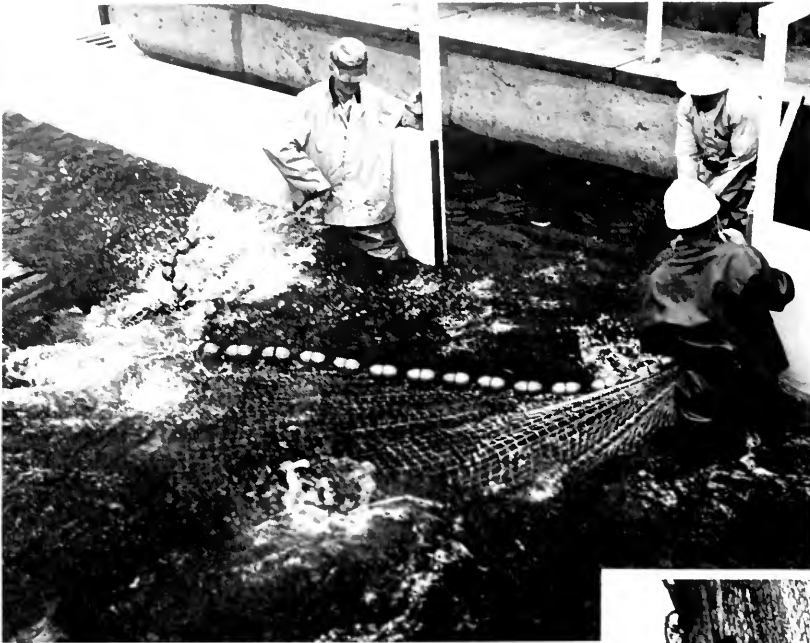
For at least 20 years, the United States and Canada have been trying to negotiate a salmon agreement. Such an agreement would limit the interception by each side of salmon originating in the rivers of the other country. If such an agreement should be reached, it would ensure that each side would gain a return on the investment it put into its salmon fisheries. As things stand, however, the question of why one country should build a salmon hatchery or engage in other salmon enhancement projects to produce more fish for the other side is still in need of an answer.

Scientific knowledge about Pacific salmon stocks has not been lacking; nor has there been a lack of genuine interest on both sides to reach an agreement. But politically, because of the complex

fisheries involved, the problem has been that the fishermen who would benefit from the proposed agreement are not necessarily those who would pay its price. For example, the Alaskan fisherman, asked to reduce his catch of salmon bound for Canadian rivers, is not the specific person that benefits when Canadian fishermen reduce their catch of salmon bound for the rivers of Washington State. This very basic consideration has made it impossible, to date, to resolve the problems associated with the transboundary Pacific salmon stocks.

**Tuna:** Tuna is a transboundary stock in the truest sense. Tuna stocks migrate through the 200-nautical-mile zones of a number of countries, and the high seas areas beyond, in the course of their migration patterns. For this reason, the United States maintains that tuna may effectively be conserved and managed only through international management by regional organizations. The United States has not asserted jurisdiction over tuna off its coasts, and does not recognize the jurisdiction of other nations over these species.

The U.S. viewpoint is regarded as valid from a



*Collecting salmon eggs in British Columbia. Without a U.S.-Canadian agreement on salmon fishing, operations to improve stocks by one country may help only fishermen of the other country. (Photo by Jen and Des Bartlett, PR)*

scientific perspective, but it is generally not accepted from the viewpoint of international politics. This means that, in the case of tuna, a different kind of transboundary stock problem is present—a difference in jurisdictional perspective. The United States is prepared to work within international organizations to conserve and to manage tuna stocks, but, because the United States does not recognize the jurisdiction of coastal nations over tuna, American fishermen pursue the species into 200-nautical-mile zones of other nations, where such fishing is prohibited. One consequence of such fishing is occasional seizure of American tuna vessels. The United States then must become diplomatically engaged to secure the release of the vessel. The end result is often a diplomatic incident, which may include trade embargoes and the termination of foreign aid.

**Georges Bank:** Georges Bank, one of the world's great fishing areas, lies off the coast of New England and Nova Scotia. Most of the commercially important fish on the bank—such as cod, haddock, and scallops—are from localized stocks associated with the bank itself. When the United States and Canada established their 200-nautical-mile fishery zones in 1977, a serious dispute arose over where the boundary between those zones should be. The United States believed it was entitled to all of the bank; Canada believed it was entitled to the northeastern third of the bank.

It proved impossible to resolve this dispute by negotiation and the issue was put to the World Court for a binding decision.

In the Gulf of Maine (Georges Bank) case, the United States argued that the World Court's decision should minimize disputes and the potential for conflict and facilitate resource conservation and management by not placing the boundary in such a



*U.S.-Canadian negotiations on salmon fishing have been stymied by difficulties in equitably allocating hardships and benefits. (Photo by Josephus Daniels, PR)*

Hauling in a tuna. The U.S. refuses to recognize any national claims to tuna. Consequently, American boats are periodically seized by other nations.



way that transboundary stocks would be unnecessarily created. Instead, in the U.S. view, the goal of the court should be to place the boundary northeast of Georges Bank, leaving most fish stocks entirely within the jurisdiction of either the United States or Canada—that is, minimizing the creation of transboundary stocks. By contrast, a boundary that divided the bank, as Canada sought, would make most, if not all, the stocks on the bank transboundary stocks.

The judgment of the court did not specifically address the arguments the parties put forward about transboundary stocks, but the effect of its judgment was to establish a boundary line on Georges Bank essentially “splitting the difference” between the claims of the parties. Accordingly, the rich fisheries of Georges Bank, once the exclusive province of the American fisheries, later the target of the great distant-water fleets, and more recently jointly fished by the United States and Canada, are now transboundary stocks ranging between U.S. and Canadian jurisdiction. No one should minimize the bilateral difficulties that will be faced in the conservation, management, and utilization of these stocks in the future.

### Control Elusive Despite EEZ

In conclusion, the conservation and management of a transboundary stock is often a first-class source of political, diplomatic, and fisheries management headaches. In the long run, effective conservation and management of transboundary stocks requires the cooperation of all nations concerned. But such cooperation is not easily found when fishermen are competing for a scarce resource. If these sound like words from the pre-200-mile days, so they are. In the case of transboundary stocks, one country does not control the range of political and economic factors affecting the fishery. For the United States, the simple jurisdictional assertion of a 200-nautical-

mile zone has not given it full control over a number of the fisheries that are mainstays of the American fishing industry.

*David A. Colson is Assistant Legal Adviser for Oceans, International Environmental and Scientific Affairs, Office of the Legal Adviser, U.S. Department of State.*

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The views expressed in the above article are those of the author and do not necessarily represent the positions of the U.S. government.

### Letter Writers

The editor welcomes letters that comment on articles in this issue or that discuss other matters of importance to the marine community.

Early responses to articles have the best chance of being published. Please be concise and have your letter double-spaced for easier reading and editing.

# Navigation, Pollution, and Compulsory Settlement of EEZ Disputes

by Bernard H. Oxman

The history of the law of the sea in the 20th century is a story of dramatic and accelerating assertions of control by coastal nations over areas that previously were regarded as free high seas. An ever-shrinking minority continued to regard the free high seas as beginning at 3 nautical miles from the coast. A growing number of nations took the position that the free high seas did not begin, either in principle or for certain purposes, until a very substantial distance from the coast, such as 200 miles.

The 200-nautical-mile Exclusive Economic Zone (EEZ), as elaborated in the 1982 U.N. Convention on the Law of the Sea (the LOS Treaty), represents a compromise between those interests that sought a broad territorial sea and those that sought a narrow one. The accommodation is achieved by a functional allocation of rights and duties, rather than by splitting the difference in geographic terms.

The essence of the accommodation is a balance between the freedom of all countries and their nationals to use the zone for some purposes, such as navigation, and the right of the coastal nation to restrict or control uses of the zone for other purposes, such as fishing or mining. The more that functional balance shifts in one direction or the other, the more the Exclusive Economic Zone resembles either the free high seas or the territorial sea.

## The Problem

A major problem posed by this system is that there is no geographic litmus test\* for determining whether a coastal nation is attempting to extend its controls too far. The coastal country enjoys substantial rights to control certain activities throughout the zone. The question therefore becomes whether a coastal nation is unlawfully interfering with navigation and other freedoms.

With respect to navigation, the problem is especially pronounced. While all countries and their nationals enjoy freedom of navigation in the zone, the coastal nation has certain rights to prevent, reduce, and control pollution. It is not hard to imagine an environmental justification for countless restrictions on shipping that would yield effective control over navigation. While the nature of coastal nations' rights and the limitations on their exercise

affect in a significant way the extent to which navigation in the zone is in fact free; they also affect the degree to which a coastal nation is allowed to protect its shoreline and offshore resources.

Furthermore, there is the question of whether a coastal nation may attempt to use its unquestioned powers over certain activities, such as fishing, as a basis for expanding its control over navigation. For example, it is not hard to imagine a resource justification for prohibited zones or restrictions on dangerous cargos. An imaginative Federal Aviation Administration attorney once wondered if potential damage to fisheries from sonic booms might constitute adequate grounds for restricting the *Concorde*.

None of this is a problem from the perspective of those interested in free navigation if one of three assumptions is correct. The *first assumption* is that coastal nations have been educated by the Third U.N. Conference on the Law of the Sea and now recognize that their interests would not be served by interfering with global free navigation. If the history of the Law of the Sea is any guide, this is not a conservative assumption regarding the probable behavior of countries outside Europe and the United States.

The *second assumption* is that the major maritime powers, in particular the United States, will effectively oppose attempts by other coastal nations to extend their control over navigation in the Exclusive Economic Zone. There is little in 20th century history to suggest that the United States or other major maritime powers would now expend sufficient political or economic capital, not to mention military force, to dissuade coastal countries from such a course of action. There are infrequent exceptions, such as our actions against Cambodia during the Ford Administration, and Libya during the Reagan Administration. These, however, are examples of those rare coastal nations where we had no major political or economic investment that might be compromised by a firm response. As a more typical example, representatives of companies with investments in Ecuador apparently persuaded President Nixon to waive statutory sanctions against Ecuador for seizure of U.S. tuna boats.

The *third assumption* is that the text of the Law of the Sea Treaty regarding the Exclusive Economic Zone and pollution from ships is sufficient to restrain incursions by coastal nations against navigational freedoms. This assumption rests on

\*A litmus test is a simple procedure (requiring only a sheet of specially treated paper and a chart of possible results) of the acidity or alkalinity (pH) of water.





Freedom of navigation is vital to U.S. military strategies. Here the frigate USS Bradley cruises near a coast in the South China Sea. (Photo courtesy of the U.S. Navy)

certain further assumptions: that other nations not party to the convention will join the United States in respecting the relevant provisions (see page 54); that the United States, including the Congress and the courts, will itself continue to respect the balance of the zone over time under a variety of contrary pressures; that parties to the convention will apply it to non-parties; that the words of the convention will yield to only one interpretation when the underlying question is that of balancing competing rights; and that self-interpretation and self-restraint are adequate to keep behavior within reasonably narrow limits. These are not conservative assumptions.

### **Compulsory Settlement: Another Option**

Even if one were to assume that all nations recognize that they are legally bound by all the provisions of the convention regarding the Exclusive Economic Zone and pollution from ships, including the most detailed restraints, it is evident that the drafters of the convention were still concerned with the possibility of pressure from coastal nations to restrict navigational rights. Thus they took the unprecedented step in global multilateral diplomacy of subjecting to compulsory arbitration or adjudication cases in which a coastal nation is alleged to have violated the provisions of the convention regarding navigation, overflight, and pollution, as well as cases in which a flag nation is alleged to have violated its duties regarding navigation and protection of the environment.

To recall the reflections of the author and John R. Stevenson, then Special Representative of the President, on the eve of the Conference:

*The developing factual (as distinguished from legal) situation in the oceans is one in which every country increasingly believes that it has, in effect, the option of pronouncing and attempting to achieve relevant acquiescence in its interpretation of the law.... Such a system can*

*operate through unilateral customary law, or... through existing interpretation of treaties. The degree to which this can be done in the case of a treaty is largely a function of the specificity of the treaty and the legal talent applied to the endeavor. Given the current trends in the law of the sea, there is reason to believe the process might continue even if a treaty were widely ratified... A system of compulsory, impartial, third-party adjudication is thus an essential element of the overall structure.*

If the provisions of the Convention regarding both freedom of navigation and environmental protection are subject to substantial and continuing pressure, and if states are reluctant to expend sufficient political, economic, or military capital to protect the integrity of those provisions from corrosive precedents, then a third option—a choice other than acquiescence or confrontation in the face of alleged violations—is needed to protect that balance. That third option is compulsory and binding third-party settlement of disputes.

Of course, it is no panacea. Although few wish to get into that position, some of the time some governments will flagrantly flaunt even a binding judicial decision, be it domestic or international. The “enforcement” of any court order directed to someone in command of a substantial armed force depends in large measure on the public opinion of the commander’s supporters, subordinates, and subjects, as well as the ability of others to control or exploit any resistance on his or her part.

The effect of compulsory dispute settlement on nations is analogous to the effect of the possibility of a law suit on private behavior. It encourages governments to seek legal advice before acting. It encourages lawyers to be cautious in rendering that advice. It provides those who have already acted in potential violation of the rules with a face-saving way out of their dilemma: they need not yield to outside

# Status of the Law of the Sea Convention

On December 10, 1982, 119\* States signed the United Nations Convention on the Law of the Sea (LOS Convention). An additional 19 States signed the convention between December 1982 and November 1984, which brought the total number of signatories to 138. The convention remained open for signature until December 9, 1984. It will enter into force 12 months after it has been ratified by 60 States. As of November 13, 1984, the 32 States that have not signed the LOS Convention are:

Albania	Italy	Qatar
Belgium	Jordan	San Marino
Bolivia	Kiribati	Saudi Arabia
Botswana	Lebanon	South Africa
Central African Republic	Libya	Spain
Comoros	Liechtenstein	Syria
Ecuador	Luxembourg	Tonga
El Salvador	Malawi	Turkey
Federal Republic of Germany	Nicaragua	United Kingdom
Holy See	Peru	United States
Israel		Venezuela

As of November 13, 1984, the following 14 States had ratified the LOS Convention:

Bahamas	Gambia	Namibia**
Belize	Ghana	Phillipines
Cuba	Ivory Coast	Senegal
Egypt	Jamaica	Zambia
Fiji	Mexico	

\* Includes the Cook Islands and Namibia.

\*\* Ratified by the United Nations Council for Namibia.

pressure, but only to the rule of law as embodied in the binding judgment of a disinterested tribunal. (Rare is the politician who does not on occasion rely on the courts to provide him with a graceful means of descent from a far-out limb.) Compulsory settlement also permits those who are confident they are acting within their rights to seek a judgment themselves.

While the right to bring an action under the convention is generally limited to governments, there is a special provision that permits an application for prompt release of a vessel or crew to be made "by or on behalf of the flag State of the vessel." The flag state could, by a general statute or in specific cases, authorize the owner or operator of the ship or a labor union representing the crew to seek prompt release on its behalf.

## Who Benefits?

Shipping companies, airlines, importers and exporters, oceanographers, travelers, and consumers have an interest in having compulsory dispute settlement procedures available in order to discourage unlawful detention of ships and aircraft and to obtain prompt release in the event of arrest. There are elaborate safeguards written into the convention for this purpose to which compulsory settlement would apply.

Workers and labor unions, as well as employers, share those interests for the purpose of

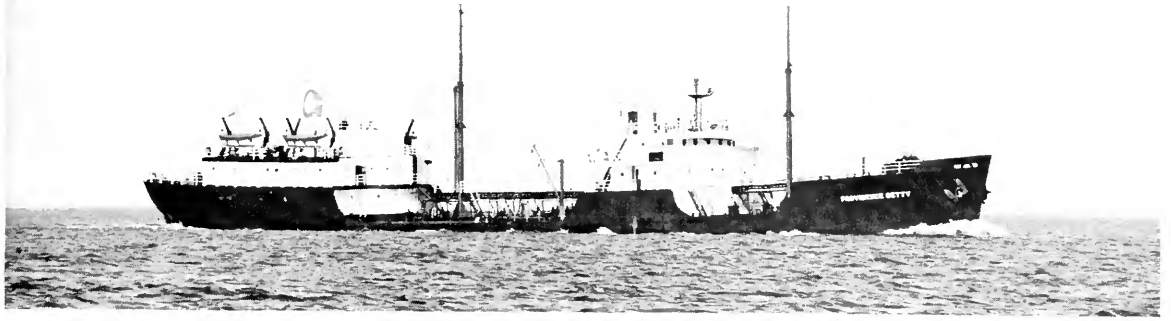
protecting the crew. For example, the convention provides that only monetary penalties, and not imprisonment, may be imposed for a pollution violation by a foreign ship in the EEZ. There is a broad provision that "recognized rights of the accused" must be observed in the conduct of proceedings for such a violation. Human rights advocates would share an interest in having international tribunals interpret and apply this provision.

Environmentalists have an interest in having these procedures available in order to encourage both flag and coastal nations to fulfill their substantial environmental obligations under the convention. They also have an interest in the broader precedent of international arbitration or adjudication to interpret and enforce such obligations.

Members of the American bar engaged in international matters have long advocated compulsory settlement of international disputes.

The United States has security, economic, and environmental interests in encouraging other countries to behave in accordance with the requirements of the convention, and in discouraging occasional temptations on its own part to set adverse precedents by doing otherwise. Thus, for example, the United States Proclamation of an Exclusive Economic Zone is modeled after the convention.

The United States refused to sign the convention because of its provisions on deep seabed



The U.S. economy depends on oil imported from overseas. This flow depends on continued freedom of navigation through many areas that could be claimed as part of an EEZ. This American oil tanker is engaged in coastal transport of fuel oil. (Photo by George Whiteley, PR)

mining seaward of the Exclusive Economic Zone and the continental shelf (see page 6). With regard to the other provisions, including those relevant to the EEZ President Reagan stated:

*[T]he United States will recognize the rights of other states in the waters off their coasts, as reflected in the convention, so long as the rights and freedoms of the United States and others under international law are recognized by such coastal states.*

*[T]he United States will exercise and assert its navigation and overflight rights and freedoms on a worldwide basis in a manner that is consistent with the balance of interests reflected in the convention. The United States will not, however, acquiesce in unilateral acts of other states designed to restrict the rights and freedoms of the international community in navigation and overflight and other related high seas uses.*

A policy of encouraging agreement in advance to compulsory dispute settlement on navigation and pollution issues to the extent required by the convention would enhance our ability to achieve the goals of that policy. It would also underscore the seriousness of our desire to ensure that we and others behave in accordance with the provisions of the convention regarding navigation and pollution.

A policy of encouraging and accepting compulsory third-party settlement of disputes entailing a binding decision should have the approval of Congress for both political and legal reasons.

This could be achieved by submitting treaties to the Senate for advice and consent to ratification. It would seem more efficient and effective, however, to ask both houses of Congress to enact a statute setting forth the circumstances under which the United States accepts such compulsory settlement. These would presumably include a condition of reciprocity. Such reciprocity could be established either by agreement or by parallel legislation on the part of other nations.

#### **Choice of Forum**

The convention gives nations broad latitude to choose the forum for dispute settlement, including

arbitration, the International Court of Justice, or the Tribunal on the Law of the Sea to be established when the convention enters into force. Arbitration is the applicable procedure unless both parties to the case have expressly accepted a different procedure. Assuming we wish to take an approach consistent with the convention, we have a wide choice available.

Arbitration has the advantage of enabling the parties to select the judges and other procedures.

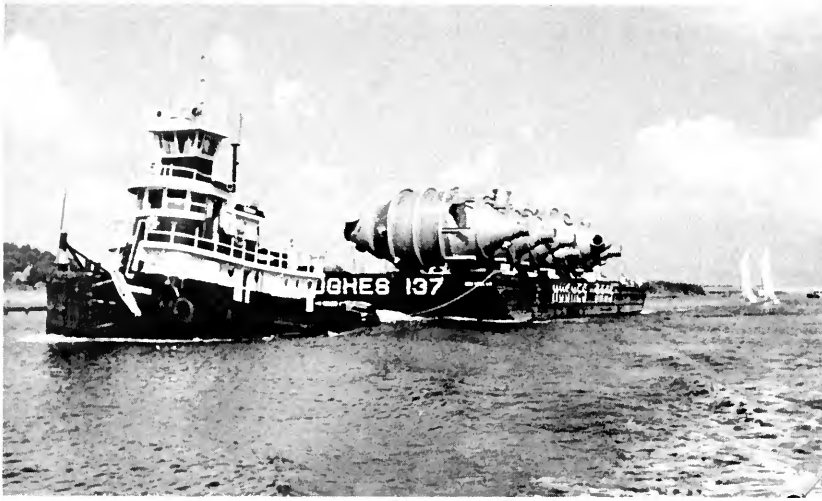
One disadvantage of specifying only arbitration is that the decisions of a standing global court may have greater practical impact as "precedent," that is as authoritative statements of the law that other nations in other situations will be inclined to respect. A further disadvantage (from a plaintiff's perspective) is that it may take substantial time to choose arbitrators, thus delaying any attempt to obtain provisional measures or an order releasing a ship from detention. For this reason, the convention provides that if no agreement on a tribunal is reached within 10 days, an application for prompt release of a vessel or crew may be submitted to the Tribunal on the Law of the Sea.

Even if there is a general preference for selecting arbitration in all cases, it might be useful to include at least the exception contemplated for prompt release of a vessel or crew, specifying either the International Court of Justice or the Tribunal on the Law of the Sea when established.

#### **Scope of Compulsory Settlement**

Since the purpose of the endeavor is to ensure respect for the provisions of the convention relating to navigation, overflight, and pollution, and the balance those provisions establish in the Exclusive Economic Zone, compulsory arbitration or adjudication should be used for alleged violations of the rules of law stated in those provisions (and perhaps some others). While the United States has not signed the convention, it should have no difficulty regarding those rules as fair and balanced statements of the relevant law, as President Reagan himself indicated.

One should be able to derive a formula from the convention that could prove acceptable to the many states that have signed the convention as well those, like the United States, that have not. In this



Sea transport is also vital for equipment too large to be transported by rail or truck, such as these nuclear power plant components. (Photo by George Whiteley, PR)

connection, the United States and perhaps others might wish to exclude from compulsory arbitration or adjudication military activities or other matters for which the convention permits exceptions.\*

### Implementation

The most difficult obstacle to this approach is convincing other countries to agree. Some nations will share our concerns, and may agree for essentially the same reasons that we have, provided we are persistent enough. A few are sophisticated enough to worry about our own potential violations as a coastal nation, and the precedent they would set. Others may refuse to accord us the benefits of compulsory dispute settlement, whatever the benefits to them, because we have refused to sign the convention.

Persuading the majority is likely to require more incentives than mere reciprocity. What is needed is an offer of something more than other nations can have without agreement to compulsory settlement.

The provisions of the convention limiting the standard-setting and enforcement powers of coastal nations with respect to pollution from foreign ships were agreeable to many coastal nations only on condition of compulsory settlement to ensure that flag states comply with environmental obligations. It would be reasonable for the United States to take the position that it will not necessarily respect all of those limitations on its standard-setting and enforcement powers with respect to ships flying the flag of states that do not accept compulsory settlement of disputes.

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\* Nations are permitted to file optional exceptions excluding disputes relating to sea boundary delimitations or involving historic bays or titles, disputes concerning military activities (but not law enforcement activities unless they concern fisheries or marine scientific research), and disputes in respect of which the Security Council of the United Nations is exercising the functions assigned to it by the Charter (unless the Council decides otherwise).

Conversely, the provisions of the convention granting coastal nations the right to enforce pollution standards against foreign ships were agreeable to many maritime powers only on the condition of compulsory settlement in order to protect navigation from abuse of that right. It would be reasonable for the United States to take the position that it will not recognize a coastal nation's enforcement powers unless that nation has agreed in advance to compulsory third-party dispute settlement with respect to such powers. The problem with this approach is that to many nations it would not be credible that the United States would resist, more than verbally, the exercise of powers that it is prepared to concede may be lawfully exercised by a nation that accepts compulsory dispute settlement. A definite set of statutory sanctions, such as closure of U.S. ports to a country that arrests a U.S. vessel for non-resource-related activities, could overcome some of those doubts.

The fact that there are difficult obstacles to overcome in persuading other countries to go along does not mean that we should not try. We succeeded against heavy odds in the convention, although in those negotiations we had additional leverage based on the links between dispute settlement and our substantive positions as well as our potential participation in the convention.

We lose nothing by a sincere effort. Whatever we gain is probably better than what we would otherwise have.

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# EEZ Offers Chance for Foreign Collaboration

by David A. Ross\*

The United States should establish an office in conjunction with our new Exclusive Economic Zone (EEZ) to promote and develop international cooperation in marine science. The Law of the Sea Treaty, regardless of whether or not it is ultimately ratified, will bring marine science in approximately 42 percent of the oceans under the control of various nations through its EEZ and continental shelf provisions, or their own. American marine scientists will be (and already are) experiencing difficulties in working in such foreign waters; examples presently include India, and Trinidad and Tobago. If such difficulties do not cease, there will be problems in implementing many important international oceanographic and marine programs.

The Law of the Sea Treaty and the declaration of a U.S. EEZ mark the beginning of an exciting new era in oceanography. To capitalize fully on this opportunity will require the collective efforts of government, industry, and academia. The benefits of such a collaboration would far exceed the modest funds needed to initiate an "Office for International Cooperation in Marine Science."

## Background

In the last few years, there have been considerable changes in how various foreign countries perceive the oceans. This, in turn, may influence future U.S. marine scientific research in foreign waters. The two principal factors behind these changes have been the Law of the Sea (LOS) Treaty and advances in marine science and technology, mainly by American scientists and engineers. In the latter case, the increased knowledge and potential for ocean use, exploitation, and modification could result in many economic benefits for coastal countries.

This ocean "promise" has been especially attractive to developing coastal countries, which see major economic potential in their new marine territories. Full application of the LOS Treaty would result in approximately 42 percent of the ocean coming under coastal nations' jurisdiction. The combination of these two factors has led many of the world's coastal countries to focus increased or new attention on their marine and coastal environment.

However, it also is apparent that most developing countries have little or no marine

science and technology capabilities with which to undertake the necessary studies to capitalize on or even to explore the potential of their new territories, whereas the United States has considerable experience.

The dimensions of the problems and opportunities for some foreign countries are immense. Consider, for example, Portugal, which with its new EEZ (including zones for its offshore islands) is now about one part land and nineteen parts water; other countries have even more impressive ratios.

Control by coastal states over their EEZs (including jurisdiction over marine science) is a reality regardless of whether or not the LOS Treaty is eventually adopted, since most countries have already established EEZs and have or are considering legislation that covers and/or controls most ocean uses in this zone.

This enclosure of the coastal ocean comes at a time when the U.S. marine science community faces a decrease in the number of available ocean-going ships and increasing budget constraints. However, it also is a time when major studies, in areas such as air-sea interactions (for example, climate and global ocean circulation) and new technological applications (for example, satellites), could lead to innovative ocean use.

## The Need For A Global Effort

These studies and others will require access to *all* EEZs, as they include essentially all upwelling zones, most subduction zones, most real or potential marine resources, and, of course, all continental margins. EEZs encompass that part of the ocean that has the most variability, receives most of the erosion and waste products from land, and is the most used and abused. To exclude this region from active research would narrow the effectiveness of ocean science studies.

Many oceanic phenomena are global or regional in nature and cannot be fully understood by research in just one part of the ocean. For any American scientist to propose and conduct efficient and effective studies in a foreign EEZ will require cooperation with scientists and scientific institutions from the foreign nation. This collaboration will have to be structured so as to help to define the problems, develop and implement the methods of observation, exchange information, and publish the results.

Thus, the success of U.S. international marine research will depend on continued access

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\* This article is based on testimony of the author before the Subcommittee on Oceanography, U.S. House of Representatives, 26 September 1984.



*This is one type of marine scientific activity requiring a cooperative effort. (Photo by Michael Schofield, WHOI)*

to foreign waters, and this will require developing cooperative programs with scientists or institutions in these foreign countries. A single program may not be sufficient to ensure continuing access for any researching nation. Longer, more continuing relationships may often be necessary.

This is a challenge for oceanographers. Controls and regulations on marine science in foreign EEZs are many and complex. They require detailed negotiations, permission, data exchange, possible training and assistance efforts; especially required is close cooperation with the foreign country in all phases of the research activity. The challenge is to develop and maintain successful and viable foreign programs without sacrificing excessive amounts of time and the resources of any marine scientific community. Meeting this challenge will require skills and infrastructure not presently available to most marine scientists.

Despite the obvious need for increased cooperative efforts in marine science with foreign countries, there exists no central U.S. organization that can represent the spectrum of American marine activities and interests. Several governmental agencies have international marine affairs offices (the National Oceanic and Atmospheric Administration [NOAA], the National Science Foundation [NSF], and the State Department, for example) and several institutions maintain active international operations. These

offices are not highly visible, however, and they primarily serve (and correctly so) the organizations they represent. At the same time, there is a limited awareness between agencies, organizations, and institutions of the foreign programs engaged in by others. A coastal country looking to cooperate with the United States may find this array of organizations a bewildering labyrinth. From the viewpoint of our marine scientific community, a foreign program undertaken by one U.S. organization may not always lead to benefits elsewhere (such as continued access or knowledge of how to work with that country).

All of the major U.S. oceanographic institutions in the last few years have received inquiries for assistance in what is generally called "marine policy." They have immediate questions concerning coastal zone use—for example, development and conservation of marine resources (fish, minerals, tourism, and so on). The Woods Hole Oceanographic Institution (WHOI) already has developed specific programs with Colombia and Ecuador and has efforts pending with Jordan and Brazil. These four projects are quite modest and are principally funded by private foundations.

With Jordan, WHOI is exploring a cooperative research program concerning the Gulf of Aqaba and its increased use. With Brazil's Interministerial Commission for Marine Resources, WHOI is developing a marine resources training

program. With Colombia, several of that country's uses of its marine environment have been analyzed and suggestions have been made for future activities. With Ecuador, the Marine Policy and Ocean Management Center at WHOI is assisting in developing a management plan for the Galápagos Islands, including consideration of a marine park. Although these programs have been successful in their objectives, considerably more work remains, not for just WHOI, but for the entire oceanographic community in the United States.

### The Opportunity

The United States and its marine scientists (from government, industry, and academia) can benefit from the establishment of foreign EEZs as well as offer assistance to these coastal countries. The marine community in the United States has developed extensive expertise in coastal management (NOAA's Coastal Zone Management Program, for example), in marine resource development (National Marine Fisheries Service, Sea Grant, and industry) and in basic marine science and marine policy studies (academia).

The question then is: Is the United States efficiently and successfully making American skills and academic resources available for foreign cooperative opportunities? We could and should be doing better. To do so would lead to increased scientific research opportunities and other benefits for our marine community and, indirectly, for the nation. This is not to criticize the several excellent cooperative foreign programs in existence, but rather to suggest that there are many more opportunities, and they are being missed.

### A Proposal

The establishment of an Office for International Cooperation in Marine Science would provide a focal point for foreign contacts seeking to develop cooperative programs with the U.S. marine scientific community, and vice versa. The main objectives of such an office could be:

- To improve opportunities for those in the marine community wishing to work with foreign countries (and in foreign waters).
- To improve access for foreign countries and institutions to marine scientific research and training opportunities in the United States.
- To collect and circulate information in our marine scientific community concerning opportunities, mechanisms, and funding sources for foreign programs.
- To identify countries or areas with particular problems or requirements, and advise on mechanisms for dealing with such problems (based on information from scientists who have had experience in such countries).
- To identify American scientists interested in working in specific fields in specific foreign countries.
- To assist in the development of multidisciplinary (and perhaps multinational) teams.

Before discussing these objectives more fully, two points should be addressed. Is such a mechanism needed? If so, where should it be located?

### Is Such a Mechanism Needed?

The interest of other countries in studying, evaluating, and exploiting their coastal and offshore potentials is obvious to those individuals involved with international activities. Two recent reports\* by the Ocean Policy Committee (OPC) of the National Academy of Sciences have described this interest. U.S. marine scientists have shown continued interest in working in foreign waters regardless of LOS problems. In addition, there seems to be a clear, yet undocumented, increase in the visits of foreign scientists and officials to marine institutions in this country, in many instances to explore mechanisms for cooperation.

The 1981 study by the Ocean Policy Committee (conducted by its Marine Technical Assistance Group) looked at several specific points and recommended policies and mechanisms for future U.S. programs of marine technical assistance and cooperation. A workshop held in La Jolla, California, was attended by about 60 persons, including 20 representatives of developing countries, international institutions, or industrialized countries other than the United States.

A key recommendation of the meeting was that an office be established as a central point of contact for American or foreign investigators seeking information on U.S. support for marine-related projects. It also was recommended that economists and social scientists be involved in planning, management, and evaluation of marine-related projects to assure adequate consideration of the sociopolitical and economic framework of the host country.

One mechanism that has been partially successful for U.S. scientific involvement with foreign countries has been the Intergovernmental Oceanographic Commission (IOC) and the Marine Division of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). However, some future U.S. opportunities may be reduced or eliminated because of the U.S. withdrawal from UNESCO, scheduled for Jan. 1, 1985, unless reconsidered.

The Agricultural and Industrial Development Agency (AID) of the U.S. State Department has recently turned its attention toward marine problems and development in foreign countries. This agency, with its considerable capabilities, may make an important contribution toward international marine science cooperation.

Another approach for development of foreign marine scientific projects has been the Sea Grant International Program. However, this program currently has no specific budget, although a few small foreign efforts have been developed with private funds. Private foundations, such as the William H. Donner Foundation, the Tinker

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\* See references.

Foundation, and others, have funded cooperative foreign programs (at the University of Miami, Scripps Institution of Oceanography, the University of Delaware, and WHOI, for example), but foundation resources are limited and often directed toward specific geographic regions.

### Where Should the Office be Located?

There are several obvious locations for such an office, including within the federal government (State Department, NSF, or NOAA), within the academic community (a specific institution, the University National Oceanographic Laboratory System [UNOLS], or the Joint Oceanographic Institutions [JOI]), or somewhere separate from any of these entities, such as within the National Academy of Science. The first few years of this program would be an experimental period. At any location, a key challenge would be to ensure that the office is perceived as (and indeed is) an "honest broker," willing to consider all interests of the marine community (academia, government, and industry). To maintain the broadest possible spectrum of contacts, the office probably should be located outside the U.S. governmental structure, where it would be neither an official agency nor responsible for coordinating governmental programs (nor would it be a funding agency).

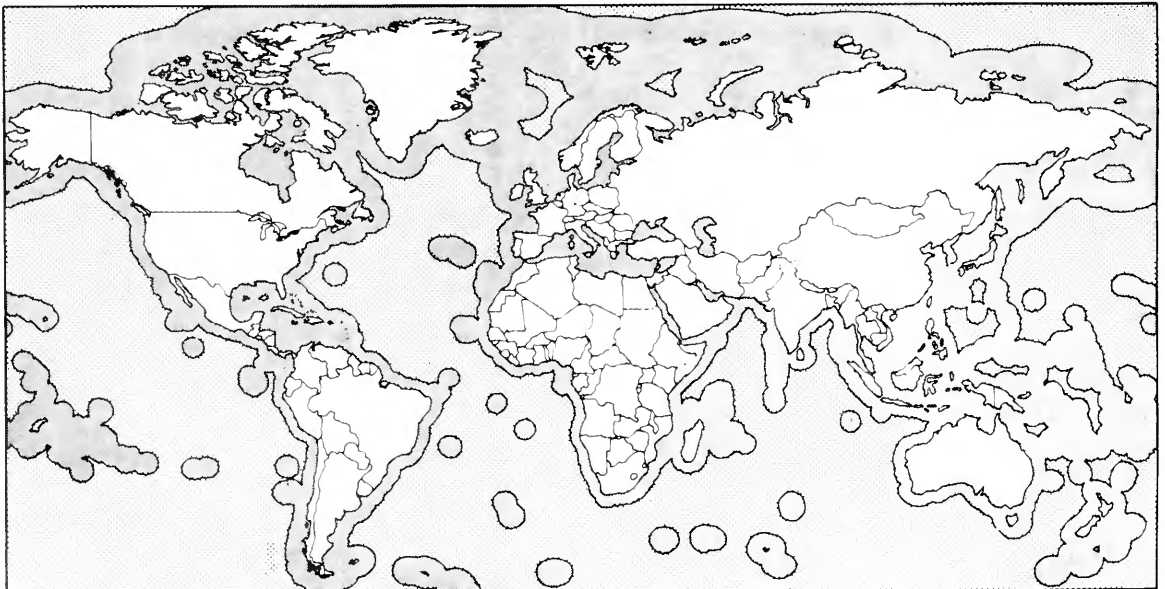
Coordination, policy direction, and new initiatives for cooperation within the U.S. government would remain, as before, the role of appropriate governmental bodies. The Office for International Marine Science Cooperation should become an instrument for marine technical cooperation, but it should not lobby for specific programs or requests. The office must carefully distinguish U.S. foreign policy considerations from

scientific considerations. If science is used to develop foreign policy objectives, the policy must be kept separate from the research protocol.

### Specific Tasks

The focus of the office would be to help develop new cooperative programs with foreign countries. The office would not interfere with or supplant individual programs or activities within any part of the marine community. Specific tasks could include:

- *Serve as the contact point in the United States for foreign scientists or organizations interested in developing cooperative marine programs with U.S. organizations.* This would require informing foreign governments and agencies as to the existence of the office. U.S. agencies, institutions, and universities also must be informed, not just of the existence of such an office, but also of its benefits and objectives. A good communications network would have to be established.
- *Search for opportunities both within the United States and in foreign countries, and distribute this information to American participants.* This would require a good U.S. and foreign contact network that would be developed as part of the preceding task.
- *Determine interests of specific American marine scientists, engineers, administrators (in government, academia and industry) in working in foreign countries, including their fields of specialization as well as geographical interests.* This would involve contacting marine institutions and organizations,



Potential EEZ claims (shown in dark gray) could carve up 42 percent of the oceans. It is vital that marine scientific research continue in these areas. (Map source: U.S. State Department)



developing a list of interested individuals, and obtaining other appropriate information. Data would be computerized and be quickly available to others via computer networks already in existence.

- *Help match American scientists and their interests with foreign requests.*
- *Maintain an up-to-date collection of rules and regulations of foreign countries for marine scientific research in their waters.* This would involve obtaining data from the State Department, other agencies, and American scientists. This could become an important task, especially if, as can be anticipated, countries vary in their interpretation of the LOS Treaty. A collection of "operating rules" might be critical in dealing with certain countries. Material would be made available on request to American scientists and institutions.
- *Follow up on success or failure of foreign programs and develop a data base of key contacts, style, and so on of marine science activity in specific foreign countries.*

### Conclusion

The establishment of a U.S. Office for International Cooperation in Marine Science would make American marine scientists better aware of the opportunities and benefits of working in foreign waters and would improve such opportunities. It also would allow the successful implementation of many U.S. oceanographic programs. In addition, such an office could lead to increased funding possibilities for American marine scientists and commercial opportunities for U.S. industries. Finally, such action by the United States would emphasize the willingness of this country to continue as a leader in international marine activities.

*David A. Ross is a Senior Scientist in the Department of Geology and Geophysics at the Woods Hole Oceanographic Institution. He also is Director of the Marine Policy and Ocean Management Center and Sea Grant Coordinator at the Institution.*

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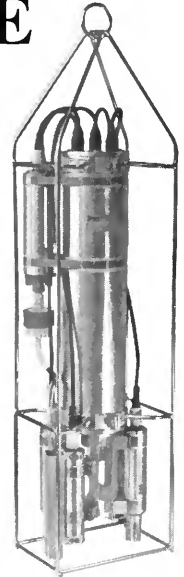
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# Future Uses and Research Needs in the EEZ

by Michael A. Champ and Ned A. Ostenso

In not signing the Law of the Sea Convention, the United States applied to the sea the basic principles that have governed its growth on land. The main thrust of these principles is that there is no free lunch—that the sea's resources are available to those willing to take the risks and invest the labor and capital necessary to extract them.

By emphasizing this philosophy, the United States has avoided a comprehensive focus on conserving and protecting the marine environment. A number of laws tackle portions of the issue, but usually in relation to a specific commercial or industrial use of the ocean. For example, the Magnuson Fishery Conservation and Management Act of 1976 stated that the policy of Congress is "to authorize no impediment to or interference with recognized legitimate uses of the high seas, except as necessary for the conservation and management of fishery resources" [emphasis added]. But the Exclusive Economic Zone (EEZ) Proclamation, even though it encourages the development and utilization of ocean resources, emphasizes *conservation and protection of the marine environment*, not just commercially valuable fisheries.

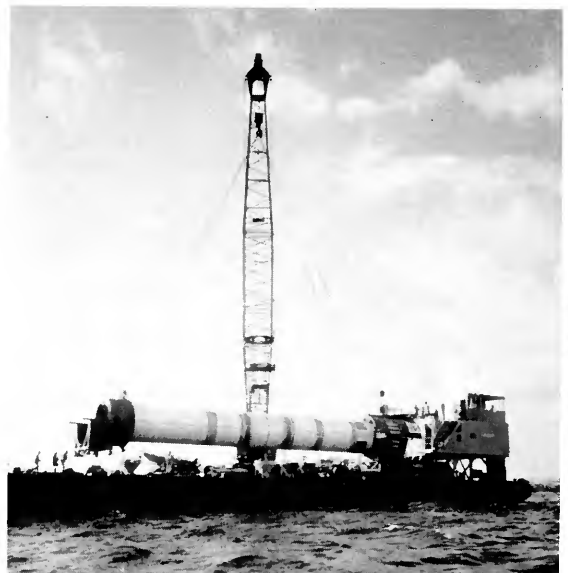
The United States has learned from its experiences on land that costs to clean up environmental contamination can run as high as 10 times those to prevent it. Therefore, the EEZ Proclamation is unique in that it has not only a strong ocean use and development philosophy, but also a strong conservation and protection mandate. Accomplishing both these goals will require innovative technologies, and create new regulatory and research needs.

These dilemmas are felt in other countries as or more strongly than in the United States. Of the 139 independent coastal nations, fewer than 10 percent can be considered true maritime nations having multiple and global interests. The others have minor or single-purpose interests with little or no economic or technological capacity to develop the resources of their EEZs, but the responsibilities of these nations within their EEZs may be staggering. For example, Portugal, with its new EEZ, is now nineteen parts water to one part land. For many nations the ratio is even greater; Nauru and Kiribati have ratios of several thousand to one. The United States ratio is one part ocean to 1.2 parts land (see page 3).

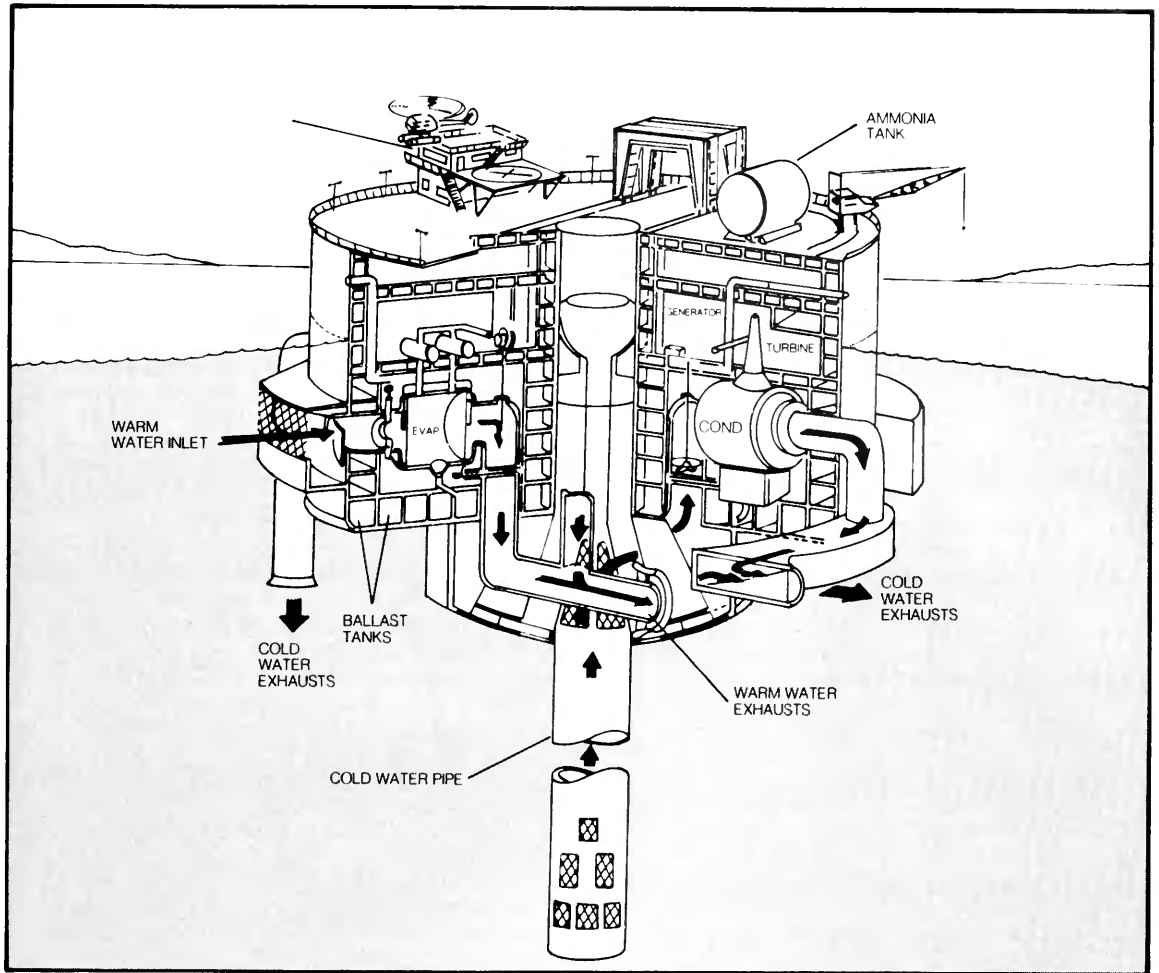
To place the EEZ in proper perspective, one must look at the contributions of the different U.S. economic sectors to the Gross National Product (GNP). In 1972 (the only year for which the Department of Commerce has done a comparative study), the ocean sector's contribution to the GNP was \$30.6 billion; agriculture, \$35.4 billion; mining, \$18.9 billion; construction, \$58 billion; transportation, \$46.2 billion; and communications, \$29.4 billion. The economic contributions of the oceans already are not small potatoes, but new ocean uses now being developed will increase the importance of the EEZ in the future.

## Energy Conversion

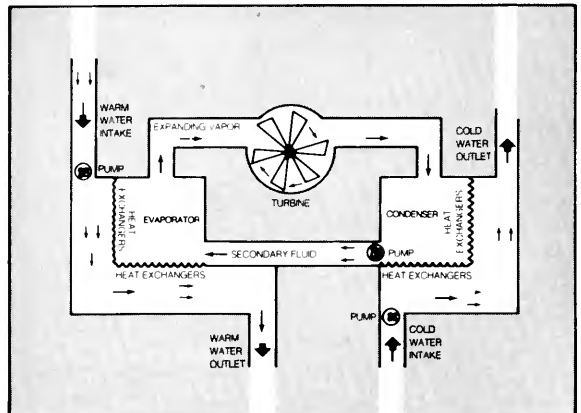
The energy in the Florida Current (a section of the Gulf Stream flowing 30 kilometers East of Miami) has been estimated to be 50 times greater than the energy in all the rivers of the world. The Gulf Stream off Florida and Cape Hatteras carries up to 30 million cubic meters of water per second at speeds of up to



The cold water pipe for an OTEC power plant being lowered from a barge.



The OTEC power plant pictured above relies on variations in water temperature to generate power. Warm surface waters heat an easily evaporated fluid, such as ammonia, which drives a turbine as it expands (diagram at right). Cold water from great depths is then used to liquefy the ammonia.



3 knots. The idea of tapping the power of such currents was first proposed by William J. Mouton, Professor of Architecture at Tulane University. Paul Lissaman, Vice President of Aero Vironment, heads a group designing experimental turbines to harness the renewable energy of such currents.

A second source of renewable ocean energy is thermal gradients, which are used to drive ocean thermal energy conversion (OTEC) electric power plants. The idea, first suggested in 1881, is to use

warm, solar-heated surface waters to cause a working fluid (such as ammonia) to evaporate; the expanding vapor would drive a turbine attached to an electricity generator. Then very cold (near freezing) deeper ocean water would be pumped to the surface to reliquify the ammonia vapor. Because water stores heat very effectively, ocean thermal energy is available day or night (unlike energy from solar-powered photocells). OTEC plants could be ideal for islands or coastal areas near deep waters

with a thermal gradient of more than 20 degrees Celsius. A prototype OTEC plant is already operating in waters off Hawaii. (See *Oceanus*, Vol. 22 (4): 12–22).

The Special Projects Office of the National Oceanic and Atmospheric Administration (NOAA) is coordinating research for the Department of Energy's OTEC Program. NOAA is developing a technical information base intended for use by industry in developing commercially viable systems. These efforts have resulted in preliminary designs for floating and fixed systems, hydrodynamic and structural design models, small-scale laboratory experiments, larger scale at-sea tests, and development of procedures for inspection, maintenance, and repair.

In April of 1983, at-sea testing began on a small-scale, model OTEC plant. Suspended from a barge, the model plant is located near Honolulu Harbor, Hawaii. In April 1984, testing began on another model, this one directly attached to an underwater mountainside off Keahole Point on the west coast of the island of Hawaii. Measuring forces from currents and waves, these tests are being conducted to determine the long-term survivability of steep-slope OTEC installations, the major technical risk associated with their development.

OTEC's early promise as a new energy source has been slow to develop because the original emphasis was placed on large-capacity (more than 100-megawatt) plants that could compete economically with oil-fired or nuclear plants. In the late 1970s, progressive increases in the cost of fuel oil turned scientific attention toward these large-capacity plants with attendant high capital risks. The softening of oil prices in the 1980s, however, slowed down development and testing. To date, only small (100-kilowatt) pilot OTEC plants have been built, and then operated only for short periods of time. Still, some researchers feel that OTEC-type renewable energy could be important to small islands because it could shelter their economies from the destabilizing effect of inflationary imported fuel prices. These plants also could manufacture energy-intensive products, such as aluminum, ammonia, hydrogen, chlorine, and magnesium, as well as drinking water (very important to small islands). These researchers recommend that future emphasis should be on building small plants to prove OTEC's potential.

### Man-Made Islands

In Japan, because of the steepness of the mountains, only about 30 percent of the land area is habitable. Anticipated population increases and land shortages have made offshore space a very valuable resource. The creation of new land space in offshore areas is being studied intensely. In June of 1985, the first major international conference on ocean space utilization will be hosted by Nihon University in Tokyo.

Offshore space utilization in Japan falls into three categories: 1) reclaimed land, 2) near-shore, man-made islands, and 3) offshore man-made islands. The development of offshore islands has several advantages: 1) environmental preservation of

inshore marine ecosystems, 2) greater freedom of site selection, 3) creation of barriers, making for calmer waters inshore, and 4) hazardous or polluting facilities can be relocated to such islands, reducing contamination in densely populated areas.

Present plans call for several offshore man-made islands to house coal-powered electricity generating stations. Major benefits may result from relocating these plants to offshore islands: the need for deep-water port facilities for coal transport ships could be eliminated, and solid wastes produced by the generating process could be mixed with other materials (municipal or industrial wastes or sludges, contaminated dredge materials, and so on) and used in land reclamation for the facility. These features could help prevent contamination of ground waters while greatly reducing waste treatment costs for the generating plant. A 1,000 megawatt coal-burning electricity generating plant produces approximately 1,000 tons of coal wastes (fly ash, scrubber sludge, and bottom boiler ash) per day. Land-based coal waste disposal in the United States currently costs from \$1 to \$6 per dry ton. After the offshore man-made island has been fully reclaimed (in about 20 years), the entire island can be converted to other activities, such as farming or recreation.

In the United States, a man-made containment island project has been proposed for the New York Bight at the 12-mile dredge-material dumpsite. The idea, originated in the mid-1970s, is to dredge the Erie Canal, ship the dredge material to the dumpsite, and build an island there. However, the U.S. Army Corps of Engineers' Environmental Impact Statement for the mud dumpsite stated that, beyond 3 nautical miles, a containment island would be unfeasible because of construction costs in deeper water. Their estimates, though, did not consider all possible uses of the island—such as a major airport for New York City, or relocation of heavy industry to the island.

### Oil and Gas Production

The dominant activity in the U.S. EEZ in terms of economic value and strategic importance is oil and gas production, currently valued at \$26 billion, plus \$7 billion in leases and royalties, annually. Offshore production in 1983 accounted for 11 percent of the total U.S. oil production and 24 percent of the gas production. More than 90 percent of the oil and almost 100 percent of the natural gas produced in the EEZ has come from the Gulf of Mexico, with the remainder from off California. These percentages could change significantly as commercial production is developed off Alaska. In the North Atlantic, 45 exploratory wells have been drilled; 4 found natural gas, and one both oil and gas.

Future U.S. exploration is expected to be in deeper waters, up to at least 750 meters (2,500 feet) by next year. Technological advances made in the North Sea are allowing us to drill deeper and farther offshore. However, the risks and dangers seem to increase by the mile. In the last 5 years, 360 people have died in the sinkings of four offshore oil rigs. The most recent was in February 1982, when the *Ocean Ranger*, the world's largest floating oil-drilling rig sank

during a blizzard (see photo, page 34). The *Ocean Ranger*, 37 stories high, was considered by many to be beyond the fate of the environment.

The technology for oil exploration and drilling has been developing at a frenetic pace; even if adopted conservatively, it would be impossible to test engineering prototypes in the complete range of environmental conditions. Researchers estimate that 60 percent of U.S. oil and gas resources are under the ocean. Therefore, it is important that the United States promote and develop offshore technology for oil and gas exploration and production.

### Biotechnology/Industrial Products

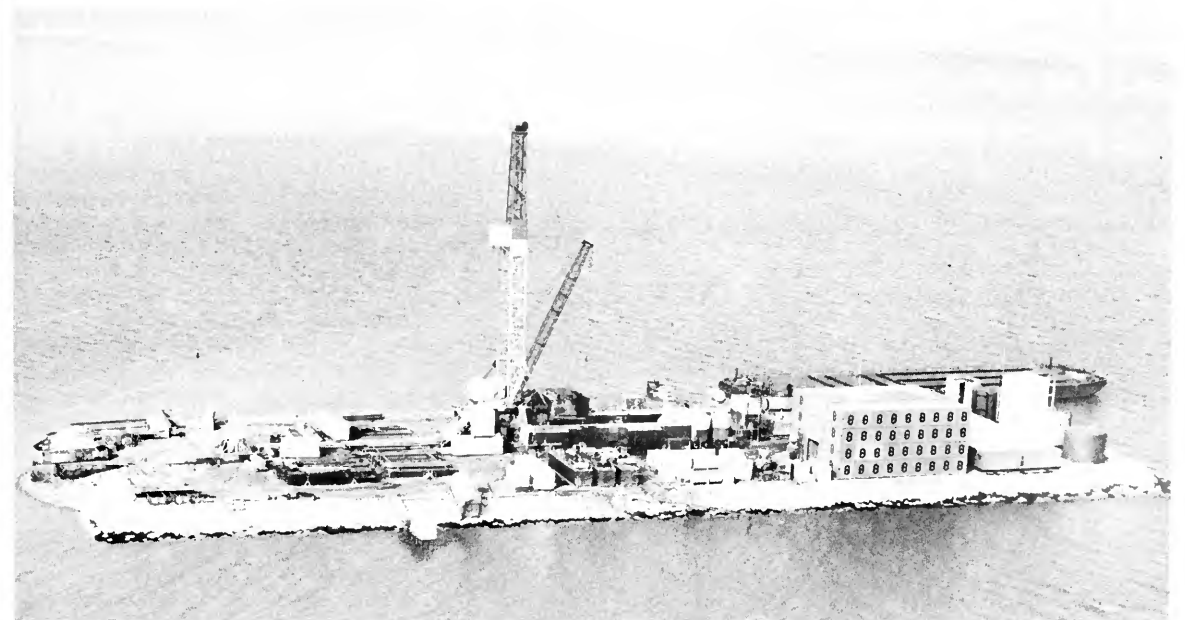
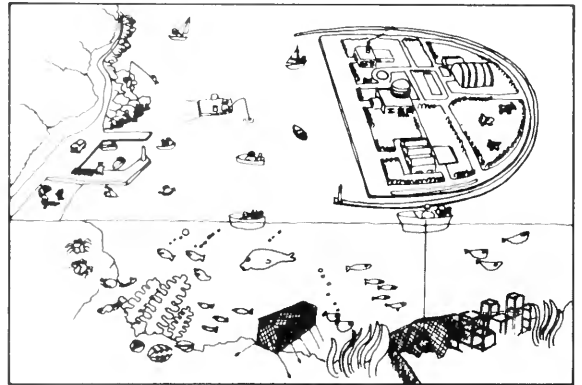
A whole series of very interesting new products are being developed from marine organisms found within the EEZ. For instance, the tissues of some mid- and deep-water fishes have been found to hold up to 4.5 percent of an oil that is 90 percent wax esters. Until 1970, these esters, which are used in high-pressure lubricants, came from the blubber of sperm whales.

Another example is a green algae, *Dunaliella*, which when grown in a high-salt environment produces and stores glycerol. This glycerol could be used in cosmetics, plastics, and explosives. Seafood processing wastes contain up to 30 percent chitin, which can be extruded to form biodegradable surgical sutures for promoting healing. Biopolymers, such as chitosan from seafood wastes, can be used in the extraction of valuable elements such as uranium, from seawater.

Agar and alginic acids from seaweeds have been used by microbiologists for many years. Carrageen, a protein from red seaweeds, is widely used as an extender in foods and related products, from powdered milk to toothpaste. Giant kelp, a brown seaweed, is used as a food supplement; it is high in iodine, potassium, vitamins, and carbohydrates. Farmers in Europe use kelp as a fertilizer and a source of potash.

Kelp is also the principal source of algin. A gelatinous substance found in the cell walls of kelp, algin is used by many industries as a thickening,

Offshore islands are already being used in oil drilling off Alaska (below). Japan, however, plans to use offshore islands for industry, farming (right), and as sites for coal-fired electric power plants. (Photo by Paolo Koch, PR. Diagram after *New Offshore Space Utilization in Japan*.)



presence of bacterial toxins (see *Oceanus*, Vol. 27, No. 1, Spring, 1984, pp. 13–18).

### Artificial Upwelling

In an experiment conducted on St. Croix, nutrient-laden waters, brought up from 870-meter depths, were used to stimulate the growth of cultured algae. The system produced more than 250,000 gallons of cultured diatoms, which were fed to shellfish (oysters, little neck clams, quahogs, and scallops). The growth rate of the oysters was such that they were ready for market in 6 months.

### Recreational Uses

The Great Barrier Reef of Australia, 40 to 200 miles offshore, is usually visited by day cruises on small vessels. However, some people cannot take such a long boat ride without getting seasick and therefore might not feel well enough to snorkel once they reach the reef.

Reef Link, one of Australia's first companies to try to overcome this difficulty, is planning to develop a floating hotel (barge/ship), with 120 rooms, its own waste treatment system (to protect the reef), and its own desalinization plant (for drinking water). People could ferry out to the reef, by boat or small pontoon plane, then stay for several days snorkeling and diving at their leisure.

Reef Link already operates a 60-passenger semi-submersible vessel on the John Brewer Reef off Townsville, Queensland, which is where they are thinking of locating the hotel. The submersible allows nonswimmers to see the living reefs through porthole windows. Similar operations might be feasible in the waters off Florida, California, or Texas.

### Why Research?

In the last 10 years, there has been very little science fiction literature about the sea—until extremely recently. Space travel and the possibility of extraterrestrial life have attracted our imagination in a way that the ocean has not. If we had spent the same time and effort exploring the ocean as we have space, we probably would have “walked” on the bottom of the ocean by now. The science and engineering for the exploration and development of the ocean are perhaps just as complex as for space. To date, benefits from space programs have come from the going, associated with either the knowledge gained from or the technology developed for the experience. From the ocean, knowledge, technology, and resources will be the immediate benefits.

Three significant scientific advances have occurred in the last decade that will require the United States to rethink its resource-development philosophy for the EEZ: 1) the discovery of the presence and uniqueness of deep-sea organisms in population levels greater than previously considered; 2) the discovery of exotic biological, geophysical, and geochemical processes at sea-floor spreading centers; and 3) the growing potential for biotechnological and pharmacological products from the sea. Until these discoveries, the deep ocean was considered a biological desert, and the ultimate sink for materials from land.



As oil exploration pushes farther into the stormy waters of the North Atlantic, greater risk to life and property must be anticipated. Above, a drilling rig in rough weather. (Photo courtesy of Tenneco)

stabilizing, suspending, and gelling agent (for example, in milkshakes, dairy products, cake mixes, and the brewing of beer). Algin stabilizes the texture and thawing characteristics of mixtures containing water. The kelp industry in California harvests as much as 156,000 metric tons a year (see *Oceanus*, Vol. 27, No. 1, Spring 1984, pp. 19–26).

In Japan, tetradoxin (a very potent poison), found in the liver and gonads of the puffer fish, is being tested for its selective toxic action on tumor growth. Nereistoxin, an insecticide found in the marine annelid *Lumbrineris brevicirra*, has been commercially manufactured and marketed since 1966. The antibiotic cephalosporin was first produced by a strain of fungus isolated from a marine sewage outfall. Extracts of many marine bacteria, fungi, and algae have been found to be toxic to human pathogens.

*Limulus* amoebocyte lysate (LAL), produced from horseshoe crabs, is perhaps the most significant pharmaceutical product from the sea. In the manufacturing of pharmaceutical products, water used in the process is treated and sterilized; even after all bacteria have been killed, however, toxins produced by them may remain in solution. To assess the purity of the solution, minute quantities of LAL are added, because LAL forms a gel or clot in the

The discovery of hydrothermal springs and cold seeps, with their associated exotic life forms (see *Oceanus*, Vol. 27, No. 4, Fall, 1984), is causing complete revision of our thinking about the deep sea. What was thought to be a passive sink is now known to be an active source of elements with considerable mineral deposits; and what we once thought biologically barren is now known to hold oases rich in life forms, with a food chain based on chemosynthesis rather than photosynthesis. The potential impact of the marine hydrothermal (venting) process upon the physical and biological sciences is profound.

If the previously enumerated possibilities are to be realized, a great deal of research will be needed. The research will, among other tasks, help delineate and quantify the resources, recover known resources, assess the potential of the EEZ for disposing of municipal and industrial wastes, and maintain environmental quality in the face of greater use. Additionally, increased research on ocean dynamics and air-sea interactions in the EEZ will improve both meteorological forecasting and understanding of atmospheric phenomena (such as interseasonal climatic variability, acid rain, the "greenhouse" effect, ozone balance, et cetera). In short, research and information needs in a wide variety of fields are the major hurdles facing our exploration of the seas.

### **Biotechnology**

Recent advances in genetic engineering allow genetic material to be removed from a "producer" organism and then inserted into "receptor" bacteria. These bacteria, when cultured, can produce desired compound(s), originally found in the "producer" organism, in large quantities. These new techniques bring exotic chemicals found in marine plants and animals within reach of industrial production.

Economical production of food and a wide variety of chemical substances from marine plants, animals, and microorganisms will require enhancement of their growth rates and changes in their metabolisms. This could be accomplished through alteration of their genetic constitutions; as yet, however, the basic science and methodologies for genetic engineering of marine organisms have not been developed.

Bacteria, yeasts, and fungi from soil and land plants are the agents for biotechnological production of many enzymes, pharmaceuticals, and other chemicals of enormous commercial and medical importance. The chemical components and corresponding pharmacological properties of marine plants and microorganisms, including a vast array of microalgae, have been little explored. What is known about the chemistry of marine organisms shows them to be rich in novel organic compounds. Through biotechnological processes, certain marine organisms may become sources of useful new biochemicals or industrial organics such as polysaccharides, hydrocarbons, organic acids, and alcohols (see *Oceanus*, Vol. 27, No. 1, Spring, 1984, pp. 3-12).

Marine bacteria and microalgae also are important candidates for exploitation in ways that



*The Yellow Sub, a semi-submersible vessel that allows non-divers to explore the Great Barrier Reef of Australia. Passengers observe through underwater windows.*

depend on their unique biochemical processes. For example, nonphotosynthetic sulfur bacteria can obtain energy by oxidizing hydrogen sulfide and other sulfur compounds. The energy is used to convert carbon dioxide to organic matter. This suggests using these bacteria for detoxification of industrial effluents containing hydrogen sulfide and carbon dioxide.

### **Fisheries Management**

The most important problem in fisheries management is understanding the factors that determine the survivability and "recruitment" of a given year-class. It has been long known that the bulk of a given fishery stock is composed of individuals from but one spawn. If survivability is relatively constant from year to year for a given fish species, as it is for humans, then there would be a normal demographic distribution. Skewing of this distribution would be consistent for each species and its environmental setting, such as the differences in age distribution between the human populations of, say, Canada and India. It isn't that simple, however, and the inconsistency of fish populations has been variously ascribed to overfishing, habitat degradation, pollution, predator/prey relationships, and so on.

The basic problem is that environmental data are in real time and of high spatial and temporal resolution, whereas fisheries data are largely dependent on catch statistics that cover one to several years in time and tens to hundreds of miles in space, and are distributed over one or more catch seasons. Despite this fundamental mismatch, fishery recruitment is becoming an experimental science. This has been successfully demonstrated with blue crabs in Chesapeake Bay, where it has been shown that repopulation of the bay is largely determined by offshore winds and currents at critical times of the year rather than by broodstock size, environmental pollution, predators, or other factors. Experimental protocols have been developed for other fisheries with sufficient background information, including pollock, king crab, bluefin tuna, and Pacific salmon.

The ability to forecast year-class success could save tens of millions of dollars annually in resource allocation and wasted catch effort. More importantly, such an understanding would serve as the basis for rational artificial restocking. In 1982, commercial fisheries landings by U.S. fishermen at ports in the 50 states were valued at \$2.4 billion, whereas fishery exports were only slightly above the billion-dollar mark for the fourth straight year. It is an explicit goal of the U.S. government to encourage and assist the private sector in increasing domestic fisheries' contribution to the Gross National Product and offsetting the foreign balance of payments. Basic research on recruitment variability is the most critical contribution to that goal.



Accurate weather forecasting is vital to the exploration and exploitation of the EEZ. The difference between working on an angry sea versus the rather idyllic conditions on the right is more than one of convenience—lives may depend on it. (Above photo by Vicky Cullen, WHOI; photo at right by Peter Wiebe, WHOI)

## Waste Disposal

A special aspect of research is the potential use of the oceans and seafloor as a "resource" for waste disposal. Aside from the fact that waste disposal is now considered one of the five largest "industries" in the United States, we are faced with severe political and social stresses caused by conventional approaches to waste disposal. From recent studies of hydrothermal venting at sea-floor spreading centers, we now know that the oceans are not the passive catch basins, inexorably accumulating natural and anthropogenic wastes shed from the continents, as originally conceived. Rather, the oceans are an active biogeochemical processing plant of yet undefined dimensions and capacity.

Another important area for increased research is on processes in the water column and at the benthic boundary layer.\* If we are going to effectively husband the resources of the EEZ, we must better understand the complex chemical, biological, and geological interactions between the water column and the ocean bottom. Particularly important are the fluxes of matter and energy between the seafloor and the water column. Understanding complex interactions between natural and anthropogenic chemical compounds and the biota of the water column and seafloor is critical if the oceans are to be successfully and safely used as a disposal site for mankind's waste products.

With the increase of industrial activity in the EEZ, it is essential that we better understand the basic electrochemistry and biology of the corrosion and bioturbation processes. Marine corrosion in its many forms is one of the most serious factors detracting from our ability to build structures in the EEZ that will remain durable and reliable for long periods of time. It is estimated that the battle against corrosion cost the United States about \$70 billion in 1982, of which about 20 percent was due to marine corrosion.

## Technology Needs

Powerful new technologies have become available for collecting the data essential to producing bathymetric charts and assessing the nature of the seafloor. These include multi-beam bathymetric sounders, sophisticated, multi-sensor, deep-towed

and untethered vehicles, sidescan sonars, and precise global-positioning systems. These devices are as revolutionary to charting practices as modern computers were to calculating machines of three decades ago. To meet the challenges of the EEZ, research vessels must be equipped with a variety of such new equipment.

Submersibles provide valuable and unique data resulting from direct, *in situ* observations, measurements, and sampling. The deep-sea research submersible *Alvin*, operated by the Woods Hole Oceanographic Institution, is presently being used to its operational capacity. Additional remotely operated vehicles, both tethered and acoustically controlled, are needed for EEZ research.

## Weather Forecasting

Among the most valuable services used by the public within the EEZ are weather, seastate, and ice forecasts. Without timely and accurate forecasts, lives are in peril and property at risk. Such dangers have markedly increased with the expanded exploration and development of offshore resources within the last decade, particularly in the frigid Alaskan waters.

Unfortunately, advances in the science of weather prediction have not always kept pace with the need for accurate forecasts in remote offshore areas. Supplementing the satellite information used for forecasts are a series of weather-data buoys, deployed on the middle and outer continental shelves, which transmit real-time oceanographic and meteorological information. Neither the satellites nor the weather-data buoys, however, are without their limitations; the satellites are restricted to cloud-free conditions for certain monitoring, whereas the weather buoys are so sparsely sited that the data are often of more local than regional interest.

The weather buoys, where available, provide a good measure of ground truth to the satellite information and provide sea-surface measurements not possible from satellites. These buoys also have the advantage of transmitting regardless of weather conditions. Unfortunately, there are not enough of these buoys to cover the EEZ.

\*The benthic boundary layer is that area above the seafloor in which the floor itself exerts an influence on the overlying water.





To compensate for a shortage of weather-data buoys, fishermen in marine coastal areas have been asked to provide actual surface weather conditions. These at-sea observations are transmitted via radio to shore stations for subsequent transmission to the nearest National Weather Service office where they are integrated into the next forecast. This inexpensive program has resulted in weather forecasts of increased precision and resolution. The program is hindered, however, by at-sea observations being restricted to those areas where vessels are working.

### The First Steps

Although we are moving toward developing the ocean uses described in this article, further progress depends largely on political factors. Decisive and visionary leadership is needed. Balancing the conflicting claims for research funds and for ocean access is likely to be a thankless task, but is crucial to the nation's future. The dollar amount of ocean commerce in the United States, much of it associated with the EEZ, exceeds \$250 billion a year. This is not a paltry sum in these days of deficit worries. The zone's commerce potential is much the same as the area itself—that is, largely unexplored.

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## The Geology of the Atlantic Ocean

**K.O. Emery and Elazar Uchupi**, Woods Hole Oceanographic Institution, Woods Hole, Mass.

This is a comprehensive account of the geologic development of a young ocean basin and its adjacent marginal seas. Combining widely dispersed data and concepts with new investigations made especially for this book, the authors present a detailed, carefully integrated study of the topography, igneous composition, structure, and sediments of the Atlantic Ocean. The potential economic value of ocean resources is carefully evaluated. Eleven pairs of detailed, oversize charts accompany the book; the charts are also available separately.

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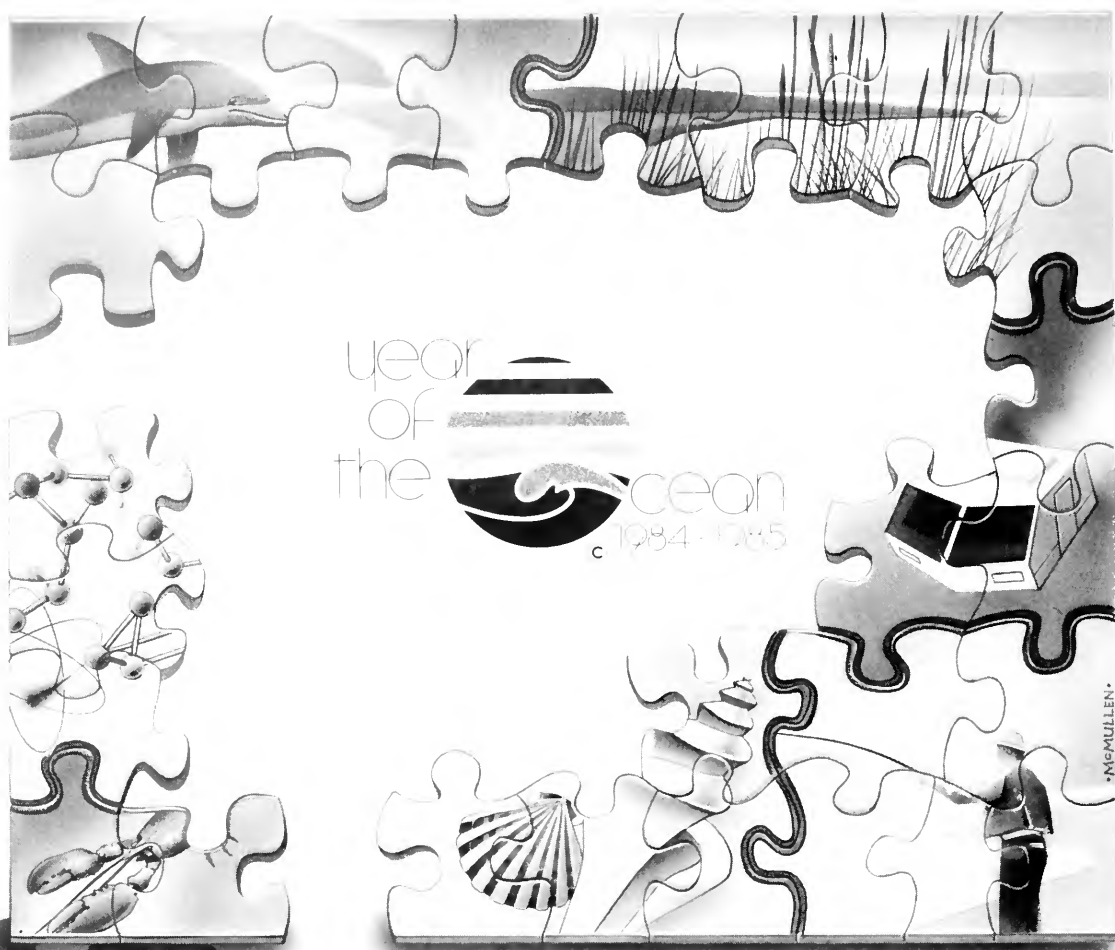
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## This is a picture of the ocean

The ocean. How you picture it depends, quite simply, on your perspective. To some it's food, to others, sandy beaches. But the ocean is a lot more than just water and fish. It's an amazing complexity of almost incomparable proportions. It's the cradle of life, the arbiter of weather, the testing ground of science and the border of nations. And that's just for starters.

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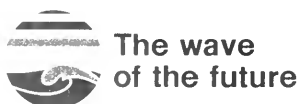
The uses and users of the ocean are currently escalating at an astonishing rate. And more and more these users are having to come to grips with their own inseparability. Yet in order for this great resource to function properly, all these components must interlock.

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# profile **Stephen Jay Gould:**



Portrait by Charles Kerins

## **From Dinosaur Nut to ‘Punctuated’ Man**

**by Frank Lowenstein**

In 1959, three ships sailed from the Woods Hole Oceanographic Institution (WHOI) to undertake the first detailed mapping of the

Gulf Stream. Presiding over the efforts were Valentine Worthington and William G. Metcalf (both now Scientists

Emeritus at WHOI), but below decks a young and as yet unknown Stephen Jay Gould worked to record the salinity of

the North Atlantic.

"When you want to go to sea you need warm bodies," recalls Worthington. "Steve was an agreeable, hard-working, bright guy. I don't think we paid him much."

"I didn't have a great sense of the science," explains the now 43-year-old Stephen Jay Gould. "Although it was one of the more important expeditions in the history of physical oceanography, I was just a small cog in it. It was exciting to me just because I had never done anything like that—to be at sea for six months, to land in Bermuda, in Martinique."

Besides the excitement of the journey, the cruise provided Gould with his first chance to participate in the research of other scientists, and he learned not only from the work itself, but from his associations. "The thing I really liked about both Worthington and Metcalf is they took me seriously," he recalls, "They didn't condescend, and when you're sort of an 18- or 19-year-old, very insecure person, as I was at the time, to suddenly be treated as an equal person by people like those guys was very important to me."

### At Home At The Top

Today Gould has the leading role. An intermittent stream of people pass in and out of his office at Harvard's Museum of Comparative Zoology, seeking his signature on political petitions, recommendations for graduate school, advice on science and careers. But Gould is known beyond the confines of his university, and even beyond the confines of his profession; he has achieved a rare position for a scientist—he's famous.

"Wherever I go, people talk like Steve Gould was the only person at Harvard!" exclaims Ernst Mayr, Professor of Zoology Emeritus at the same university. "Others of us can write learned papers, but the lay person never reads them; or, if he does, he's terribly bored. Steve has such a felicitous way of coming up with nice sentences and choosing quotes from the literature. He and Lewis Thomas are the only two who everyone

reads."

Indeed, through his numerous essays, most published first in *Natural History* magazine and later compiled into three books (*Ever Since Darwin*, *The Panda's Thumb*, and *Hen's Teeth and Horses Toes*, with a fourth scheduled for publication early in 1985), Stephen Jay Gould has become one of the foremost popularizers of science in the country. "There's a strong interest in science," notes Gould. "It would have happened anyway, but there are a few of us who haven't hurt by our writings."

Gould's chair rests in the only clear spot in his office, surrounded by a few aging wooden chairs, a bank of file cabinets, and a large desk with a file folder veneer. The walls are covered with peeling green paint, from under which the words "sponges and protozoa" peer forth, a faded leftover of former years. Nearby hangs a watercolor (done by Gould's wife, Deborah) of angels supervising the creation of the dinosaurs. Kicked back in his chair, Gould pauses a moment; flexes his large, bony hands; stares up as though looking through the ceiling; and then continues in a tumble of thoughts:

"That's not why I do it mind you. If there's one thing an evolutionary biologist understands, it's that the effects of things often have nothing to do with their motivations. It happens in evolution all the time. You evolve a wing to insulate a small running reptile, and it turns into something you can fly with later. I write essays for myself. I write essays so I can learn things. I'm a literary person, and I have this great goal that all writers do to write the perfect essay. I love trying. I've written about two or three out of 110 that are as good as I can do, and I'm really proud of them. They're not the popular ones, because they turned out not to be on real jazzy subjects—the one on Nicholas Steno and the *Prodromus*; the one that was published two months ago [June, 1984] on Gosse and *Omphalos*, the argument that God created

the Earth with the appearance of pre-existence; and the one on angler fishes.

"I write them for me. I love writing, and I learn a lot every time I write. I always choose topics that I don't know a lot about so I can learn stuff. Now if it happens to have the secondary effect that people read them and learn something about science, I think that's great. That's important, but it's not why I write."

Gould's wide-ranging curiosity has carried him (and his readers) into some strange locations. He has written on the evolution of corn, on parallels between mass extinctions in the historical record and the possible effects of a nuclear winter, on why nature only invented the wheel on a microscopic level, on the identification of animals and plants among primitive peoples, on cultural biases in studies of intelligence, and on a phylum's worth of other topics. "My essays are really journeyman's essays," explains Gould. "They're really all about evolutionary theory and history. I don't write about things I really don't know anything about; I write about areas that I know about, but I love to choose subjects that I know nothing about."

Gould often does not rest with accepted interpretations of these subjects. In 1965, while still a graduate student at Columbia University, he launched an assault on the concept of uniformitarianism, which had been a guiding principle in geology since the early 1800s.

### In The Temple of Uniformity

Uniformitarianism, as put forth by Charles Lyell in 1830, argues that the laws of nature are the same everywhere, and that they have not changed through time. Consequently, the geological record (rocks and the structures within them) should whenever possible be interpreted as the result of processes that continue today, rather than as the result of special events or processes occurring only in the past. Few scientists in any discipline could make much progress without belief in the constancy of nature,

and the second aspect of this theory is in agreement with the preference for simplicity that guides much of science. Lyell, however, went a step farther, arguing that geological forces operate only gradually—at constant, slow rates. In a paper that still evokes controversy, Gould argued that uniformitarianism was really a hodgepodge of two ideas—a principle of constancy that is basic to all science, and a principle of gradualism that is not essential to the first principle and might not be correct.

In the early 1970s, working with Niles Eldredge, Curator of Invertebrates at the American Museum of Natural History in New York, Gould expanded his criticism of gradualism by suggesting that speciation, the formation of new species from established ones, occurs by a process of punctuated equilibria—long periods of stasis followed by rapid change to a new equilibrium. At the time, most paleontologists, working within a gradualistic mindset that dates to Darwin and Lyell, believed that evolution occurs as a result of gradual, small changes caused by natural selection operating on large populations. Unfortunately, the fossil record primarily shows long periods of little change, followed by the sudden appearance of new species, and sometimes by rapid disappearances of older species. Traditionally, paleontologists have suggested that the lack of evidence in the fossil record for gradual evolutionary change is because of the imperfection of the record itself. In other words, because fossils are found only in sedimentary rocks, and because most such rocks are not preserved, enough of the geologic record is missing that we shouldn't expect to see evolution occurring. As Gould points out in the recently published *Catastrophes and Earth History* (see Book Review section, page 89):

*The argument works, but at what a cost: the admission that they [evolutionary paleontologists] never (or hardly ever) see evidence of*

*evolution, the very phenomenon they wish most to study.*

Punctuated equilibrium offers a way out of this bind, postulating the rapid formation of species in small, isolated populations that, because of their rarity, one would not expect to find preserved as fossils. Thus the rapid replacement of one species by another can be interpreted as evidence for evolution, rather than as evidence of a gap in the fossil record. "Up until Eldredge and Gould, paleontologists were not very concerned about speciation," Mayr notes. "They did not recognize the importance of speciation in macroevolution. The majority of them still don't recognize it, but to my mind it's terribly important."

***I was this nobody who showed up with some enthusiasm.***

According to Norman Newell, Curator of Invertebrate Paleontology and Historical Geology Emeritus at the American Museum of Natural History and Professor of Geology Emeritus at Columbia University, punctuated equilibria is not a new theory, but it has been given new life by Gould's strong championship. "It wouldn't have gotten off the ground if Steve Gould hadn't been carrying the banner," Newell explains. "Steve is such a fine salesman that he could sell most anything. He had the ability to sell the whole profession on the concept that evolution is jerky rather than continuous."

Gould himself claims to be surprised by all the fuss that his and Eldredge's paper evoked: "I thought it would probably get

lost in one of those symposia volumes." But with typical bravado he put on his psychologist's hat (again in *Catastrophes and Earth History*) and began weaving a hypothesis to explain the long predominance of gradualism and the reluctance of paleontologists to accept the theory of punctuated equilibria:

*Lyell and Darwin did not "see" gradualism in the rocks and thus cast their generalization as a simple induction from the facts of geology. Nature is multivocal; she speaks ambiguously on any issue as broad as the nature of change. . . . I am convinced that the cultural and political context of European society had an input equal to, or greater than, nature herself. In saying this, I do not criticize Lyell and Darwin for letting "extra-scientific" influences cloud a supposedly objective judgment; nor do I claim that Lyell and Darwin were explicitly aware of this influence. The notion that science operates apart from culture by a universal method that yields truth according to canons of observation and experimentation is a myth that has been carefully nurtured by scientists themselves. Science operates, as does all creative thought, within a cultural context that influences all practitioners in various subtle and unacknowledged ways.*

*When scientific theories of a static world order collapsed toward the end of the 18th century, a new ideology rose to justify social stability within a world now dominated by ceaseless change. If change is intrinsic and fundamental, what could be better than a notion that it must proceed with excruciating slowness, move from one system to another through countless intermediary stages, and always be weighted down by an inheritance from the past.*

*Gradualism became the quintessential doctrine of liberalism as it faced a world increasingly engulfed by demands for revolutionary change.*

### **The Scientist and Society**

"About a third of my essays are about the way in which society influences science," explains Gould, "the way scientists record the biases of their times." Like the scientists he writes about,

Gould's professional career has been influenced by his beliefs. For example, in the early and mid-1970s Gould and Richard Lewontin, Alexander Aggasiz Professor of Zoology at Harvard, taught a course in biological determinism, with an unusual twist. Although it was quite controversial at the time, the memory of the course has clearly faded. It takes Gould several minutes of digging through his files and muttering under his breath to produce a letter to Edward T. Wilcox, (then Director of Harvard's Committee on General Education), a portion of which is excerpted here:

*We teach a course which disputes the biological claims that status distinctions in society (races, sexes, classes) have a genetic basis. We felt that it would be wrong (if not hypocritical) then to turn around and enforce those very same distinctions socially by the usual threat of grades. Consequently, we have the following policy: A student who wants to "opt out" of the usual system may receive a B if he does all the work (quite substantial) and writes a, pardon the expression, "no-bullshit" paper. A student who wishes to compete for a higher grade may do so on the usual basis by writing a much more substantial paper which we then grade in the conventional manner (awarding an A if we think the paper deserves it). . . . I should add that our system worked quite well last year—i.e. the papers were serious and of at least as high an overall quality as those in any conventional course I have taught.*

In a similar vein to this course, Gould devoted an entire book, *The Mismeasure of Man*, to documenting the various ways that have been used to test intelligence, and how those tests have been used to justify racist and sexist doctrines. "The area where he's very inflexible is about racism," notes Newell. "That's one of his reasons for existence—to fight against injustice and inequality."

Other social issues also have attracted Gould's attention. In a 1981 challenge to an Arkansas law mandating equal time for "creation science" and evolution, Gould was a witness for the plaintiffs. Writing in the

magazine *Science For The People*, the Harvard professor laid out his philosophy:

*As a professional evolutionist, I am inevitably drawn into this battle. Other leftists might dismiss it as unimportant if not a bit ludicrous. But I remind everyone that creationism is just one part—perhaps a relatively small one—of the coherent political program of the evangelical right in America. The other parts—from anti-ERA, to anti-abortion, to militant (if not military) anti-communism—are more easily appreciated as threats. All are parts of a piece; all are surrogates, one for the other. We are all in this together.*

### **City Roots and Dinosaurs**

His politically egalitarian views at least partially arise from Gould's childhood. "Steve says it comes from his father, who was a Marxist," explains Newell. "He was a man who felt there was so much injustice in the world that he leaned strongly toward populism."

Growing up without luxury also may have influenced Gould's views. "I didn't grow up with much," Gould notes. "I didn't grow up particularly poor, but I didn't grow up with any extra resources. You know we were lowest middle class, we were okay. But the point is that in my background there were no intrinsic advantages whatsoever. I mean nobody in my immediate family had an advanced degree, very few had college degrees. My mother did, my father didn't. Nobody in the family was an academic or any kind of professional."

Within this context, Gould's decision to become a paleontologist was almost accidental. A skeleton of a tyrannosaurus in the American Museum of Natural History and a loud sneeze from a fellow onlooker teamed up to terrify a five-year-old Stephen Gould, with lasting results. "It sounds weird," Gould admits, "but if you think about it for a minute, it's really not uncommon, because a lot of paleontologists were childhood dinosaur nuts. I'm one of the rare dinosaur nuts that stuck with it.

"I think your more typical

background in natural history— which is why there are so few of us Jews in the field, let's face it— is it is largely a profession that appeals to people who've had rural upbringings and grown up with animals and nature. But there is a subset of city people, many of them inspired by museums, like me. That's why museums are so important."

In the absence of nature (he didn't leave New York City until after his 10th birthday), Gould relied on frequent trips to the museum; what little help his parents, Leonard and Eleanor, could give him; and information garnered from the famous scientists that he wrote to.

"In that context," Gould notes, "people become very important. People who were kind to an 8- or 9-year-old nobody. It's easy to be nice to the daughter of your professor, or the daughter or son of your colleague, but I really have great respect for the people who helped me. I was this nobody who showed up with some enthusiasm and wrote them a letter. Like Ned Colbert, who's the perfect paleontologist, still alive, an older man now, written a lot about dinosaurs, who patiently answered my silly childhood letters to him. He encouraged me.

"And then George Gaylord Simpson, who is the greatest writer. I sort of discovered him when I was 10 or 11. In fact, it was through reading Simpson that I discovered there was a body of ideas, namely evolutionary theory, behind these dinosaurs. I don't think the phenomenology of dinosaurs is enough to maintain a fascination. I know I couldn't possibly have understood most of it, but obviously I understood enough of it to appreciate that there was this body of thought. It was very exciting; it made all these bones and fossils fascinating.

"And then later on, when I was in high school, Norman Newell, who later became my thesis adviser, was the interim paleontologist at the museum. He was very nice to me, which is kind of interesting because Newell is not a classically warm man—any more than I am. For

that matter I'm much like him. He doesn't spend a whole lot of time with you or with kids that come in. He's a gracious man, a kind person, and I guess he could see that my enthusiasm was genuine. He didn't go way out of his way, but he was very encouraging."

Newell remembers a poised, modest, and self-confident Steve Gould, who came to him looking for a research project. "I put him to work on something," Newell recalls, "and to my astonishment he produced some original work—some things that hadn't been known before. He was pretty sure of himself—so much so that he didn't need teachers. He was looking for opportunities." This work (on the clam *Neotrigonia*) eventually became the basis for what Gould refers to as "a few of my more obscure papers."

From high school, Gould went on to Antioch College, located in Yellow Springs, Ohio. "He got some very fine grounding out there," notes Newell. "He knew a lot about the history of science when he came to Columbia as a graduate student." It was through the work-study program at Antioch that Gould wound up at WHOI, on board the *Crawford*, manning the salinometer.

Today when Gould returns to WHOI it is to work with William Berggren, Senior Scientist in the Geology and Geophysics Department, on the evolutionary changes in forams, which are small marine

invertebrates. These organisms display extremely gradual changes through the fossil record, but Gould hopes that his and Berggren's research will show that the changes are responses to changing environmental conditions without genetic change—much as Americans are, on average, taller today than 100 years ago due to improved nutrition and other environmental changes.

After graduating from Antioch, Gould returned to New York City, got his doctorate from Columbia University, and then proceeded on to Harvard, where he has stayed ever since. In addition to his passion for evolutionary theory, Gould maintains a strong interest in professional baseball and sings with the Boston Cecilia Society chorale. As this issue of *Oceanus* goes to press, he is scheduled to appear in a performance of Bach's Mass in B Minor in early December.

At Harvard, as Professor of Geology and Curator of the Museum of Comparative Zoology, Gould works and publishes furiously. Even when he was discovered to have cancer in 1982, and had to undergo both radiation and chemical treatments, Gould never missed a deadline for his *Natural History* column. Mayr recalls, "When he was hit by this malignancy and he had these terrible treatments and looked like so much skin and bones, he never gave up hope. I think it was his fighting spirit that brought him through. And now it's in remission; he might even be cured for all we know."

## Enthusiasm and Oratory

Gould also works to convey his enthusiasm for science to another generation. His introductory geology course, "History of Earth and Life," is now the most popular science course at Harvard. "He's a phenomenal orator," explains Michael McGarry, a student in the course. "He talks a lot about the various philosophies behind science, for instance wholism versus reductionism. He works in poetry, art, architecture—it's the first time I've ever seen science taught with so much of the humanities."

In 1983, in accepting a teaching award from the American Association of Geology Teachers, Gould explained the motivation behind the course:

*A course like this cannot fail to work so long as we remember and convey the intrinsic fascination of its material. It must appeal to everybody but the most frightful dullard. The earth surrounds us and its physical history powerfully influences where and how we live. We are part of life, and evolution speaks to our roots, answering, insolar as science can, the "big" questions of who we are and where we come from. I have never understood how people can read newspapers and drink coffee, never gazing out the window as they tly over the folded Appalachians. We must make our students unable ever again to commit such a sin against nature's beauty and their own intellects.*

This is Stephen Jay Gould at his most eloquent—a spokesman for science and humanity, a voice of common sense and uncommon curiosity, and a spirited man still in awe of the tyrannosaurus.

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## concerns

# The Pelagic Driftnet

Increasing attention is being given to the need to recognize and resolve problems resulting from the rapid expansion of pelagic driftnets, particularly in waters of the North Pacific beyond coastal nation jurisdiction.

The pelagic driftnet is a type of gillnet, a panel of plastic webbing suspended vertically in the water by floats at the top and weights at the bottom. A gillnet is a passive fishing device that works by entangling the gill plates and other body parts of fish and other creatures that swim into it. By adjusting the buoyancy of the net with floats and weights, the net can be suspended like a curtain at any depth in the water column; it can be either anchored in one place or left to drift with wind and current and fish the entire area through which it drifts.

Gillnets have been used for centuries and need not be any more destructive than other fishing techniques if they are used selectively and in moderation. Regulatory measures to limit the mesh size and over-all length of nets as well as the season, area, and other aspects of their use can minimize or preclude adverse impacts. Regular monitoring of a gillnet fishery can detect problems and allow necessary remedial measures to be formulated and implemented.

The situation changes, however, when plastic drift gillnets are utilized on a large scale in the open ocean beyond the reach of monitoring and regulation by coastal nations. Such pelagic driftnets are much longer than coastal gillnets and are not used selectively or in moderation. They are not



*Seabirds, porpoises, seals, and whales are imperiled, and large numbers of fish wasted, because of widespread use of pelagic driftnetting. (Photo by Nancy Foote, Greenpeace)*

biodegradable, are acoustically and visually "invisible" to fish and other animals, and are nearly unbreakable with the result that fish, birds, and marine mammals become trapped in them and cannot break free. When properly set, such a pelagic driftnet is a devastatingly effective curtain of death through which nothing larger than the opening in the mesh can pass.

### Adverse Impacts of Driftnets

The remarkable effectiveness of the pelagic driftnet as a fishing technique (perhaps its only virtue) is, at best, a mixed blessing. It often results in overfishing of target species and the incidental taking and discard of marine mammals, seabirds, and unwanted species of fish.

The Japanese pelagic driftnet fishery for salmon in the North Pacific includes a high seas fleet of four motherships and 172 catcher boats, as well as a land-based fleet of 209 vessels that fish on the high seas but must return to port with their catch (rather than transferring it to motherships). Each of those 381 vessels sets an 8-mile-long, 26-foot-deep net to drift at dusk, and hauls it in at dawn every day during the fishing season. Taken together, the mothership-based and land-

land-based fleets set 3,048 miles net every night. Approximately 5,000 Dall's porpoises are entangled and die each year in the driftnets of the mothership fleet and an equal or greater number die in the nets of the land-based fleet.

The bills, feet, and wings of seabirds become entangled in driftnets when the birds swim into the net while feeding on fish below the surface of the water. In the early 1970s, the Danish high seas salmon driftnet fishery in the northwest Atlantic was estimated to be killing more than 500,000 diving seabirds each year. That mortality, in conjunction with hunting, exceeded the net annual recruitment of the seabird populations and caused their decline until the fishery depleted the salmon stocks so badly that the fishery was closed in 1976.

The same Japanese North Pacific mothership salmon driftnet fishery that kills 5,000 Dall's porpoises each year also kills between 250,000 and 750,000 seabirds each year. The nets are set near the Aleutian Islands where nesting colonies of murrens, puffins, shearwaters, and auklets may well be in decline as a result of this high level of mortality. Moreover, no information is available on the



extent of incidental taking of seabirds or other creatures by the 209-vessel Japanese land-based salmon driftnet fleet, the approximately 500 Japanese North Pacific pelagic driftnet squid vessels (which each set a 30-mile-long net at the surface every night), the some 200 Taiwanese pelagic driftnet squid vessels, or the other large-scale pelagic driftnet fisheries of Japan, Taiwan, and South Korea, which have developed in the North Pacific during the last decade.

Additionally, concern about the potential incidental catch of large numbers of North American-origin salmon by squid and other pelagic driftnet fisheries has led to increasing demands for observation and regulation of those fisheries by the flag nation and/or regional organizations. Despite the staggering amount of pelagic driftnet deployed by Japan, Taiwan, and South Korea in the North Pacific, for example, only the Japanese mothership salmon fishery is subject to direct regulation by treaty (through the International North Pacific Fisheries Commission), and only a portion of that fishery is subject to an impartial international observer program. The remaining fisheries are subject to no treaty, no international observers, and little or no observation and enforcement by even the flag nation.

The inherent nature of pelagic driftnets also causes substantial "noncatch mortality" of target fish. After becoming entangled and dying, a significant proportion of fish fall from the net. In the case of the Japanese mothership salmon fishery in the North Pacific, for example, it is estimated that one immature salmon is killed but not retrieved from the driftnet for every one that is brought aboard the catcherboat, and that one adult salmon is killed and lost for every three that are brought aboard. Even if it is assumed, conservatively, that all of the approximately 9.5 million salmon caught by the Japanese mothership fleet in 1983 were adults, that loss rate resulted in

the "noncatch mortality" of more than 3 million additional fish during 1983. Such a loss is potentially damaging to the resource and very wasteful.

#### Loss and Discard of Nets

In addition to the wasteful killing of marine mammals, seabirds, and fish, pelagic driftnetting is a wasteful technique with respect to the netting itself, which, like unwanted species of fish, is lost or thrown away. The loss and discard of nets have adverse environmental and socio-economic consequences.

It is estimated that an average of 0.06 percent of the Japanese salmon driftnet is lost and not recovered from the water during each set of the net. While seemingly negligible at first glance, this rate of loss results in a very substantial amount of net floating at sea when the enormous scale of pelagic driftnetting is considered. Taking the Japanese salmon and squid driftnet fisheries discussed previously as an example, the 172 catcherboats in the mothership salmon fleet and the 209 vessels in the land-based fleet each set an 8-mile-long net for a total of 3,048 miles of net each night, while the 500 squid boats each set a 30-mile-long net for a total of 15,000 miles of net and a combined total of 18,048 miles of net each night. The 0.06 percent rate of loss means that 10.8 miles of net are lost in the water each night. Assuming a 5-month fishing season, those fleets alone leave 1,624 miles of net to float in the North Pacific each and every fishing season.

In addition to the unintentional loss of netting, U.S. government personnel in surveillance aircraft have observed the abandonment of entire pelagic driftnets by fleeing vessels that had been fishing illegally in restricted or prohibited waters of the North Pacific. The nets, with floats and weights intact but identifying markers and radio beacons removed, are left to fish relentlessly for 24 hours a day.

The lost and abandoned plastic netting does not degrade

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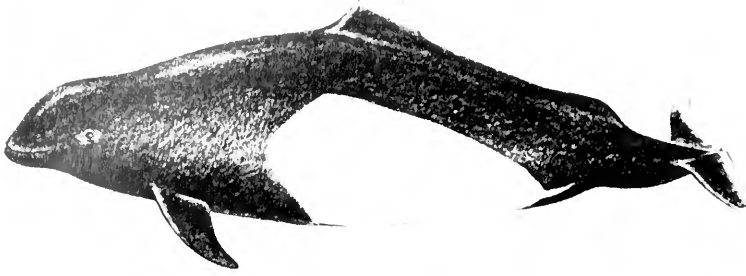
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*Dall's porpoises are among the victims.*

and continues to "ghost fish," drifting unseen and untended, until it washes ashore or sinks. Marine mammals, seabirds, and fish become entangled and die in such nets. The propellers and shafts of fishing and other vessels become entangled as well, causing economic loss and endangering human lives. Examination of an abandoned salmon driftnet revealed 99 dead seabirds and more than 200 salmon entangled in just a portion of the net. It is estimated that at least 50,000 northern fur seals also become entangled and die each year in lost and discarded nets and debris, including at least some pelagic driftnets. Mortality as the result of entanglement is suspected to be the chief cause of the continuing 5 to 8 percent decline of the fur seal population, which if not reversed, will reduce the population by half within the next decade.

Finally, while lost and abandoned nets may fish for months or even years before washing ashore or sinking with the weight of dead animals, barnacles, algae, and debris, the plastic pelagic driftnet is apparently far less durable when it is actively fished. The nets stretch, abrade, and generally deteriorate as a result of daily sets and hauls under heavy loads and this leads to yet another undesirable result: Japanese pelagic salmon driftnets must be replaced after only one season of use, and this is apparently a typical replacement rate. The pelagic driftnet technique thus results in

the annual discard of many thousands of miles of plastic netting. The disposal of this nonbiodegradable plastic poses environmental and health problems, and the several-thousand-dollar replacement cost of such a net constitutes a significant expense that likely leads to increased fishing effort, pressures on fish stocks, and resistance to conservation measures in order to generate offsetting revenues.

### Suggested Remedial Actions

During discussions at the 2d FAO World Fishing Gear Congress in London in 1963, H. Kristjonsson, representing the Food and Agriculture Organization (FAO), noted that 20 to 30 thousand gillnets were already being used in Sri Lanka as a result of their introduction there by the FAO and that the technique was being widely accepted and adopted throughout the world. He noted, however, that the high annual replacement costs of gillnets posed problems that warranted further thought and studies to facilitate selection of the most economical gear and materials. Experience gained during the succeeding 20 years suggests that there is an urgent need for studies concerning pelagic driftnets.

In an effort to draw attention to that need, Greenpeace International submitted a paper to the recent FAO World Conference on

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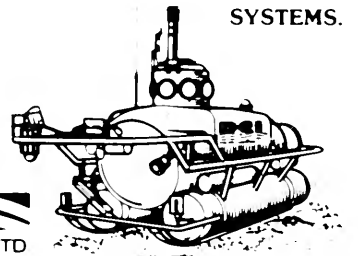
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Fisheries Management and Development in Rome. Greenpeace suggested that the World Conference initiate a re-evaluation of the pelagic driftnet technique by adopting a resolution conveying its concern, calling for a workshop and other efforts to reevaluate the technique, and calling on governments to take the following actions: 1) establish effective arrangements for an impartial observer program, the collection of information from pelagic driftnet operations at sea, and the marking and registry of all pelagic driftnets indicating the flag nation and identity of the vessels using each net; 2) undertake efforts through the International North Pacific Fisheries Commission, FAO, and other organizations to collect, share, and evaluate information, develop legal and administrative frameworks, and take such other steps as may be necessary to prevent the adverse impacts from pelagic driftnets; and 3) refrain from investment in and development of any additional pelagic driftnet fisheries unless and until the major problems that result from such fisheries are resolved.

These are reasonable and moderate recommendations designed to gather more information with which to assess the nature and extent of the problems and resolve them. The FAO World Conference concentrated its efforts on the adoption of a broad policy, the Strategy and accompanying Action Programmes and it therefore did not take action on the resolution suggested by Greenpeace.

The United States delegation, however, did distribute to other delegations at the meeting a note expressing concern about the large numbers of nontarget fish, birds, marine mammals, and other creatures that become entangled in pelagic driftnets as well as in other gear and debris and suggesting that the subject be included in the agenda for future meetings of the FAO Committee on Fisheries. In response to the note, the issue will be included on the agenda

for the April 1985 meeting of the committee. It will almost certainly be the subject of discussion in other domestic and international forums as well.

Such discussions are overdue and essential if a major controversy similar to that resulting from the tuna-porpoise problem in the 1970s is to be avoided. The estimates of the number of animals killed, based on observations of only some of the pelagic driftnet fisheries, are staggering and warrant immediate attention. While it is not clear that there are technological solutions to the problem, some attempts have been made and others have been proposed. The Japanese have installed air-tube strands in salmon driftnets to render them "visible" to echolocating Dall's porpoises—with mixed results. They also are examining the possibility that a smaller mesh size may reduce seabird entanglement. These and other approaches should be pursued.

The prospects for a reasoned and effective resolution of the problems associated with the pelagic driftnet are very likely to depend on the extent to which discussions in the near future elicit adequate information and vigorous remedial action by the nations conducting the pelagic driftnet fisheries.

**Robert Eisenbud**

*The author served as General Counsel of the U.S. Marine Mammal Commission and now serves as a consultant on marine mammal and fisheries issues for the National*

*Oceanographic and Atmospheric Administration, the Environmental Defense Fund, and other organizations. This article was adapted from a paper submitted by the author on behalf of Greenpeace International to the FAO World Fisheries Conference. The views expressed are those of the author and do not necessarily reflect those of any organization with which he is affiliated.*

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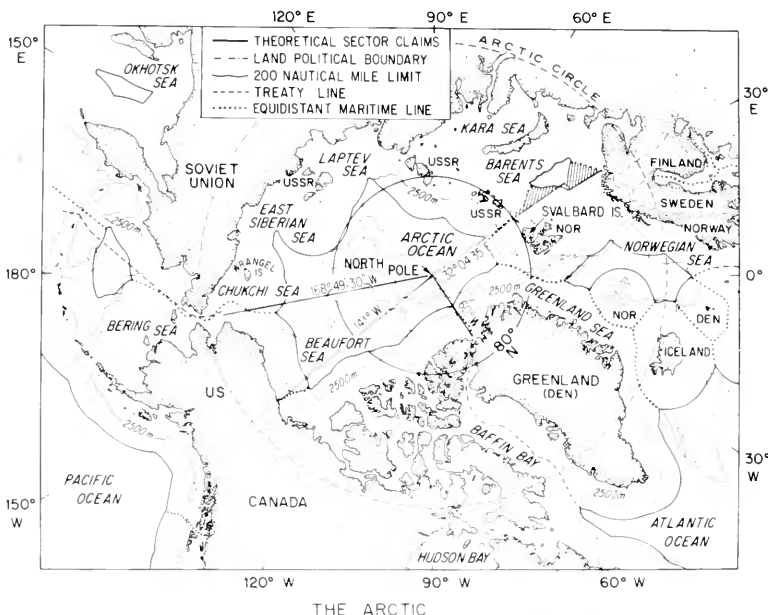
# Arctic Issues Coming to Fore

Although it is remote and often an extremely difficult place in which to work and live, the Arctic will be of growing importance to the United States during the next two decades. Issues of national security, resource development, science, and environmental protection have brought new players into Arctic affairs and have increased the activity and concern of those already involved. A prerequisite for improved relations among Arctic-rim countries is knowledge and understanding of each nation's strategic and resource-development objectives in the Arctic. Cooperation in any region is more likely to take place when nations and other constituencies are convinced that benefits can be derived from working with, or at least not against, one another.

## U.S.—Canada

During the next 20 years, development of Arctic resources will influence the relations between the United States and Canada. As the pace of this development quickens, the level of interaction will increase. Although close neighbors, the United States and Canada frequently have different viewpoints and goals regarding their Arctic interests. Even when interests are perceived as mutual, the implementation of joint projects has not always been smooth. The uncertain future of the Alaska Natural Gas Transportation System (ANGTS) illustrates how a joint development plan can lead to considerable difficulties despite the initial interests of industry and government in both nations.

If development in the Arctic continues, several present low-level jurisdictional disputes could become large-scale problems. One such dispute



Arctic affairs will become increasingly important during the next 20 years.

involves the continental shelf boundary in the Beaufort Sea. If the area contains commercially extractable oil, resolution of a once minor boundary problem becomes very important. Another unresolved difference between Canada and the United States is transit rights through the Northwest Passage. The United States apparently is prepared to accept the provisions of Article 234 of the proposed Law of the Sea Convention\* on ice-covered waters. Canada has signed but not ratified the treaty. The two nations thus may reach a mutually acceptable solution to this jurisdictional problem. Moreover, if United States oil companies do not need to transport oil through the Passage (a reasonable assumption for at least the next 15 to 20 years), then the

\* The Law of the Sea Convention will enter into force 12 months after 60 nations have ratified it.

possibility of finding a jointly acceptable solution to the issue appears greater.

Emphasis on the problems between the United States and Canada in the Arctic can obscure ongoing cooperative efforts and opportunities for future understanding and agreement. Problems do exist, but some can be constructively explored in private bilateral forums. For example, the Arctic Policy Forum has been organized by the University of Southern California and the University of Alberta. This forum is based on the premise that if a respected group of American and Canadian citizens examines issues of mutual concern and recommends a prospective course of action to benefit both nations, then those recommendations will receive serious hearings from both governments.

The Arctic Policy Forum will assess policy options on



*Oil and gas discoveries have increased the importance of boundary disputes in the Arctic, and have raised fears of environmental degradation. (Photo courtesy of the American Petroleum Institute)*

problems that are now minor, helping to prevent them from causing major rifts between the two governments. One of the specific purposes of the Forum is to ensure that once discussion is complete, constructive ideas are not allowed to evaporate without impact on policymakers.

Although Canadians generally, and at times correctly, believe that Americans have little concern for Canadian Arctic interests, many United States government officials and private citizens would like to maintain a good relationship with Canada. These individuals are eager to learn of Canadian opinions on all bilateral Arctic issues. Because the potential for problems between the United States and Canada may increase, cooperative ties between the two countries in the Arctic should be strengthened now.

The existing Canada/United States Oil Spill Contingency Plan for the Beaufort Sea is an example of a program that benefits both nations. Other efforts that might be nurtured are joint Arctic science programs and joint exploratory and developmental activities in the disputed area of

the Beaufort Sea. A successful approach in the latter case might produce joint production agreements wherein proceeds from a specific area would be shared.

Cooperative military exercises also could ease some of the tension over United States naval activities in the Northwest Passage. Canada is particularly sensitive about marine transport through the Canadian Archipelago.

In physical size and scientific and industrial activities, Canada is the larger of the two nations in the Arctic. It is advantageous for both the United States and Canada to maintain good relations in the Arctic for defense, security of energy supplies, and scientific interests.

#### **U.S.—U.S.S.R.**

Relations between the United States and the Soviet Union in the Arctic are tolerant and cautious. Since they share a common ocean boundary in the Bering and Chukchi Seas, both nations have important strategic interests in the Arctic. These interests have stimulated the construction of military installations and, recently, an increase in submarine activity in the Arctic and sub-Arctic.

A relatively new United States defense system involves the deployment of an undersea surveillance system to detect the passage of Soviet submarines through critical areas. A network of captor mines also has been placed between Greenland and Iceland in part of the geographical region referred to as the Greenland, Iceland, United Kingdom (GIUK) gap. These mines can fire torpedoes equipped with homing warheads at the passage of a "stray" Soviet submarine. The Soviets, at the same time, are deploying greater numbers of more sophisticated submarines throughout the world. With this type of hide-and-seek activity routinely occurring in the Arctic region, the chances for a costly mistake are increased.

An important strategic concern of both the United

States and Soviet Union in the Arctic is the protection of energy and other exploitable resources. This raises broad national security issues. For example, if the United States maintains its present policy of an export ban on Alaskan oil to Japan, then it also must be prepared to accept the continuation of a poor balance of trade with Japan and the

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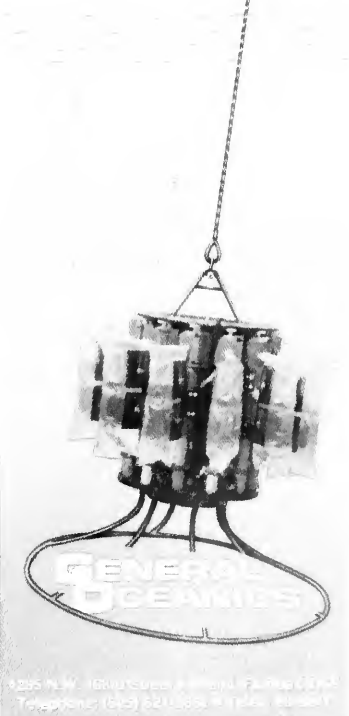
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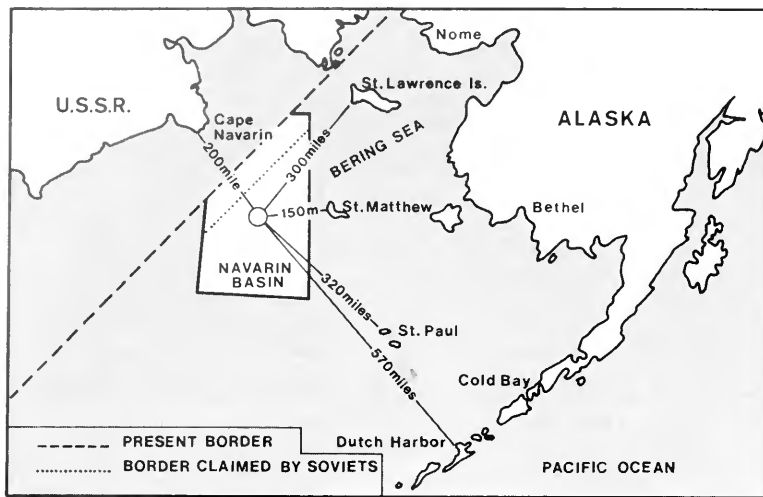
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Although U.S. companies have bid on tracts within the disputed area of the Navarin Basin, the Interior Department is holding the bids pending settlement of the dispute.

possibility that it (like some western European nations) may increasingly rely on the Soviet Union for energy supplies.

Problems and opportunities exist between the United States and the Soviet Union. Disagreement over the 1867 United States/Russia Convention Line in the Bering and Chukchi Seas (see map above and on page 80), for example, could delay oil exploitation in the area. This potential problem, however, could be an opportunity (though a remote one) for developing better relations. For example, there would be benefits derived from joint exploitation of the Navarin Basin (see map above). Such cooperation could set a precedent for resolving other Arctic problems.

The disputed area of the basin could perhaps be exploited in a manner similar to joint oil and gas exploitation activities in the North Sea between Britain and the Netherlands. The 1967 agreement between those nations resulted in a unified approach to resource development. The associated costs and proceeds are apportioned according to the size of each state's share of the common deposit. It is, of course, one thing for two West European allies to come to a resource-exploitation

agreement, and quite another thing for two nations with large numbers of sophisticated conventional and nuclear weapons aimed at each other to reach such an agreement.

There is greater likelihood that the United States and the Soviet Union would agree to the establishment of a buffer zone in the disputed area. In this zone, neither nation would be permitted to explore or exploit nonliving resources until the boundary line was mutually decided. (A similar zone was created in the Cortes Bank area between the United States and Mexico to assist in outer continental shelf leasing plans.) Because neither nation needs immediate access to potential oil resources from the area, the buffer zone approach offers an opportunity for a satisfactory short-term agreement. Alternatively, the Soviets and Americans could establish an interim arrangement that would permit exploration and provide a framework for potential development and sharing of resources. Although the Soviets are not known to have plans for exploring or exploiting any part of the basin, the United States leased (Lease Sale 83) areas within the Navarin Basin in the spring of 1984. Although U.S. companies made bids for some tracts in the disputed section of the basin, the Interior

Department is holding these bids and not permitting further development, pending settlement of the dispute.

Arctic science is another area in which cooperation could be mutually beneficial. A large proportion of the Arctic research efforts of both the Soviet Union and the United States are classified for military purposes. For example, various scientific studies, including those of ice dynamics and Arctic water acoustics, have enabled the United States to develop a sophisticated underwater and under-ice hydrophone surveillance system for the detection of submarines.

Yet the possibility exists for sharing knowledge about the Arctic. For example, joint Soviet-American projects might be possible in nonsensitive areas, such as climate research and pollution control. The United States could benefit from scientific knowledge that the Soviet Union has acquired during decades of work in the Arctic, while the Soviet Union could benefit from learning more about those subjects in which the United States has a comparative advantage. Although individual American and Soviet scientists sometimes discuss informally, the possibility of joint Arctic projects, official sanction or even discussion of joint scientific efforts appears remote.

### Inupiat Concerns

No group has been as affected by development in the Arctic as the Inupiat.\* Through their native-owned corporations, established in the 1970s, the Inupiat control several million acres of land throughout Alaska. They interact with environmentalists, developers, and both the state and federal governments with mixed results. Progress was made throughout the 1970s, and continues to be in the 1980s, on the organization and articulation of Inupiat concerns and demands. The numerous issues of concern to the Inupiat can be grouped under one basic umbrella:

\* Alaskan Eskimos.

development interferes with subsistence hunting and with the native lifestyle in general. Inupiat leaders worry about what will happen to traditional native values when the oil industry leaves the Arctic. The major source of money will depart, leaving behind a wide range of sociocultural problems, including alcoholism and suicide.

State and federal agency representatives are visiting Inupiat villages in an effort to curb the negative impacts of development. This outreach is designed to assist the Inupiat in adapting to changes that will occur in tandem with development activities.

Although the visits usually are made by individuals that have a pro-growth orientation, they are generally tempered by real concern for the protection of native lifestyles.

Inupiat leaders credit efforts by the State of Alaska in helping to raise the standard of living in the villages during the past decade. The Inupiat have welcomed funds for improved health services, and water and sewer facilities. In the past, agency representatives came to the villages and told the natives what was needed. They now benefit more, it seems, by going directly to state and federal agencies with specific requests for assistance.

Industry will not shoulder the major responsibility of ensuring minimal disruption of Inupiat culture. The National Petroleum Council has suggested that state and federal agencies should provide the assistance necessary to local communities planning for oil and gas development. Industry is aware, however, of Inupiat concern that development take place in a manner that meets native social and financial goals. Industry also has been made aware that subsistence activities, such as hunting and fishing, are of vital importance in preserving native cultural heritage and integrity.

An important link between Arctic development and the Inupiat lies with the Inupiat-controlled regional governments (corporations),

such as the North Slope Borough. In 1972, Inupiat leaders obtained the right to form regional governments and to tax petroleum properties. They then designed a capital-improvements program. The State of Alaska has followed a similar course. However, as oil reserves decrease, both may find during the next few years that they have insufficient funds to build or operate the facilities that are presently planned.

Several of the native regional corporations are participating in oil and gas development to fulfill their mandate as profitmaking organizations. Inupiat business people are sometimes involved in subcontract work for the oil companies. Frequently, for example, they sell sand and gravel for the construction of offshore islands. As more effort is made by these corporations to get involved in oil development, the maintenance of traditional subsistence skills and practices is threatened. Often, little keeps natives in the villages other than subsistence living. Long-term socioeconomic problems, therefore, may result as the social and economic network of the village breaks down.

### **Developers, Environmentalists**

American resource developers and environmentalists often have very different goals in the Arctic. Expanded efforts in the 1970s and 1980s to explore, exploit, and transport petroleum from U.S. Arctic areas have stimulated legal controversies that will continue into the 1990s if nothing is done to change the operating framework in which developers and environmental groups confront each other.

Continued resource development in the Arctic means some degree of environmental degradation will occur. Consequently, conflict between developers and environmentalists is likely to continue. The question then becomes, on what level should development take place while protecting the environment? Too often disputes between resource developers and environmentalists appear as

"either/or" situations: either massive development occurs with its attendant environmental damage, or development of resources does not take place at all in order to protect the environment. Such an outlook is often simplistic and ultimately counterproductive. In the Arctic, as elsewhere, a compromise position is almost always possible.

### **Federal—State Relations**

Because the federal government owns a large portion of land in Alaska and because oil development is the principal industry of the state, extensive planning between the state and federal governments has been required. Difficulties may characterize federal-state relations in Alaska for several years, though they are likely to be less intense than they were throughout the 1970s.

Since most land-ownership and management issues have been settled by Congress, relations between the federal and state governments have improved. Offshore-leasing, land-ownership, and wildlife-management issues are likely to prove more problematic. Differences have been expressed over lease tracts, land claims, offshore-boundary jurisdictions, pipeline preferences, and the export of oil to Japan.

The State of Alaska favors properly planned and managed development of its energy resources. The state has joined with other states and citizen's groups in opposing the large-scale federal offshore-leasing program initiated by former Secretary of the Interior James Watt because it does not offer a sufficient framework for resource-management planning.

In March of 1984, Secretary of the Interior William Clark announced that the size of the Diapir Basin lease sale area would be reduced by 50 percent. He accepted Alaska's demands for more stringent leasing stipulations to protect against potential oil spills and other environmental hazards. Clark's announcement indicated that Alaska Governor Bill Sheffield had successfully

promoted the state's goals. The state government is especially concerned about ensuring a moderate approach to development of offshore lease tracts because Alaska will derive only limited revenue benefits from exploitation in those areas while shouldering most of the social and environmental costs.

The state government would like to see either the Alaska Natural Gas Transportation System (ANGTS) or the more recently proposed Trans-Alaska Gas System (TAGS) built. Either system would increase tax revenues for the state; however, market forces will probably delay either project for the next several years. The federal government continues to officially support the ANGTS proposal, one reason being that the federal government would like to maintain good relations with Canada. In sum, despite the problems, opportunities for a better relationship between the state and federal governments exist, particularly in areas of cooperative resource management.

### Policy Concerns

Offshore oil and gas development in the Arctic is poised to make a significant contribution to the nation's future energy supply. The development of these resources will require a combination of public and private efforts. A number of services and programs will have to be provided if resource exploitation is to proceed in a safe and responsible manner and if other uses of the Arctic Ocean are to be protected. Industry and government studies have been conducted to help determine which sector—public or private—should provide these services. Disagreements and areas of responsibility not covered by either sector remain a problem.

In determining the appropriate mix of public- and private-sector responsibility in the United States Arctic, four political and economic factors shaping resource development in the region should be kept in mind. Each is significant, but as

a group they demand special policy consideration to assure efficient and responsible development.

The first factor is that the federal government is operating under budgetary constraints; this will affect the level and quality of government services and programs. A second factor is the trend toward reduced government regulation of industry. A third is the desire of the federal government to pass greater autonomy and responsibility on to the states. The fourth factor is that, increasingly, the nation's hydrocarbon resources will be derived from offshore sources.

Present United States Arctic policy, as formulated in National Security Decision Memorandum 144 of December 1971 and the more recent National Security Decision Directive (NSDD) 90 of June 1983, provides only a general framework for United States interests in the Arctic. A clarification of procedures and areas of responsibility between the private and public sectors in the Arctic is needed. This clarification is required in view of present national policy toward a more limited role of government in general, and the national objective of reducing the activities of federal agencies in particular. Although NSDD 90 calls for a review of ways to enhance United States resource development in the Arctic, it does so in the context of a smaller overall federal role. The unique physical and human environment, the potentially huge energy resources, and the severe operating conditions in the Arctic may require a greater, not smaller, federal role, if resource exploitation is to occur



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in a safe and responsible manner and if relations between the United States and its Arctic neighbors are to be harmonious.

**Kurt M. Shusterich,  
Policy Fellow,  
Marine Policy and Ocean  
Management Center,  
Woods Hole  
Oceanographic Institution**

### Suggested Reading

Westermeyer, William E. and Kurt M. Shusterich, eds. 1984. *United States Arctic Interests: the 1980s and 1990s*. New York/Berlin: Springer-Verlag.

### Corrections

Because of a typographical error in the Profile of Holger Jannasch in the September 1984 issue, it appeared that WHOI scientists like to nibble on gold nuggets—bullion—for lunch. Actually, their taste is much more prosaic. It was bouillon in that lunch box.

The painter's name who did the cover was also misspelled. She is a Scot—Suzanne MacDonald—and not Irish—McDonald.



### Summer Courses and Scholarships

1985 course will include tropical marine ecology, tropical invertebrates, biology of fishes, analysis of marine pollution, and environmental contingency planning and damage assessment. Financial aid averages 55% of course costs.

#### For more information, contact:

Dr. Susan Cook  
Education Director  
Bermuda Biological Station  
Ferry Reach 1-15, Bermuda



milestones

# New Ocean Drilling Program Goes to Sea

by Roger L. Larson

In January, 1985, the Ocean Drilling Program (ODP) goes to sea with a newly-refitted vessel called the *JOIDES Resolution* (SEDCO BP/471) to begin a 10-

\* JOIDES stands for Joint Oceanographic Institutions for Deep Earth Sampling.

year program of drilling in the deep sea for purely scientific purposes. At first glance, ODP looks much like the old Deep Sea Drilling Project (DSDP) conducted with the *D/V Glomar Challenger*, so why go to all the trouble for a new program and a new ship? This is like asking, "Why drive across the country

in a new car, when you can get there in a Model-T?"

As our new "vehicle," the *JOIDES Resolution* (Figure 1) is about 60 percent larger in displacement tonnage and has nearly twice as much positioning horsepower per displacement ton as the *Glomar Challenger*. The computer-controlled automatic station-keeping system is at least two

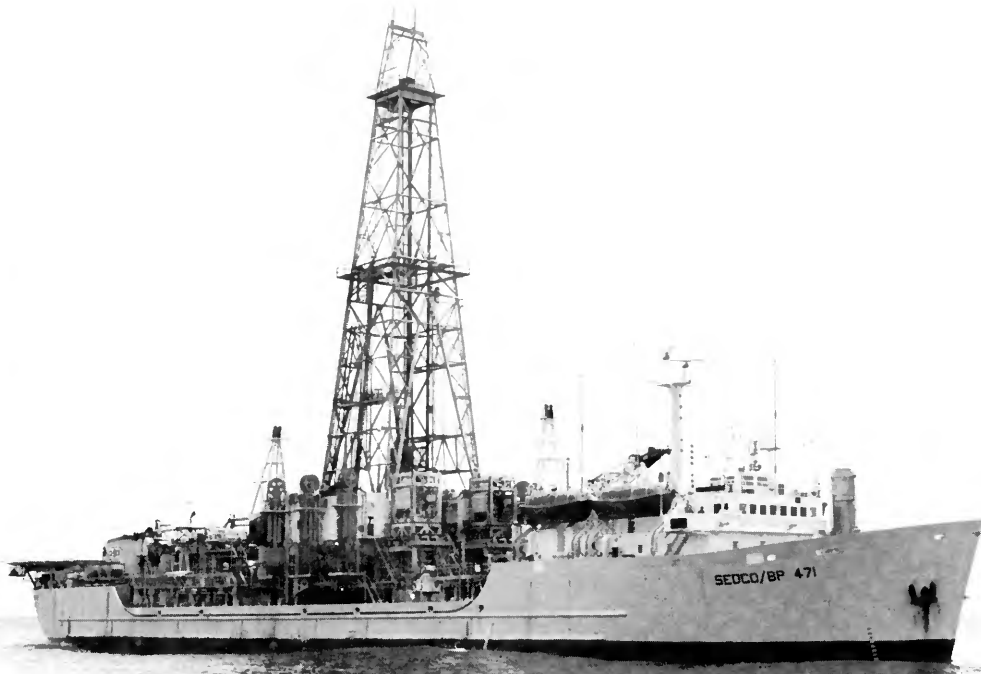


Figure 1. The *JOIDES Resolution* (SEDCO/BP 471) is 470 feet long and 70 feet wide and has a displacement of 16,596 long tons. The derrick looms 200 feet above the water line. A computer controlled dynamic positioning system can be used in water depths as great as 27,000 feet. The rig will be converted to have a 30,000 foot drill string. It has a crew of 52 and can accommodate a science party of up to 50. Approximately 12,000 square feet of shipboard space will be equipped with science laboratories.

generations beyond *Challenger's* computer; that, coupled with the added tonnage and power, translates into an ability to maintain position and drill in substantially higher wind conditions and sea states than were possible with the previous vessel. This positioning ability and the *JOIDES Resolution's* strengthened hull for ice conditions put within our reach scientific goals in the polar oceans that could not be attempted by DSDP. The ship will accomplish absolute positioning by a combination of conventional satellite navigation, LORAN C, and the new, satellite-based Global Position System (GPS).

### New Capabilities

The drilling system is similarly scaled up from *Glomar Challenger*: 30,000 feet of working drill string versus the old limit of 23,000 feet; larger draw-works and heave compensator capabilities; and electric versus hydraulic power to turn the drill string. All of these mean drilling in deeper water, with deeper penetration, and more reliability than ever.

The new vessel's six-story laboratory will be one of the most modern and complete complexes for the study of marine geological samples on land or afloat. For example, a cryogenic magnetometer will go to sea for the first time on the *JOIDES Resolution*. Many of the scientific instruments are computer controlled or have computerized analysis capabilities, and a high-powered computer system will be available for use by the scientists on board.

There will be an X-ray fluorescence device (an ARL 8400 Hybrid Spectrometer); X-ray diffraction will be done with a Philips ADP 3520. Both of these will have full microprocessor control. Drill sites will be located with a digital, single-channel seismic profiling system powered by water guns with real-time processing capabilities. The laboratory systems will be computerized via two DEC Vax 11/750s that drive several dozen

DEC PRO 350 microcomputers.

A system for both routine and special geophysical logging is being devised by investigators at the Lamont-Doherty Geological Observatory. The system will include equipment to reduce the effect of the ship's motion on the results by about 90 percent.

### New Science Concepts

More important, however, is the question: What type of science we can do with our new "car"? The answer really comes in two parts, a conceptual answer and a technological one. Conceptually, the Ocean Drilling Program differs from the old Deep Sea Drilling Project both in its implied longevity and in its experimental design. Because this is a 10-year program instead of a short-term project, long-term plans for sea-floor laboratories that can be revisited and remeasured can be made, and expensive, time-consuming projects involving riser and blow-out prevention capabilities can be considered. The experimental nature of DSDP was essentially that of a reconnaissance mission, while that of ODP is to fully exploit, with state-of-the-art measurements, all holes that are drilled.

### Spreading Center Experiments

Another goal of ODP is to set up sea-floor experiments, consisting of a number of related holes all outfitted with re-entry cones that could allow visits to the same hole by other research vessels. Some of these holes also would be instrumented with long-term measuring devices. The first of these sea-floor experiments is being planned by scientists studying the ocean lithosphere. They plan a series of holes at the exact spreading centers on the Mid-Atlantic Ridge and East Pacific Rise.

These holes will require the ability to initiate drilling into a bare and bumpy hard-rock surface some 3 kilometers below a heaving drill ship. Moreover, on the East Pacific Rise it is necessary to drill and recover samples in formations

that are highly susceptible to fracturing, are saturated with hydrogen sulfide, and have an ambient temperature of several hundred degrees Celsius. If that can be done, we will need the ability to make sensitive measurements in conditions similar to those encountered on Venus, namely a highly acidic environment existing above 300 degrees Celsius. All of this is an engineering challenge larger than any conquered in the Deep Sea Drilling Project.

The bare-rock drilling system will go to sea for the first time in October, 1985. Soon after that scientists will study one of the most dramatic discoveries of the last 10 years, the hydrothermal vent phenomena that often culminate as so-called black smokers at medium and fast spreading ridges (see *Oceanus*, Vol. 27, No. 3). Observations of these systems have been confined to deep-towed cameras and deep-diving submersibles; these observations imply that major, if not overwhelming, processes related to heat transfer and geochemistry lie just below the sea floor.

The *JOIDES Resolution* crew will attempt to drill into, or very near to, these active hydrothermal systems to measure heat transfer rates, water flow rates, and geochemical ion exchange rates. All of these are expected to be geologically important and to have large temporal and geographic variations.

It is hypothesized by some that a large percentage of Earth's heat is lost through these hydrothermal systems and that a major amount of the world's seawater cycles through these systems every 100 years. Thus, vents on the ridge crests not only act as the Earth's "radiators" (or more properly "convectors"), but also as major, and hitherto unknown, elements in the planet's chemical exchange system.

### Paleoclimate and Polar Oceans

Some like their new challenges hot, while others like them cold. The latter will have their first chance in the Norwegian Sea

and Baffin Bay next summer, with later (after January, 1987) cruises planned in the Weddell and Davis Seas in the Southern Ocean. Our ability to go to these areas depends on the increased vessel stability, station-keeping ability, and strengthened hull of the *JOIDES Resolution*, not to mention a heating system for the crew's quarters far superior to that on the old vessel.

While much of the mandate to go to the polar oceans is the same as that of TV's *Starship Enterprise*, "to boldly go where no man has gone before," the main scientific rationale is to study the paleoceanography of our planet. Despite massive commitments of time, energy, and money, we still do not really know what caused the ice ages, and we have an even more vague idea of the general temperature variation on the planet over the last 100 million years, much less any understanding of its cause. This is partially due to a sampling problem in the polar oceans.

We cannot really understand the climate of a planet with significant ice concentrations at its poles until we understand polar geology and climatology, because the forcing functions operate there. The oceanic circulation systems, and thus the temperature distributions and their changes, are all "driven" by Arctic and Antarctic conditions.

It is both the blessing and the curse of the science of geology that in order to truly understand an area, one must go there and study it carefully. And so we go, with John Masfield, "down to the sea again, to the lonely sea and the sky." But this time we will have at our disposal considerably more than just "a tall, tall ship, and a star to steer her by."

*Roger L. Larson is a Professor of Marine Geophysics in the Graduate School of Oceanography at the University of Rhode Island and Chairman of the Planning Committee for the Ocean Drilling Program.*

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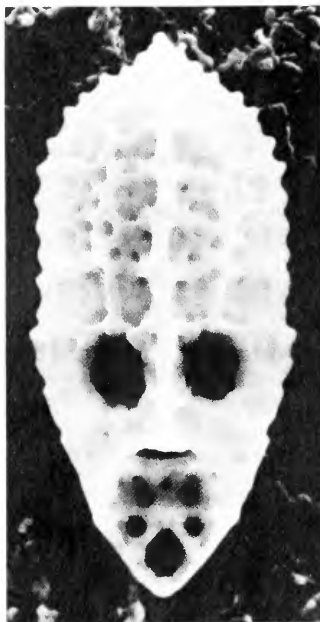
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# book reviews

***A New, Expanded Guide to the Birds of Alaska* by Robert H. Armstrong and the editors of Alaska Magazine. 1983. Alaska Northwest Publishing Company, Anchorage, Alaska. 332 pp. \$16.95.**

If one is going to Alaska and wants a field guide to the birds of that state, this is the only guide available. This book, covering 405 species, is an updated and expanded version of the 1980 edition, which covered 386 species. There has been no other guide to Alaskan birds since the comprehensive *Birds of Alaska* by Gabrielson and Lincoln (1959), now out of print and very difficult to find.

*A New, Expanded Guide to the Birds of Alaska* is paperback, fairly compact (9 x 6 inches) and relatively light (18 ounces). For the most part, color photographs are used to illustrate the birds. Where photographs were not available, several fine paintings by John C. Pitcher have been included. Many of the photographs are excellent and can be used easily for field identification. However, the birds in some of them are too small, too distant, or out of focus, and therefore these photographs are not very helpful. Several of the less-good photographs in the 1980 edition have been replaced with better ones in this book, but in a few cases the earlier photographs were clearer or more graphic.

For some birds (ducks especially), pictures of both the male and female are shown. This is extremely helpful, as the different sexes of several species have distinctly different color patterns. For birds with different summer (breeding) and winter (non-breeding) plumages, for example the ptarmigan, all color phases usually are pictured. In a few cases, such as some of the shorebirds, the immature plumage is pictured as well as that of the adult. All these extras help the birder in the field identify a specific bird.

On some pages, more than one species is described. Sometimes it is hard to know whether the description of the bird is next to or below the picture because the layout is not consistent throughout the book. All pictures are labeled, but with a quick glance at a page, an inexperienced birder could be confused.

The text that goes with each bird is made up of two sections: identification and habitat. It is brief, concise, and descriptive. In some cases special notes have been added. Following the text for each bird there is a table showing the bird's status and distribution in each of six geographical



TUFTED PUFFIN  
(W. E. Townsend)

Status and Distribution	SPRING	SUMMER	FALL	WINTER
Southeastern *	R	U	R	R
Southcoastal *	C	C	C	R
Southwestern *	C	C	C	U
Central	—	—	—	—
Western *	C	C	C	—
Northern	—	+	—	—

## TUFTED PUFFIN (*Fratercula cirrhata*) LENGTH: 15 IN

**Identification.** Breeding adult has long, curved yellowish tufts that hang behind the eyes and entirely dark body. In winter distinguished from Horned Puffin by dusky rather than white sides. Smaller Rhinoceros Auklet has a considerably narrower bill.

**Habitat.** Breeding — inshore marine waters, islands. Nests principally in burrows in the soil but rock crevices are also used. In winter — inshore and offshore marine waters.

*A typical page from Birds of Alaska.*

areas of Alaska (indicated on a map at the beginning of the book) for each season of the year. A checklist of the birds of Alaska is included, also at the beginning of the book, which is useful for keeping records of one's own bird sightings.

Following the species accounts is an updated list of accidentals—birds that have been seen only once or just a few times—including where they were sighted. The 1980 edition had two color plates of John C. Pitcher's paintings of the accidentals, with each bird numbered to match the list. It is too bad that these plates had to be left out of this edition, as they were helpful for identification, but the accidentals list is no longer the same. The book closes with a bibliography, greatly extended from the first edition, and indices of the scientific and common names of the birds.

**Janet Mcl. Williams,  
Research Associate,  
Swarthmore College  
Swarthmore, Pennsylvania.**

**Catastrophes and Earth History**, W. A. Berggren and John A. Van Couvering, eds. 1984. Princeton University Press, Princeton, N.J. 464 pp. \$19.50 (paperback); \$65 (hardcover).

This collection of 18 technical papers, chosen mostly from two symposia, is suitable for the serious lay reader of science and its philosophy. It appears to catch geologists unprepared to answer the criticisms of philosophers. In the opening chapters (not from the symposia), S. J. Gould, R. H. Benson, P. E. Gretener, and D. V. Ager philosophize about rare and rapid natural events and the limits of the assumptions of uniformitarianism, the traditional basis of geology. These contributions broaden the interest of the book considerably.

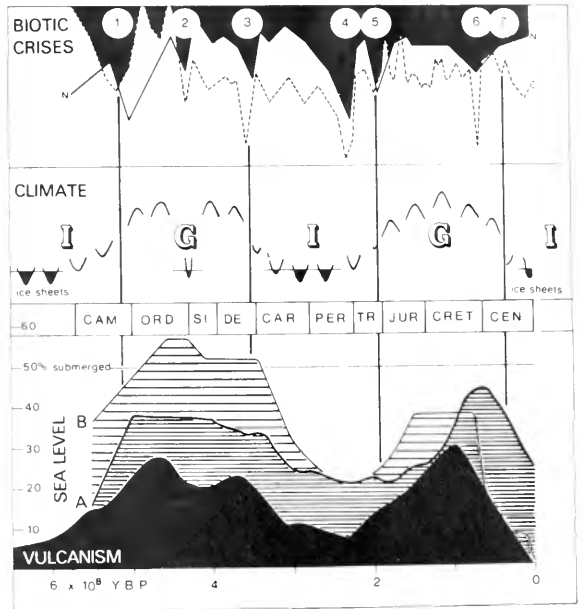
The remaining chapters are case studies by various authors. They provide data summaries, attempt explanations of events at stratigraphic boundaries (particularly the Cretaceous-Tertiary event of 65 million years ago), and struggle weakly with the previously presented philosophical challenges of catastrophism.

Van Couvering, in the introduction, defines a "new uniformitarianism" that includes the tool of uniformitarian logic but permits certain catastrophes and surprises.

Gould lists the assumptions that define uniformitarianism: natural laws are invariant; past results are explainable by causes still operating on Earth; and change operates at a uniform rate. He sees geology as mired in gradualistic prejudice, having missed the dominant, punctual tempo of natural change.

Benson gives a history of catastrophism beginning with George Cuvier (1769-1832), and defines "catastrophe" as an event that occurs in the history of a system when stress is sufficient to cause alteration of the system's principal structures and subsystems survive but fail to absorb all of the stress. Gretener rejects the terms "catastrophism" and "uniformitarianism," because catastrophism implies destruction and should not be used to describe geological events that are simply fast changes, while uniformitarianism provides a false sense of security. He criticizes the geologists' tendency to consider the rare event impossible rather than improbable, thereby neglecting it. He points out that acceptance of the possibility of the rare event removes some important happenings from the realm of rigid scientific analysis, and that "the fact that we cannot rationally deal with it [the rare event] does not mean that it does not exist."

The authors of the case studies show few signs of considering or testing alternatives to the assumptions of uniformitarianism. E. G. Kauffman's chapter, entitled "the Fabric of Cretaceous Marine Extinctions" and taking up a quarter of the book, dominates the case studies. It is sufficiently comprehensive for the reader to understand his struggle. He criticizes the graphical depiction of stratigraphic data as unwavering straight lines between data points, absent of detail, with large gaps in the record that may lead to misconception, but he fails to address the data with other than uniformitarian assumptions. He sees worldwide sea level rise,



An illustration from *Catastrophes and Earth History* showing the relationship of sea level changes, vulcanism, climate, and biological crises.

generated by plate tectonics accompanied by warming, as the first cause of the Cretaceous-Tertiary extinction event. The biota/ecosystem was "shocked" from environmental changes stemming from this, 0.5 to 2.0 million years before the final extinction. He allows an extraterrestrial event, such as a meteor or comet impact, at the boundary between the two periods; however, biological evidence shows that most of the event was over before the final microplankton catastrophe, so the suggestion is that an extraterrestrial event was "the straw that broke the camel's back."

Kauffman and the other authors of case studies are uncomfortable with the rare or rapid event and treat it as an unwelcome guest. They use "catastrophe" and "rapid" imprecisely and fail to distinguish the difference in time scale between a rapid geological event, of one million years duration, and an extraterrestrial event which may be periodic and affect the earth for minutes or thousands of years. D. A. Russell alone speculates briefly on this question and suggests that the extinction event that marks the end of the Cretaceous Period cannot be understood in terms of geologic processes normally operative on Earth. The authors, in assessing their data and conclusions in the catastrophic framework, lack a common language for and a sense of the nature of rare and unfamiliar events. Nevertheless, all this makes an important and interesting book on the ways of science.

James W. Mavor, Jr.,  
Woods Hole, Massachusetts.

# Books Received

## Biology

***Fish Reproduction: Strategies and Tactics*, G. W. Potts and R. J. Wootton, eds. 1984. Academic Press, New York, N.Y. 410 pp. + xiv. \$49.00.**

Based on papers presented at a meeting of the Fisheries Society of Great Britain, this series of review articles covers theoretical modeling, ecology, and behavioral and experimental studies. There are 20 chapters, beginning with a review of the applicability of modern evolutionary theory to the questions of strategies and tactics in fish reproduction. The review chapters cover the deep sea, tropical and temperate seas, and estuarine and freshwater conditions. Specific problems in fish reproduction and development are discussed. The final chapter deals with the effects of commercial fishing on fish reproduction.

***Sharks: An Introduction for the Amateur Naturalist* by Sanford A. Moss. 1984. Prentice-Hall, Englewood Cliffs, N.J. 246 pp. + x. \$10.95.**

This book is devoted to the biology of sharks and their close relatives, skates and rays, with an emphasis on recent research findings. The first two chapters describe the "negatives" and "positives" of sharks—for example, damage to fishing gear on the negative side, and sharks as food on the positive side. There are eight chapters on the biology of sharks, covering such topics as their evolution, feeding, sensory perception, brain and behavior, swimming, reproduction, and metabolism. Finally, a chapter on "friends and enemies of sharks" describes incidences of commensalism, mutualism, and parasitism with and on sharks.

***Cephalopod Life Cycles: Volume 1, Species Accounts*, P. R. Boyle, ed. 1983. Academic Press, New York, N.Y. 475 pp. + xvii. \$120.00.**

This book is a collection of research reports on cephalopod biology,

broadly describing the life patterns of the group. Cephalopods are carnivorous soft-bodied invertebrates—such as, *Nautilus*, cuttlefish, squid, and octopus. They are important food sources for marine vertebrates—fish, birds, seals, and whales eat enormous amounts of squid. The book has 19 contributors from nine countries, including the United States. After the introduction there are four sections—on *Nautilus*, cuttlefish and sepioids, squid, and octopus. Individual papers within the sections report on—research on individual species life-cycles. Finally, the editor provides a commentary.

***The Cell Biology of Sponges* by Tracy L. Simpson. 1984. Springer-Verlag, New York, N.Y. 662 pp. + xix. \$85.00.**

A review and analysis of sponge biology, this book contains nine chapters divided into four sections: morphology, cellular structure, cellular functions, and development. It is an extensive review of data, with many references, intended for interested parties in the fields of biochemistry, developmental biology, and physiology.

***Biological Oceanographic Processes* by Timothy R. Parsons, Masayuki Takahashi, and Barry Hargrave. 1984. Third edition. Pergamon Press, New York, N.Y. 330 pp. + xii. \$40.00 (hardcover); \$19.95 (paperback).**

An introduction to the field of quantitative biological oceanography, this book does not rely on discussions of special marine environments, such as the littoral zone. Instead, the material selected can be explained either with empirical equations or by definite biological and chemical descriptions. The first two chapters describe the composition and distribution of organisms in the plankton community; Chapter 3, the formation of particulate material; Chapter 4 is on feeding processes and production in the pelagic food chain. In Chapter 5, the authors combine various processes into biological cycles; Chapter 6

introduces benthic communities and their biological processes. The last chapter presents example problems in the marine environment of importance to the biological oceanographer, including monitoring programs, other studies of marine pollution, larval fish survival, and other fisheries studies.

***Seabirds of the Eastern North Pacific and Arctic Waters*, Delphine Haley, ed. 1984. Pacific Search Press, Seattle, Wash. 214 pp. \$39.95.**

Marine birds are a familiar, friendly, and often glorious sight to people at sea. This large book, concentrating on the seabirds of the eastern North Pacific, is beautifully illustrated. The editor introduces seabirds in a general way, discussing the ways seabirds and humans interact, and how seabirds have influenced various human cultures. Also covered are the general biological and ecological characteristics that typify seabirds. The greater part of the book is taken up with chapters on the three orders of birds of the eastern North Pacific—



Procellariiformes (albatrosses, fulmars, shearwaters, gadfly petrels, and storm-petrels), Pelicaniformes (tropic birds, boobies, pelicans, cormorants, and frigatebirds), and Charadriiformes (phalaropes, skuas, jaegers, gulls, terns, skimmers, and alcids). Finally, there is a discussion of marine bird conservation and a classification of eastern North Pacific and Arctic seabirds.

**Seabirds of the World** by Ronald M. Lockley; photographs by Eric Hosking. 1983. Facts on File, New York, N.Y. 159 pp. \$22.95.

More than 120 species are illustrated in 147 photographs, most of them quite large, allowing one to observe small details very easily. After the introduction, a section called "The Seabird as an Individual" describes their role in the ocean food chain, their senses, feather care, behavior, and other aspects of their growth and ecology. There are six chapters, covering penguins, petrels, cormorants, gannets, boobies, skuas, gulls, terns, and auks.

**The Return of the Brown Pelican**, photographs by Dan Guravich, text by Joseph E. Brown. 1983. Louisiana State University Press, Baton Rouge. 118 pp. + viii. \$24.95.

Here is a portrait of the brown pelican's life in isolated colonies and among humans, including roosting, mating, fishing, and caring for the young. In the mid-1960s, the brown pelican nearly disappeared from the United States, due to a number of factors, including DDT. The determined efforts of scientists, conservationists, and the public helped bring the ancient species back. The book chronicles the recent history of pelicans, discusses continuing problems the bird faces because of increasing human encroachment on its habitat, and reports on positive developments in people's "pelican awareness."

**Microbial Mats: Stromatolites**, Yehuda Cohen, Richard Castenholz, and Harlyn O. Halverson, eds. 1984. MBL Lectures in Biology, Volume 3. Alan R. Liss, New York, N.Y. 498 pp. + xviii. \$88.00.

What did early life on this planet look like? The oldest record of life, dating back 3.5 billion years, is believed to be a remnant of an ancient microbial mat. During the Archean and Proterozoan eras, microbial mats may have been responsible for the primordial oxygen buildup in the atmosphere which allowed the evolution of higher life forms. The purpose of this book is to present the major fields of research on microbial mats and to promote an interdisciplinary approach to their study. The sections of the book are: community structures and primary production; decomposition of microbial mats; biogeochemical

changes of microbial mats with time; evolutionary aspects of microbial mats and possible global impact; and the interdisciplinary approach to the study of microbial mats: perspectives for future research.

**Animal Behavior: An Evolutionary Approach** by John Alcock. 1984. Third edition. Sinauer Associates, Sunderland, Mass. 596 pp. \$25.00.

In this book, the author presents evidence that animals behave in ways that enhance the survival of their genes in the context of their environment. Proximate, immediate causes of behavior, and ultimate, or evolutionary, causes of behavior are integrated throughout the text via discussion of evolutionary theory. In this edition, the author has rewritten each chapter, updating the examples and expanding the treatment of certain topics (such as hormonal control of behavior). Color photographs on the endpapers highlight important aspects of animal behavior, with reference to appropriate chapters for in-depth discussion. The author examines natural selection (stressing individuals rather than groups) and discusses genetics and the development of behavior. There are 15 chapters.

**Fish Physiology**, W. S. Hoar and D. J. Randall, eds. 1984. Academic Press, Orlando, Fla. Volume X: *Gills, Part A: Anatomy, Gas Transfer, and Acid-Base Regulation*. 456 pp. + xxii. \$59.00 and, Volume X: *Gills, Part B: Ion and Water Transfer*. 416 pp. \$69.00.

Gills are multifunctional organs involved in ion and water transfer as well as oxygen, carbon dioxide, acid, and ammonia exchange. For a relatively few species, many aspects of gill structure and function have been studied extensively, but much work remains to be done. This volume, in two parts, reviews the structure and function of fish gills, with some material on the methodology used in studying gills. Part A has six chapters: general anatomy, internal morphology, innervation and pharmacology, model analysis of gas transfer, and acid-base regulation. It also contains an appendix of physicochemical parameters for use in fish respiratory physiology. Part B has 10 chapters on various aspects of ion and water transfer, from water and nonelectrolyte permeation to

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perfusion methods for the study of gill physiology. Both books are indexed by author, system, and subject.

## Chemistry

***Chemical Sediments and Geomorphology: Precipitates and Residua in the Near-Surface Environment***, A. S. Goudie and Kenneth Dye, eds. 1983. Academic Press, New York, N.Y. 439 pp. + ix. \$58.00.

This is a summary of recent work on the nature, origin, relationships, and geomorphological implications of chemical sediments in near-surface terrestrial environments, intended for researchers and advanced students in geomorphology, or as an introduction to the literature for sedimentologists, soil scientists, and others. After the introduction, there are 13 chapters covering particular types of sediments and chemical sedimentation processes.

***Complexation of Trace Metals in Natural Waters***, C. J. M. Kramer and J. C. Duinker, eds. 1984. Marinus Nijhoff/Dr W. Junk, Publishers, Dordrecht, The Netherlands. Distributed by Kluwer Boston, Hingham, Mass. 448 pp. + xxi. \$67.50.

These proceedings from the first International Symposium on the Complexation of Trace Metals in Natural Waters—held at the Netherlands Institute for Sea Research, in May 1983—examine the various ways that have been developed to determine the nature and extent of complexation of trace metals in natural system. The volume contains 42 essays in six parts: techniques; theoretical approach; application to natural waters; interaction with particles; interaction with organics; and biological response.

## Environment/Ecology

***Key Environments: Galápagos***, R. Perry, ed. 1984. Pergamon Press, New York, N.Y. 321 pp. + x. \$19.50.

Part of a series produced in collaboration with the International Union for Conservation of Nature and Natural Resources, this book covers the history of the Galápagos Islands, the climate, native climax forests, lichens and bryophytes, seabirds, seals, environmental problems and protection, and many

other areas of biological and ecological interest. The goal of the book is to gather relevant information into a convenient,

## GALAPAGOS



Foreword by HRH The Duke of Edinburgh

Pergamon Press

reliable source for interested professional scientists and lay people.

***Hydrobiology of the Mangal: Ecosystems of the Mangrove Forests***, Francis Dov Por and Inka Dor, eds. 1984. *Developments in Hydrobiology* 20. Dr W. Junk Publishers, Kluwer Academic, The Hague and Boston, Mass. 260 pp. + x. \$69.00.

Muddy, midge-infested quagmires, mangrove forests are unattractive compared to coral reefs and other more glamorous tropical ecosystems. Nevertheless, the mangrove forest (mangal) is very important, covering about 60 to 70 percent of tropical coasts. This book addresses a neglected aspect of the mangal, the ecosystem approach. It has four parts: general considerations of mangrove forests; aquatic biota of the mangal; productivity and decomposition studies; and a case study of the mangal of the estuary and lagoon system of Canaëia (Brazil).

***The Structure and Distribution of Coral Reefs*** by Charles Darwin. 1984. The University of Arizona Press, Tucson, Arizona. 214 pp. + xii and plates. \$7.95.

The first edition of this classic work appeared in 1842, after 20 months of preparation. In Darwin's own words, "The object of this volume is to describe from my own observations and the works of others, the principal kinds of coral reefs, more especially those

occurring in the open ocean, and to explain the origin of their peculiar forms." In the first three chapters, he describes the three main classes of coral reefs: atolls, barrier reefs, and fringing reefs. The fourth chapter is on the biological aspects of coral-reef theory. In the fifth chapter, Darwin introduces his theory for the formation of the different classes of coral reefs. The sixth, and last, chapter gives evidence for the theory with a map of global coral-reef distribution.

***Trophic Interactions within Aquatic Ecosystems***, Dewey G. Meyers and J. Rudi Strickler, eds. 1984. American Association for the Advancement of Science and Westview Press, Boulder, Co. 472 pp. + xiii. \$35.00.

Twenty-one aquatic ecologists review interactions within aquatic food chains and the structure and function of aquatic ecosystems. The four chapters, each comprising several papers, span the first three trophic levels—phytoplankton, zooplankton, and fish—and discuss the community concept in aquatic ecosystems.

***The Global Climate***, John T. Houghton, ed. 1984. Cambridge University Press, Cambridge, England, and New York, N.Y. 233 pp. + vi. \$49.50.

Scientists in the World Climate Research Programme (WCRP) explain the program's background, aims, and main lines of research. The emphasis is on those climatic changes that occur over periods of a few weeks to decades, and on changes that could be induced by human activities. The book's first two chapters introduce the WCRP and global climate research; following are chapters on climate variability established from atmospheric observations; atmospheric circulation models; studies on the interaction between deserts and climate; the cryosphere; the ocean and air-sea interaction; and much more.

## Fisheries

***Pacific Coast Clam Fisheries*** by Timothy D. Schink, Katherine A. McGraw, and Kenneth K. Chew. 1983. Washington Sea Grant, University of Washington, Seattle, Wash. 72 pp. \$4.50.

Although only a small part of the total American clam industry, the

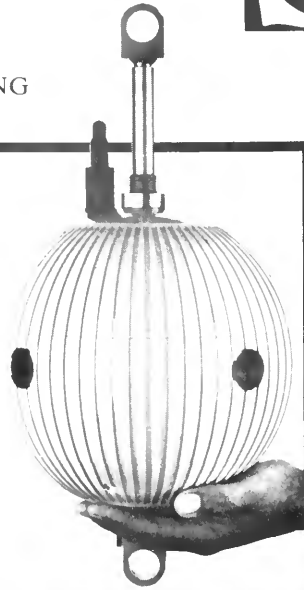


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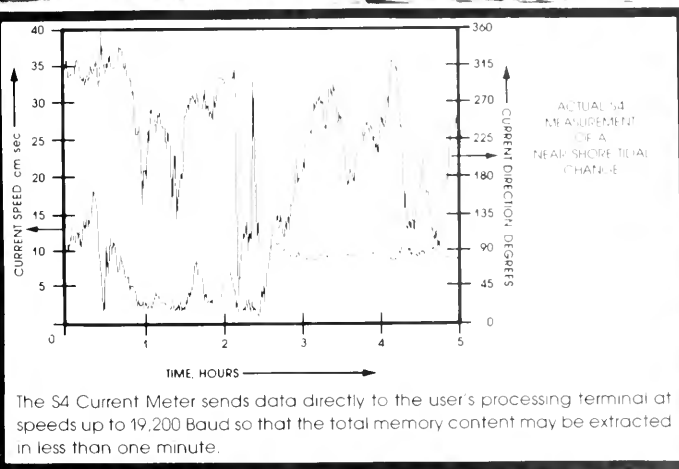
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Pacific coast clam fishery is nevertheless historically and economically important in some communities. This book reviews the Pacific coast clam fishery by state. Principal commercial species are listed, with history, current population trends, and anticipated future developments. There is an introductory chapter on species and harvesting methods.

## General Reading

**Origins of Sea Terms** by John G. Rogers. 1984. Mystic Seaport Museum, Mystic, Conn. 220 pp. + xv. \$15.00.

This book contains 1,249 entries, emphasizing the origins and earliest meanings of sea terms. The entries pertain to life on board ship, hulls and rigging, ship handling, sea and weather conditions, and naval and technical subjects. The book is prefaced with explanatory notes (about usage and abbreviations), charts of the language periods (in alphabetical order from Anglo-French, A.D. 1066 to 1200, to Viking, A.D. 700 to 1100) and a chart of the Nautical Alphabet (black-and-white drawings of flags next to the letters they represent). Three appendices list older spellings of currently used sea terms, a few

modern pleasure-sailors' corruptions of sea terms, and ropes.

**The Wilder Shore**, photographs by Morley Baer; text by David Rains Wallace. 1984. Sierra Club Books, San Francisco, Calif. 162 pp. + xiii. \$50.00.

Very large format, with photographs—both black-and-white and color—arranged no more than one to a page, this book is about the California landscape, as perceived by two artists. The book is structured like a journey beginning at the wild Pacific edge of the continent, passing through the

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# THE WILDER SHORE



Morley Baer David Rains Wallace

FOREWORD BY WALLACE STEGNER

coastal lands, mist forests, over the coastal ranges and into the great valleys, over the Sierra Nevada and to the desert edge of California's eastern border. It has been said of Californians that their landscape is a substitute for articulate religion; the photographs in this book convey the beauty and spirit that led to that statement. The text explores the influence of the landscape on writers who've lived and worked in California.

***Oceans from Space: Towards the Management of Our Coastal Zone*** by Frank E. Bunn, with U. Dom, D. Huntley, H. Mills, and H. Silverstein. 1983. The Institute for Research on Public Policy, Montreal, Quebec, and Brookfield Publishing Company, Brookfield, Vt. 82 pp. + xxvi. \$6.00.

Along with 119 other nations, Canada signed the United Nations Convention on the Law of the Sea on 10 December 1982 in Montego Bay, Jamaica. This confirmed the Canadian 12-nautical-mile territorial sea and established sovereignty over the 200-mile Exclusive Economic Zone adjoining Canada's coast, the longest coastline of any nation. This study argues that the only way Canada can develop control of its economic zone is through the use of remote sensing from space. The book explores advances in remote sensing with applications to Canadian needs; discusses Canadian resources in the 200-mile zone; and presents an argument in favor of updating data management for the Canadian EEZ.

***The Experience of Science: An Interdisciplinary Approach*** by Martin Goldstein and Inge Goldstein. 1984. Plenum Press, New York, N.Y. 400 pp. + xxiv. \$22.50.

Written for college students of sciences and non-sciences, this book is meant to teach the scientific approach: the inherent logic (or lack of it) in scientific discovery, how theories come about, how they are tested, and why they are believed or discarded. Using case histories, the authors examine the surprising and unpredictable way scientists really work, in an effort to portray science as an art, and remove the misapprehensions of non-scientists while broadening the horizons of students planning to concentrate in science. There are 18 chapters.

***Fundamentals of Naval Leadership by the Department of Leadership and Law, U.S. Naval Academy.*** 1984. Naval Institute Press, Annapolis, Md. 276 pp. + xviii. \$16.95.

A basic reader on leadership for midshipmen at the U.S. Naval Academy and other officer candidates or student officers, this book gives an outline of the Navy's

concept of leadership, covering human behavior, motivation and learning conflict and frustration, and many other topics important to officers and officer-candidates. The last chapter, "Case Studies in Leadership," presents 55 situations for readers to try to solve. For nonmilitary people interested in the training of the military mind, this book is quite interesting.

## Physical Sciences

***Applied Oceanography*** by Joseph M. Bishop. 1984. John Wiley & Sons, New York, N.Y. 252 pp. + xiv. \$32.95.

This is a reference work and introductory text, linking the scientific relationships of physical oceanography to their applications. There are two parts: "A Survey of Physical Oceanography," has five chapters outlining the basic concepts of physical oceanography; "Topics in Applied Oceanography" has nine chapters of application examples in marine pollution, marine resources, and marine transportation.

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Issues not listed here, including those published prior to Spring 1977, are out of print. They are available on microfilm through University Microfilm International; 300 North Zeeb Road; Ann Arbor, MI 48106.

- **Deep-Sea Hot Springs and Cold Seeps**, Vol. 27:3, Fall 1984—The biology, geology, and chemistry of hydrothermal vents and sulfide seeps. Other articles deal with the exploration of the vent sites and the funding of oceanographic research.

- **El Niño**, Vol. 27:2, Summer, 1984—A comprehensive exploration of the El Niño phenomenon, the oceanic temperature anomaly blamed for abnormal weather worldwide during 1982 and 1983. Articles cover the ocean/atmosphere connection, positive effects of El Niño, its effects on the Earth's rotation, and much more.

- **Industry and the Oceans**, Vol. 27:1, Spring, 1984—Positive uses of the oceans, including genetic engineering, and salmon ranching. Also, a new article on marine science in China, and a history of the Naples Zoological Station.

- **Oceanography in China**, Vol. 26:4, Winter 1983/84—Comprehensive overview of the history of marine studies in China, including present U.S.-China collaboration, tectonic evolution, aquaculture, pollution studies, seaweed-distribution analysis, the changing role of the Yangtze River, and the administrative structure of oceanographic programs.

- **Offshore Oil & Gas**, Vol. 26:3, Fall 1983—Historical accounts of exploration methods and techniques, highlighting the development of seismic theory, deep-sea capability, and estimation models. Also covers environmental concerns, domestic energy alternatives, and natural petroleum seeps.

- **General Issue**, Vol. 26:2, Summer 1983—Articles cover the effects of carbon dioxide buildup on the oceans, the use of mussels in pollution assessments, a study of warm-core rings, neurobiological research that relies on marine models, the marginal ice zone experiment, and career opportunities in oceanography. A number of "concerns" pieces on the U.S. Exclusive Economic Zone round out the issue.

- **Seabirds and Shorebirds**, Vol. 26:1, Spring 1983—Feeding methods, breeding habits, migration, and conservation.

- **Marine Policy for the 1980s and Beyond**, Vol. 25:4, Winter 1982/83—The problems of managing fisheries, the controversy over ocean dumping, the lack of coordination in U.S. Arctic research and development, military-sponsored oceanographic research, the Law of the Sea, and international cooperation in oceanographic research.

- **Deep Ocean Mining**, Vol. 25:3, Fall 1982—The science and politics of mining the deep ocean floor.

- **General Issue**, Vol. 25:2, Summer 1982—Contains articles on how Reagan Administration policies will affect coastal resource management, a promising new acoustic technique for measuring ocean processes, ocean hot springs research, planning aquaculture projects in the Third World, public response to a plan to bury high-level radioactive waste in the seabed, and a toxic marine organism that could prove useful in medical research.

- **General Issue**, Vol. 24:2, Summer 1981—The U.S. oceanographic experience in China, ventilation of aquatic plants, seabirds at sea, the origin of petroleum, the Panamanian sea-level canal, oil and gas exploration in the Gulf of Mexico, and the links between oceanography and prehistoric archaeology.

- **The Oceans As Waste Space**, Vol. 24:1, Spring 1981—A debate over the appropriateness of ocean disposal.

- **Senses of the Sea**, Vol. 23:3, Fall 1980—A look at the complex sensory systems of marine animals.

- **General Issue**, Vol. 23:2, Summer, 1980—Plankton distribution, El Niño and African fisheries, hot springs in the Pacific, Georges Bank, and more.

- **A Decade of Big Ocean Science**, Vol. 23:1, Spring 1980—As it has in other major branches of research, the team approach has become a powerful force in oceanography.

- **Ocean Energy**, Vol. 22:4, Winter 1979/80—How much new energy can the oceans supply?

- **Ocean/Continent Boundaries**, Vol. 22:3, Fall 1979—Continental margins are being studied for oil and gas prospects as well as for plate tectonics data.

- **General Issue**, Vol. 21:3, Summer 1978—The future of deep-ocean drilling, the scanning electron microscope in marine science, helium isotopes, seagrasses, paralytic shellfish poisoning, and the green sea turtle of the Cayman Islands.

- **The Deep Sea**, Vol. 21:1, Winter 1978—Over the last decade, scientists have become increasingly interested in the deep waters and sediments of the abyss.

- **General Issue**, Vol. 20:3, Summer 1977—The controversial 200-mile limit constitutes a mini-theme in this issue, including its effect on U.S. fisheries, management plans within regional councils, and the complex boundary disputes between the U.S. and Canada. Other articles deal with the electromagnetism sense of sharks, the effects of tritium on ocean dynamics, nitrogen fixation in salt marshes, and the discovery of animal colonies at hot springs on the ocean floor.

- **Sound in the Sea**, Vol. 20:2, Spring 1977—The use of acoustics in navigation and oceanography.



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