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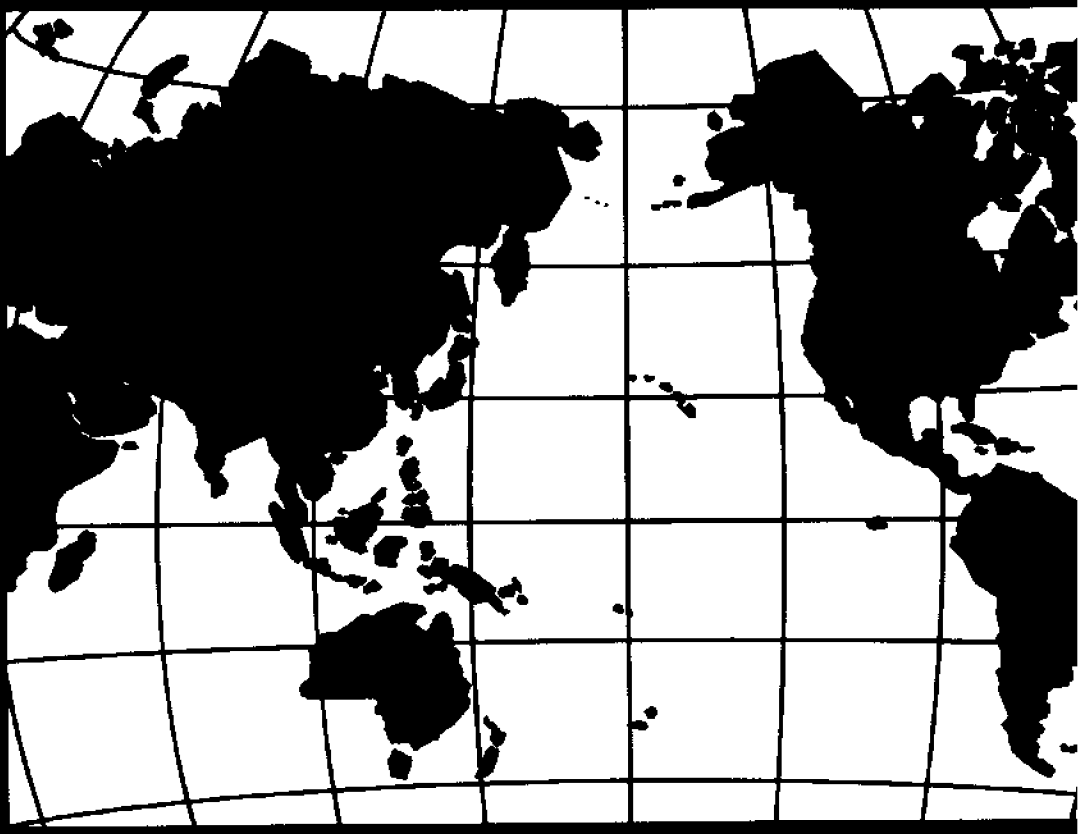

Passages to the Pacific Century

Edited by Courtland L. Smith

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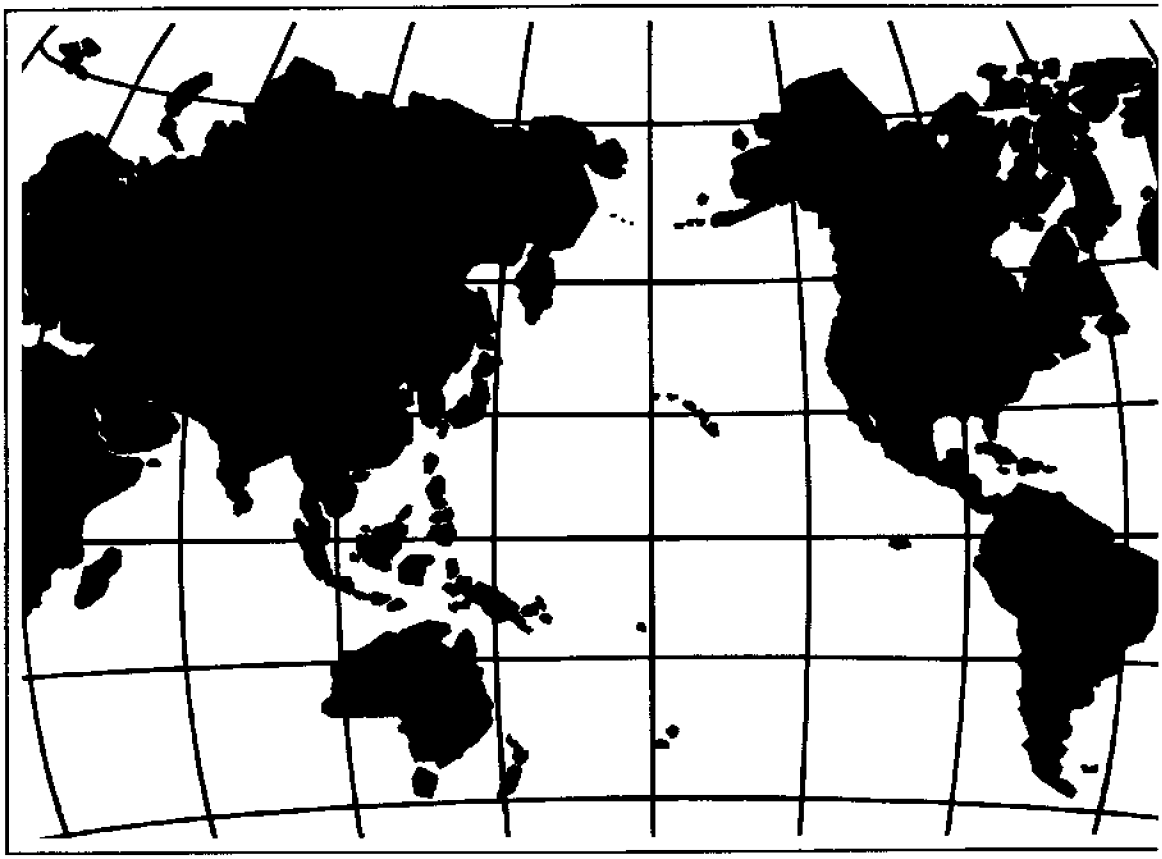

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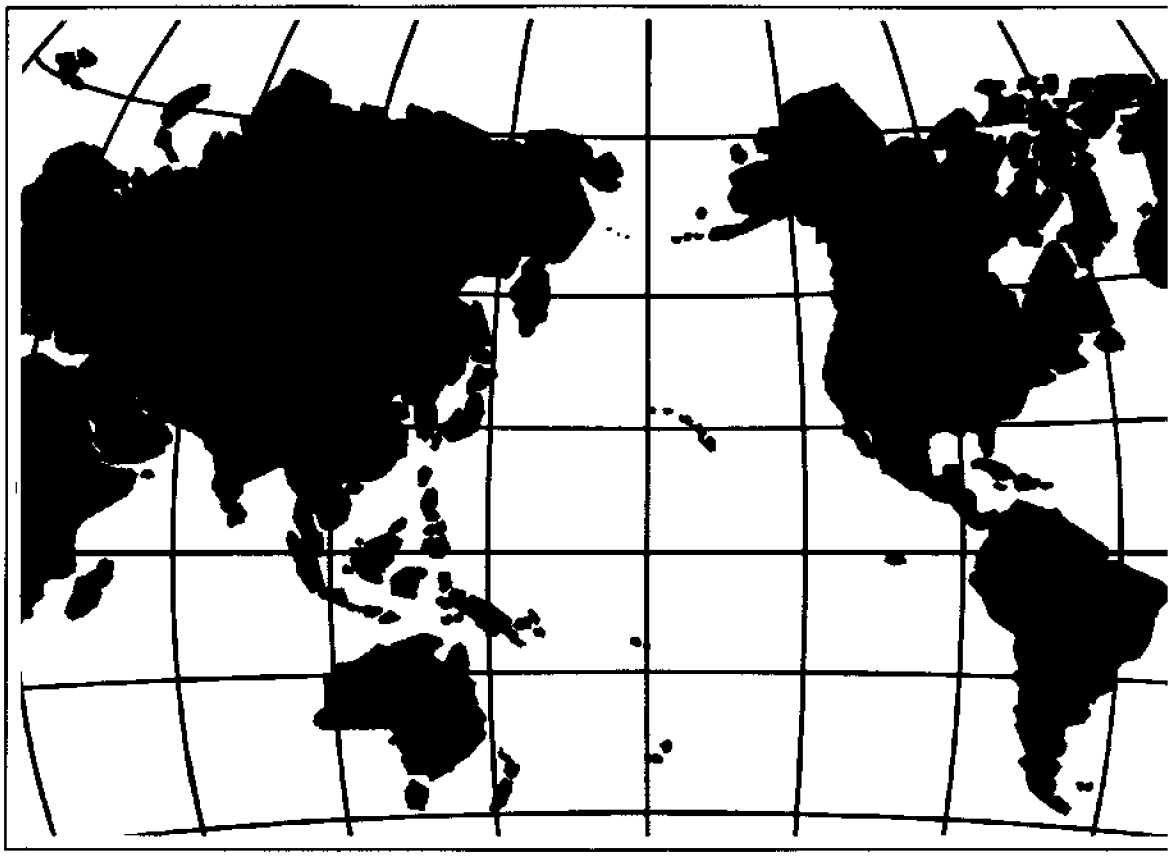


Passages to the Pacific Century

Edited by Courtland L. Smith

Oregon Sea Grant
ORESU-B-89-001

Contents

Acknowledgments

The dedication of many people to the Sea Grant concept gave rise to this volume. *Ocean Agenda 21: Passages to the Pacific Century* is one of the projects for the twenty-first anniversary celebration of Oregon Sea Grant. Most important to the publication of this volume was the technical editing by Sandy Ridlington. Bill McNeil, John Rohovec, and I enthusiastically challenged the authors to give their insights into the role of the oceans in the twenty-first century. We asked them to address emerging ocean issues and to consider how advances in technology, transportation, and trade will bridge the Pacific Ocean and make the West Coast of North America a partner with Asia. Sandy is the person who turned this enthusiasm into the following volume, one in which you find many stimulating insights.

It was William Q. Wick, program director, who initiated a celebration of two decades of research, advisory, and educational service. The anniversary was not an occasion for looking back, but a time to probe the future. Frederick J. Smith headed the committee coordinating the anniversary program events.

The first event, on May 25, 1988, at the LaSells Stewart Center, was an awards ceremony recognizing Oregon Sea Grant founders. The occasion was the premier showing of Jim and Elaine Larison's film, *The Living Ocean.* Written by Joe Cone, the film describes the state of knowledge about the world's ocean. The founders recognized at the ceremony were Bob Alexander, Jim Knudsen, Fred Burgess, Wayne Burt, Emery Castle, Chapin Clark, Joe Cox, L.B. Day, Herb Frolander, Joel Hedgpeth, James Jensen, Pete Klingeman, Bill McNeil, Bill Pearcy, Ivan Pratt, Betty Roberts, Tom Scott, Russ Sinnhuber, Charles Warren, Bill Wick, and Roy Young.

During the fall of 1988, Sea Grant sponsored a youth arts contest, organized by Vicki Osis and Kathleen Heide. Students were asked to identify which aspects of the ocean would be most important to them in the twenty-first century. Elementary school children expressed their concern for the oceans with haiku. Talented and gifted middle schoolers contributed essays, and high school students shared their visions in poster art.

Specifically, *Ocean Agenda 21* grew out of a conference, held February 20, 1989, to celebrate the twenty-first anniversary of Oregon Sea Grant. In this volume we look ahead. However, our objective is not to say we know the future but rather to stimulate discussion about what the future can be. The oceans play a dominant role in all of life. By looking ahead and planning, we can encourage the pursuit of visions for a better future for the oceans and all of humanity.

Courtland L. Smith

Introduction

Courtland L. Smith
Department of Anthropology, Oregon State University

The longitude of world trade and influence is shifting from the Atlantic to the Pacific. Atlases reflect the past maritime dominance of Europe by drawing the world with the Atlantic Ocean and Europe at the center. The Pacific Ocean, divided, appears on the right and left edges of the pages. Maps for the twenty-first century will reflect a world that unfolds differently. More and more the twenty-first century is being referred to as the Pacific Century (1).

The passing of time calls for assessing the past and projecting the future. Georgian, Jewish, Chinese, and Islamic calendars divide the year somewhat differently, but the passing of a year brings review of the old and raises expectations for the new. The end of significant time periods, like a decade and a century, command similar, only more comprehensive, reviews. As Western culture approaches the end of a millennia, tradition dictates looking ahead.

Fear characterized much of the public response to the end of the first millennia. At midnight December 31, 999, people gathered in the old basilica of St. Peter's fearing the end of the world. Many preached during the year 999 that the sun would set on the world. While we are not without issues for concern, our outlook for the twenty-first century is characterized by much more optimism and hope.

Now is a good time to look at the oceans and the role they can play in the twenty-first century. We've asked Pacific Coast business, government, and academic leaders to sketch their views on mineral resources, fisheries, marine products, coastal management, business and trade, and the management of ocean resources. This volume draws together 22 papers analyzing visions, trends, and approaches to ocean uses in the twenty-first century.

The authors met in Portland, Oregon, February 20, 1989 to share their visions for the future. Dr. Robert Abel, President of the New Jersey Marine Sciences Consortium and someone who has helped set the twentieth-century agenda for ocean scientists, guided us through a review of our future agendas.

Perspectives on the future take several courses. One is to create a vision of what would be desirable and work toward that goal. To some extent all of us have a vision. The people labeled visionaries are recognized, with the benefit of hindsight, as having said or done something that directed people's approach to the future. A second course is to review the trends that appear to chart the future. Trends do not point future directions consistently, but they suggest successful tacks to take. Much of the future is uncertain. Uncertainty requires adapting to changes by setting a new or altered route. While the future is about change, past experience provides much useful tradition.

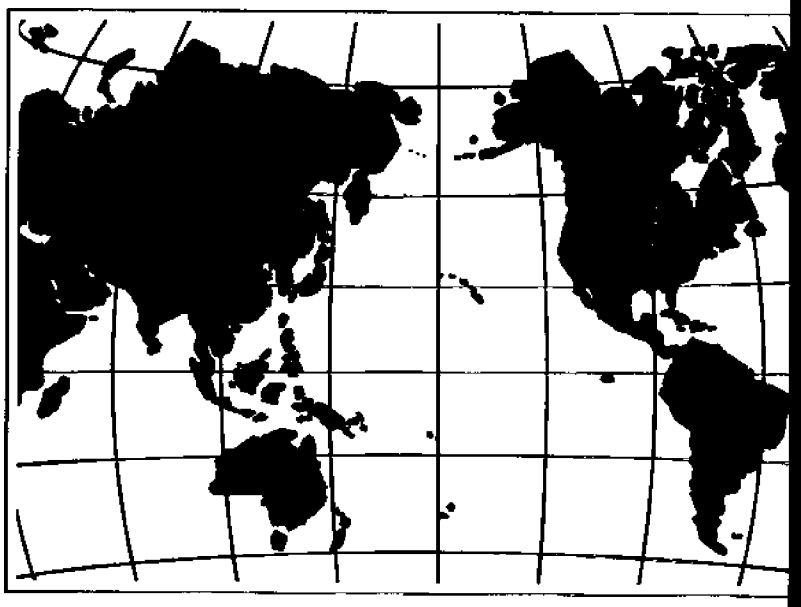
The oceans have been the testing ground for many visions. When conventional wisdom defined the earth as flat, some ventured to circumnavigate the globe. The ocean sailors, ships, and metaphors—*Magellan, Discovery, Challenger, Atlantis*—used in naming space shuttles further this tradition of exploration. Our knowledge of the ocean surface and depth has expanded greatly in the last half millennium. We know much more about the ocean's part in global processes. While we look to space, the oceans continue to hold most of our destiny.

These papers predict dynamic changes for the world's oceans and in our relation to them. In fact, the perception of oceans as barriers may be removed by new transport and communication technologies. The papers help us see the oceans in new ways. The authors point to new products and approaches to managing ocean affairs. They give us much to think about in terms of formulating policies, identifying opportunities, and setting new directions.

Reference

D.P. Gardner. 1987. The Pacific Century. Science 237:233. Former Senator Mike Mansfield, as ambassador to Japan, sought to focus U.S. business and cultural interests on the Pacific Rim.

Mineral Resources



Ocean Minerals: For Profit or Prophecy?

John V. Byrne
President, Oregon State University

> It is inevitable that the known commercial mineral resources on land will be expended and new deposits must be found to take their places. The day will certainly come when the mineral prospector will be forced to look to the sea for ore deposits. In all likelihood the sea will be exploited successfully long before that day arrives. Advancing technology is bringing us closer to the time when those with initiative and imagination will turn to the sea simply because it is easier to make a profit there than on land. That day may not be far away. In fact—it may be at hand (1).

That statement was written in 1964. It reflects the thinking, and the hype, of that decade, a decade during which there was a hard sell for ocean science. I know because I wrote it.

Now, 25 years later, the world does not seem so simple. We are near the beginning of the twenty-first century (America's third), a period which is already being called the Pacific Century, and during which complexity and change will be more prevalent than ever before.

As we look ahead to that century, it may be instructive (even fun) to look back to see where we have come from.

- One hundred years ago (thanks to Franklin, Darwin, Maury, Berryman, Thomson, Murray, Agassiz, and others), we had a rudimentary knowledge of the ocean, of wind patterns, surface currents, coral reefs, the general shape of the ocean basins, and the fact that manganese nodules occurred on the seafloor.
- Nansen had not yet jammed the *Fram* into arctic ice; the *Titanic* was not yet on the drawing board. We didn't know much about deep-sea trenches, midocean ridges, fracture zones, deep-sea circulation, El Niños, or the composition of seawater.

By the late 1960s, we thought we were pretty sophisticated in our knowledge of oceanography; in fact, the modern era of oceanography was still in its infancy (perhaps it still is).

- The Stratton Commission report, "Our Nation and the Sea," was yet to be published.
- The Deep Sea Drilling Project had not yet started.
- Plate tectonics was still hypothetical.
- Remote sensing of earth and ocean from space had not begun.
- The Third United Nations Conference on the Law of the Sea hadn't started.
- There was no fisheries management zone around the U.S., and the term "Exclusive Economic Zone" had not yet been thought of.
- We knew nothing about thermal vents or the biological communities associated with them; and no one even dreamed of the massive polymetallic sulfide deposits associated with the vents.

Change

Since the late 1960s, we have come a long way in our knowledge of the ocean—and of the earth. And that knowledge is increasing with incredible acceleration. But the increase in knowledge is no more rapid than the speed of economic, political, social, and environmental change throughout the world. To appreciate the rapidity of this change, we need look only at the United States' economic situation.

To quote from a paper I produced for the USDA in 1988 (2):

> In less than ten years we have seen our federal budget deficit swing to extremely negative multi-billion dollar figures. During this same period, the United States, the largest creditor nation of the world, turned into the greatest debtor nation of the world; and our positive trade balance shifted to a massive negative trade deficit. At the same time a number of nations changed from developing nations to "newly industrialized" countries, while many others went deeply into debt.
>
> An analysis by Kotkin and Kishimoto in their book *The Third Century* (1988) points to the rapid increase of Asia as the setting for the major economic nations of the world [3]. "In 1960, America's trade with Asia was less than half its trade with

Europe; within 20 years the total Asia-bound volume surpassed trade with all of Europe. By 1986, the trans-Pacific commerce of the United States reached $215 billion, exceeding by over 50 percent trade with Western Europe. And by 1995, according to the President's Commission on Industrial Competitiveness, the volume will be *twice* that with the Atlantic-facing world." Further, "today the Pacific-basin countries constitute the largest source of new legal immigrants, with Europeans accounting for barely one in ten newcomers." A new diversity of culture and values is developing within our borders.

The rise of Japan as an economic power has been especially rapid. "As late as 1960 the gross national product (GNP) of Japan was smaller than that of Great Britain, of France, or of West Germany. By 1986 the GNP of that small island-nation exceeded that of Britain *and* France combined by over 30 percent and is twice that of West Germany." They point out that Japan, which is "home to eight of the world's ten largest public companies, ranks first in industrial endeavors with steel production to consumer electronics to industrial robots." And, "by the late 1980's Japan had also emerged as the world's leading financial power." Japan is being hard-pressed by other Asian nations: Hong Kong, Taiwan, Singapore, South Korea—and China. Further, Kotkin and Kishimoto point out that "demographers estimate by 1990 Europe could account for less than ten percent of the world's consumption of goods and services, a figure that could drop to little more than six percent early in the next century." World-wide changes of production and consumption as well as financial resources have an impact on every producing area of the world. . . .

The world is changing socially. In a 1988 report, "New Challenges, New Opportunities: U.S. Cooperation for International Growth and Development in the 1990's," by Smuckler, Berg, and Gordon of the Center for Advanced Study of International Development at Michigan State University, world-wide social trends are addressed [4]. They point out world populations which already exceed 5 billion people are increasing. Life expectancy has increased dramatically with the taming of major diseases. Even in third-world countries where poverty continues to be a problem it is estimated that the world's population will grow by another billion people in the 1990s. Food production and *distribution* will continue to be major problems in addressing the dilemmas of a starving world. . . .

If the world is changing rapidly economically and socially, so is the earth's environment. It is undergoing swift changes as a result of human activity. In a recent report prepared by the American Meteorological Society and the University Corporation for Atmospheric Research entitled "The Changing Atmosphere—Challenges and Opportunities" (1988), it is pointed out that "there is wide-spread agreement among atmospheric scientists that over the next fifty years—easily within the lifetime of today's school children—we will witness an accelerating change in climate of a magnitude greater than ever experienced since the beginning of human civilization. State of the science climate models suggest that an average global warming of at least three degrees fahrenheit and possibly ten degrees fahrenheit is likely over the next 50 years. Although three degrees fahrenheit may seem small, it is larger than any sustained global warming experienced in the past 100,000 years. Furthermore, regional changes are likely to be much greater, perhaps several times as large" [5]. These changes are driven by a long-lived greenhouse effect resulting from increased amounts of carbon-dioxide, methane, and other gases in our atmosphere.

The point of all of this is that the changes of the past two decades are unprecedented, and all indications are that they will continue and will most likely accelerate. Those nations that will succeed—even survive—during the coming century will cope with change and find ways to capitalize on it. They will pay active attention to the changes, and that attention will require resources.

Ocean Minerals

What about ocean minerals in such a changing world? Will they yield a profit to someone? Or will they serve only as the basis for prophecy?

The minerals I am referring to are the sand, gravel, shell, coral, and heavy mineral placers

under the shallow waters of the continental shelf and the deep-water phosphorites, iron-manganese nodules, cobalt-rich crusts, metallic-rich muds, and polymetallic sulfides. These have all been reviewed in numerous publications; see, for example, *Marine Minerals, Exploring Our New Ocean Frontier,* published by the U.S. Congress Office of Technology Assessment (OTA) (6). Likewise, the technologies for exploration, extraction, and processing of such minerals have also been reviewed. (The reader is referred to the OTA report as a starting place.)

Importance of Ocean Minerals

Ocean minerals are important. History records the actual production of minerals from the continental shelf. Gold, silver, tin from placers, shell, sand, gravel, and diamonds have all made a profit for some adventurous entrepreneur.

The very potential for profit from ocean minerals has yielded less direct but no less important gains for our society. As long as we think ocean minerals can yield a profit in the future, they will be important.

During the 1960s the perceived promise of wealth from manganese nodules and other ocean minerals was used to help sell the importance of ocean science and ocean engineering. The perceived potential of resources of the seas helped to stimulate an increase in federal budgets for ocean science and technology. The knowledge gained from those federally supported programs has been useful in many ways, not the least of which is our awareness and understanding of global systems. That knowledge has served as a basis for other discoveries.

The discovery of thermal vents and polymetallic sulfides in the late 1970s and early 1980s had a profound impact on our knowledge and on the thinking regarding the genesis of ore minerals. It has been reported that the discoveries of polymetallic sulfides led to a re-evaluation of existing deposits on land and even to new ore discoveries.

The role of ocean minerals in ocean policy has been profound. Deep-sea manganese nodules were important as one of the perceived major ocean resources which should be part of "the common heritage of mankind," a concept which helped stimulate the Third United Nations Conference on the Law of the Sea. Moreover, the perceived importance of deep-sea minerals led to intense debate regarding the stewardship of such deposits. This debate prolonged the conference and intensified relationships between and among nations. However, the perceived importance of such minerals to U.S. mining interests also contributed to the decision by President Reagan to withdraw from the law of the sea conference in 1982.

The potential importance of hard minerals, oil, and gas led in 1983 to the proclamation by President Reagan claiming for the United States a 200-mile Exclusive Economic Zone. This jurisdictional claim has led to renewed surveying and scientific inquiry with federal support in the coastal ocean surrounding the United States.

If we believe that ocean minerals are a potential source of wealth, those minerals will continue to be important and will have an effect on the formulation of governmental ocean and resource policy.

Technology and the Decline of Ocean Mineral Importance

Metallic ocean minerals have potential value as a source of strategic materials. As long as the sources of strategic metals, such as cobalt, nickel, chromium, and manganese, lie outside the United States, ocean minerals that include such metals will continue to be important. However, the metals market generally is in decline. According to Cruickshank, this decline is due to a global economic recession and to a change in the pattern of metals use (7). Advances in materials research have led to substitutes for traditional and less traditional metals. During recent years, fiber optics (glass) has replaced metal wires, chrome-manganese steel has been used to replace nickel-stainless steel, and cobalt used in loudspeaker magnets has been replaced by ceramic magnets. Polymers and high-temperature-resistant ceramics are gaining wider use. The need for materials of greater hardness and resistance to higher temperatures has been satisfied by the use of new polymers, combinations of aluminum oxide and titanium carbide; silicon nitride resists higher temperatures. Composite materials are stronger and lighter than their metallic counterparts, and intermetallic compounds are used to produce materials for high temperature and structural use. With the ongoing development of such new materials, restructuring of the metals industry will continue to occur, and relatively high-cost metallic ocean deposits will become less important. The future for ocean mining will be affected by such external changes as will all industries. Time may be working against the ocean mining industry.

On the other hand, the rapid advance of technology both within and outside the industry may result in technological capabilities enabling extraction of deep-sea minerals. The development of the light, strong materials mentioned earlier may be used to advantage in the extraction and processing of minerals at sea. Fiber optics, digital computers, computer television, and other rapidly developing, sophisticated devices may in fact move ocean mining technology forward rapidly enough to compensate for the other changes. We will soon see the paradox of on the one hand, developing materials technologies that enable the exploitation of metalliferous deposits and, on the other, a diminishing need for the metals that might be recovered.

Human Resources

The global economic, political, and social changes mentioned earlier have resulted in new ways of doing business. At every level of government and society, innovative institutional arrangements are being tried. As companies, universities, and even nations perceive different needs for themselves and as they recognize their inability to marshal the resources necessary to satisfy those needs, they are turning to cooperative arrangements. This trend is not new, but it is increasing. Multinational companies, consortia of institutions, and even confederations of companies are formed to cope with problems, to integrate resources, and to cooperate in order to create and achieve opportunities. Groupings of nations with common goals are common in international fora. Consortia of companies and nations for economic protection were formed during law of the sea deliberations and, subsequently, in an effort to lay claim to large reaches of the seafloor, for mineral exploration. The final consolidation of the nations of Europe into a unified European Economic Community in 1992 is perhaps the ultimate example of subjugating independence to achieve the objectives of self interest through a different mechanism—cooperation. The ocean mining community is not exempt from this approach, and in fact may be one of its early practitioners in the private sector.

Recognition of the need for better cooperation between government, academe, and the private sector already manifests itself in new institutional arrangements and in proposals for new structures. The regulatory functions of government combined with the research and human development of academe and the development and operational capabilities of business can be an incredibly powerful combination of human resources working for the best interests of each, the improvement of all, and the benefit of the United States. The combined efforts of state, federal, and university researchers are not new to science. Studies of the ocean by such groups during the International Decade of Exploration in the 1970s have been outstandingly successful. The scientific common denominator can be powerful enough to overcome institutional impediments if the scientific goals are important to all involved. Similar relationships involving the private sector could be equally beneficial.

Such an "ocean enterprise concept" has been recently put forward by Ross, McLain, and Dailey (8). They suggest a cooperative effort to overcome the limiting factors in ocean resource development: leadership, infrastructure, and venture capital. Their proposal includes a federal in-house incubator, an ocean-going "Fannie Mae," and a quasigovernmental, nonprofit corporation. No doubt their ideas will require modification, but they are a step toward innovation and a new approach to institution building. More of this type of thinking will be required.

Summary

The challenges facing the world today may be greater than ever before. Changes in international economic and political balances occur rapidly; social needs are extreme; and we realize that no nation can be independent of others. We are aware that we live in a global community and that whatever happens to one member of the community will have an impact on the others. We see the deterioration of our natural global environment or at least rapid change in it. Human activities are changing our climate and polluting our earth systems. But our awareness of these conditions is greater than ever before, our knowledge base more profound, and the capability to address these challenges stronger than ever. We can meet these challenges if we have the individual, corporate, and national will to do so.

It is in this setting that the ocean mining industry must look ahead to the twenty-first century. While the deck may seem stacked against the industry for the near term, it is wise to look to the future. The potential for ocean minerals still exists; the competitiveness of other industrialized nations in this area is not dormant. (Cruickshank [7] reports that the

Japanese Mining Council has approved a plan to develop the technologies needed to move ahead with deep-seabed mining.) In order to increase our competitiveness in this area, a partnership of all who can contribute is essential; federal and state government, academe, and business must work together.

Recommendations

To improve the U.S. position in the world economy, the Council on Competitiveness (9) has recommended to this Administration specific steps to be taken to improve fiscal policy, science and technology, international economics and trade, and human resources. Recommendations directly appropriate to the mining of ocean minerals are those involving science and technology.

- "Increase funding for government programs that have high leverage in contributing to private sector efforts to commercialize technology.
- Create a legal and regulatory environment more conducive to the commercial application of technology.
- Increase government investment in the education, facilities, and equipment that constitute the nation's technology infrastructure.
- Widen the focus of national research and development efforts to encourage cooperative R&D, the rapid transfer of new technology to the marketplace, and a strong industrial base.
- Make R&D tax provisions consistent over the long term including making the R&D tax credit permanent."

Perhaps more pertinent to those of us in academia are recommendations we can make to universities—recommendations for improvement we can make to ourselves.

1. Review and revise research and technology transfer programs so that they are a real incentive to faculty to work with and for the private sector.
2. Enhance the faculty's awareness of the private sector and their sense of its importance; develop mechanisms for better interaction between faculty and the private sector.
3. Introduce opportunities for faculty and students to use the most up-to-date technologies (on or off campus); increase their awareness of rapid change.
4. Emphasize the internationalization of the university; increase the diversity of the student body by attracting more foreign students; require courses in foreign language and cultures.
5. Review and revise curricula constantly in view of the above needs.
6. Be active in entering into cooperative ventures that leverage human resources in education and research.
7. Recognize and emphasize change in every sector of human endeavor.

Conclusion

In a world of uncertainty and rapid change, there is no substitute—absolutely none—for knowledge. Insist there be lots of it and that it be the highest quality possible. As you enter the new century, do it at full speed. Good luck in the twenty-first century! The Pacific Century!

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Our Oceans: A Storehouse of Minerals

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Introduction

The oceans cover 71 percent of the earth's surface. Beneath them exists a great storehouse of valuable minerals that will someday be mined. Some of these riches are within reach today; the technology to recover others exists only in science fiction. Yet much of today's science fiction is tomorrow's reality.

Few of our oceans' minerals have been mined; its resources, both discovered and still unknown, await our attention. As existing land deposits become less accessible and underwater exploration and mining technology develops and matures, ocean mining will become economically competitive and doors will open to the great storehouse of mineral wealth that is in our oceans.

The formation of ocean mineral deposits is controlled by physical processes that, in part, depend on the structure and general geology of the ocean floor. Mineralized rocks occur in the submarine continental shelf adjacent to their counterparts on dry land. The shelf is covered by continental sediments of clay, silt, and sand up to thousands of feet thick. Here, currents and waves concentrate heavy and weather-resistant minerals, precious metals, and gemstones. Away from land, the shallow continental slope drops to the deep abyssal plain. Here accumulate siliceous and calcareous oozes of plant and animal remains, as well as nodules of manganese and iron oxide (1). Seamounts rising from the deep ocean floors are coated with crusts similar in composition to the nodules. The deepest oceans are underlain by basaltic rock, produced at midocean ridges by vulcanism; black smoker sulfide deposits are found here. In addition to the seafloor mineral deposits, seawater itself is a reservoir of salts, metals, and fresh water.

What abundant mineral resources the ocean offers!

Ores Beneath the Ocean Floor

Relatively shallow continental shelves are choice areas in which to explore for underground deposits. Continental deposits of coal, iron ores, and cassiterite (tin ore) that occur on shore are known to continue out onto the shelf. Sulfur has been mined from beneath the shelves where it caps salt domes that contain oil and gas (2). Other recognized continental-shelf mineral deposits that may someday be used include barite (a source of barium) and evaporites such as gypsum and rock salt (1).

Nearshore Placers and Aggregate Deposits

Beach and nearshore placer deposits contain sand-sized particles of precious metals such as gold and platinum; gems such as diamonds, rubies, and sapphires; ore minerals that contain titanium, chromium, tin, and many other needed metals; and common sand and gravel. Although most of these materials are now being recovered from geologically modern beaches, many deposits are also concentrated in sands of ancient submerged beaches and buried river channels. Worldwide changes of weather and accompanying glaciation cycles caused sea levels to lower and rise over the eons, so that such deposits now lie offshore.

Among offshore commodities being mined today, deposits of sand and gravel rate second only to oil and gas in value and volume. These deposits consist of resistant mineral grains that are concentrated by the action of waves and tides. They originate from continental sources and from carbonate shells, which come from sea animals that extract calcium carbonate ($CaCO_3$) from the seawater. These resources are plentiful and are renewable as long as processes of weathering and erosion operate and as long as sea critters build $CaCO_3$ shells.

In the next few decades the mining of deeper deposits, which have fewer negative implications for coastal environment and recreation, will replace the mining of shallower deposits.

Polymetallic Nodules and Crusts

Potato-shaped marine manganese nodules may cover as much as 15 percent of the ocean floor. Ranging from 2 centimeters up to softball size or larger, they essentially form a thin, discontinuous layer of ore on ocean floors throughout the world (3). The highest grades of

these ores are 4,000 to 6,000 meters below sea level. In contrast to the depths at which nodules are found, rich manganese crusts several centimeters thick form a veneer on seamounts approximately 1,500 meters below sea level (4). Both nodules and crusts form by precipitation of manganese and iron oxides from seawater by either organic or inorganic processes (2). The adsorption of nickel, copper, cobalt, and other metals onto the spongelike surfaces of manganese nodules and crusts accounts for the enrichment of these metals to possible ore values. Manganese nodules or crusts will someday become important sources of manganese, nickel, copper, and cobalt, and potentially of molybdenum, vanadium, and zinc (1). Nodules have even been investigated for direct use in exhaust-gas scrubbers because of their ability to adsorb large quantities of acid-rain-forming sulfur dioxide (SO_2) (5).

For now, the disadvantages of nodule and crust mining seem to far outweigh the advantages. A potential mining site would require nodule density not less than 10 kilograms per square meter on an ocean floor that is free of major obstacles, and access to 50,000 square kilometers of ocean floor to permit at least 20 years of mining (4). The number of sites having these characteristics remains to be determined.

Land-based supplies of the metals contained in nodules and crusts are currently available, and there is little economic motivation to develop ocean resources. However, the advantages of ocean mining will eventually cause them to be used. What is more, ocean manganese oxide deposits are renewed, sometimes more rapidly than the metals in them are consumed on land (5). Such ocean deposits could become our first renewable metal resources.

Oozes and Muds

In addition to manganese nodules, other deep-ocean mineral deposits that may be mined in the next 50 years are phosphorite, glauconite (used as a soil conditioner and water softener), aluminum-rich red clays (used in fire brick), and metalliferous, siliceous, and calcareous oozes (6). Oozes originate as plankton, tiny organisms that accumulate stores of phosphorus, calcium carbonate, silica, and even heavy metals such as uranium, vanadium, molybdenum, and nickel during their life cycles. When the organisms die, these minerals are released into the sediments of the shelf or deep-ocean floor, sometimes forming concentrated oozes of high purity. Uranium-rich oozes are currently being mined at the bottom of the Black Sea.

Black Smoker Deposits

News of the potential mineral wealth and biological wonders of smoker deposits, the most recent undersea mineral discovery, fills scientific journals. In the deep ocean, polymetallic sulfides are deposited at vents in the ocean floor where seafloor hot springs mix with cold, ocean-bottom water. Here, minerals of iron, copper, zinc, cobalt, lead, silver, cadmium, vanadium, barium, molybdenum, manganese, and gold form crusts and chimneylike spires of base-metal sulfides heaped on the ocean floor.

Black smoker deposits form intermittently along the 75,000-kilometer midocean ridge where the great oceanic plates are being forced apart by the formation of new igneous rock. Searches for communities of unique organisms, which are dependent on the heat and hydrogen sulfide in emerging hot (hydrothermal) solutions near the ridge, have located smoker discharge centers and the resulting mineral deposits (7). Variations in water chemistry and seafloor sediments are used in exploration for these deposits. The era of systematic exploration for hydrothermal mineral deposits at seafloor spreading centers has only begun.

The high ore grades of the smoker deposits, their moderate depths of occurrence (about half as deep as manganese nodules), and the geologically rapid rates of their formation (less than 100 hundred years compared with millions of years for manganese nodules) indicate that they may provide a source for base metals late in the next century (8). Our understanding of such unique seafloor geologic processes as the venting of sulfides will lead to discoveries of rich land deposits at "ancient" seafloor sites. These sites were transported to their present locations by the same continent-building processes that pushed up the great sheets of sea-formed limestone and sandstone that are the Rocky Mountains.

Metalliferous Brines

Metal-rich brines are genetically similar to ocean-ridge smoker deposits. Red Sea brines containing manganese, copper, zinc, lead, iron, cobalt, silver, and gold may be mined early in the next century as they are relatively shallow, unusually warm, easily accessible, well described, and close to European markets. Basins such as the Gulf of California, which are shaped by the same geologic processes that formed the Red Sea, may now be accumulating future stores of metals.

Seawater as an Ore

Water is itself an economic mineral. We are depleting our fossil reservoirs of fresh water (water which has accumulated underground over thousands of years), and we will become increasingly dependent on the ocean for our drinking water. Fresh water is already distilled from seawater on the coasts of desert lands, but the process is extremely energy dependent.

The oceans are a vast liquid mine, sometimes called a "chemical soup," of astronomical size. About 60 billion tons of gold, manganese, copper, uranium, silver, and boron are dissolved in ocean water (6). Every naturally occurring element is probably a constituent of seawater (9). These elements are leached from rock fragments that are eroded from the continents and washed to the sea. In addition, tremendous volumes of metallic solutions flow from hydrothermal vents across the seafloor.

Table salt, magnesium salts, and bromine are commercially recovered from seawater. In the future, extraction of potassium, iodine, gypsum, sulfur, sodium, fluorine, chlorine, and ammonia from the ocean may be practical. Extraction of precious metals from seawater, a longtime dream of many alchemists and metallurgists, could become a reality. The Nobel prize-winning German chemist, Dr. Fritz Haber, spent years trying to extract gold from seawater. What Dr. Haber and other scientists have found is that, based on present technology, the tremendous amount of energy required for extraction is far higher in price than the value of the most precious of metals (2).

The waters of the oceans hold tremendous mechanical, thermal, and nuclear energy. If nuclear energy is to be produced by thermonuclear fusion, thereby avoiding the radioactive waste associated with nuclear fission, then lithium or deuterium will be needed. Uranium, thorium, lithium, and deuterium (heavy hydrogen) are present in sufficient quantities in the seawater to sustain society's present rate of energy use for the remainder of the life of the solar system (2).

Mining and Exploration

For the most part, existing ocean mines are shafts sunk from shore that extend beneath the shelf, and artificial islands, which are used as bases for mining operations. We see evidence of futuristic ocean mining technology at work today in the petroleum industry. In 138 meters of storm-swept North Sea stands an 83-story concrete and steel oil-drilling rig (2). This skyscraper is a self-contained industrial park. Eventually, we will mine more efficiently with equipment that will work at the ocean bottom rather than from the unstable sea surface.

Nature has provided the energy to grind and sort mineral particles by density, generating valuable concentrations of minerals. Floating suction, airlift, and bucket-dredging systems, already being used for retrieving nearshore deposits, will be adapted for use in deep-ocean deposits. New technologies for placer mining include a three-legged "walking" dredge that works at the seafloor, hovercraft dredges, nuclear-powered dredges, and bottom-crawling robots that suck up sand with their tentacles (2).

Mining manganese nodules has been compared to the harvesting of a potato field by a Martian spacecraft flying 5,000 meters above its target at night in the fog. However, available systems have been adapted to the task. Two methods for mining nodules are ready for prototype testing, and several others are in planning stages or on the drawing boards (5, 8). Similar techniques, at shallower depths, will be used for mining phosphorites.

Although technology to fabricate the required components is available, integrated equipment to mine polymetallic sulfide deposits does not yet exist. The discovery of these deposits is too recent and the economics unfavorable.

Deep-sea research has developed systems using electrical, hydraulic, mechanical, television, and sonar components that are efficient at 5,000 meters and adaptable to mining (8, 10). Future exploration with manned and unmanned submersibles will use the latest technological advances in underwater camera systems, fiber optical systems, laser scanning, and side-looking sonar. Exotic geochemical techniques and geophysical methods such as satellite remote sensing, reflection and refraction seismology, and magnetic and gravity surveys will also be employed, along with computer-aided digitizing and imaging of data. Early in the first half of the twenty-first century, towed spectrometers will "read" the chemistry of ocean floor minerals.

Through bioindustrial processes, we can use animals and plants to either mine valuable commodities or remove toxic pollutants from the ocean waters. Sea worms can concentrate vanadium in their bodies, lobsters extract copper, and fish accumulate lead in their bones. Iodine is concentrated by seaweed by a factor of

a hundred thousand. In Tokyo Bay, the concentration of pollutant mercury by fish led to the lethal Minamata disease (2).

Genetic engineering may increase the capacity for organic extraction of economic minerals or hazardous contaminants. Uranium has been experimentally extracted by algae with side products of methane and fertilizer; gold and copper extraction from ores are being enhanced by bacteria (2). Recent discoveries of unique organisms living at smoker vents on the seafloor may help us to process our metallurgical wastes, for these extraordinary creatures are able to process pollutants, toxic to humans, for their own benefit. When we understand the mechanisms of such selective absorption, we may be able to replicate and apply them (9).

Challenges for the Future

Future exploitation of marine mineral deposits will depend on appraisal of the resource. The origin, mode of occurrence, distribution, grade, and minability of the ocean resources must be known in order to address environmental, economic, social, and political concerns.

Environmental problems must be solved before any marine mining operation can begin. Changes in the particle content of the water, in the chemistry of the water and sediments, and in the contour of the seafloor and shoreline will affect many features of the marine environment (2, 9). Research on ocean floor life must keep pace with developing mining technology. The destruction of ecologic niches is to be avoided, and it is not known how successful biological renewal of mined out areas will be. Many other problems are inherent to the mining field in general, yet all of these are tangible problems with foreseeable solutions.

Economic conditions are not predictable. Currently, there is little economic pressure to encourage the development of many of the world's ocean resources. Aggregates and offshore placer minerals are currently being produced, and deeper shelf deposits of phosphorite and glauconite are close to being economically viable, due to their proximity to areas in need of fertilizer. A significant change in the supply and demand of metals is needed before mining of the deep-ocean deposits of manganese nodules, crusts, and smoker sulfides is practical. They are a store for the future.

Each American industry started in the last century has taken an average of 30 years to develop. From the Wright brothers' first flight in 1903, the first reliable transport aircraft was developed in the 1930s, and the industry reached maturity 30 years after that with the development of the jet aircraft (8). We are just now at the Kitty Hawk of mining our oceans, a storehouse of minerals. Today's technology gives us a peek at ocean mining 30 years from now, but to perceive tomorrow's jet age in ocean mining we must look to science fiction stories. We have seen that such visions eventually become reality.

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Marine Placer Deposits on the Continental Shelf off the Pacific Northwest: Fact or Fiction?

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Introduction

The exclusive economic zone (EEZ) established a zone 200 nautical miles wide around the coastlines of the United States with the objective of defining and developing the mineral resources of the EEZ. Much of the research within the EEZ is directed at the so-called "hard mineral" deposits of the continental shelf (table 1) because several United States industries have become increasingly dependent on South Africa and Australia for supplies of certain critical metals (table 2).

Certain strategically located minerals, such as chromium and zirconium, are necessary in the manufacture of chemically resistant alloys. Another mineral, titanium, is used in high strength-to-weight alloys and nontoxic pigments (1). However, because the reserves of titanium- and zirconium-bearing minerals have decreased significantly in the United States and Australian coastal regions (2), South Africa has become the primary source of them as well as of chromium and ferrochrome for the U.S.A. In view of these circumstances, future exploration of the U.S. continental shelf, which is a potential source of these metals, is critical to our domestic supply of economic and strategic metals.

Gold was discovered and mined in the river and modern beach sands of southwest Oregon and northern California during the great gold rush days of the 1850s (figure 1; see 3 for review). Studies of the Oregon coastal region identify several areas where strategic and economic placer deposits of heavy minerals (chromium-bearing chromite, titanium-bearing ilmenite, and zirconium-bearing zircon) and metals (gold and platinum group) occur in substantial quantities in present beaches and in coastal terraces which are of ancient beach and dune origin (table 1; 4, 5, 6, 7, 8, 9, 10). The coastal terraces have been uplifted above present sea level by tectonic forces beneath the continental margin. The terrace deposits of southwest Oregon were explored during World War II for their chromium-bearing chromite and titanium-bearing ilmenite minerals, which were in short supply. These so-called black sands were mined in 1943 to produce a chromite concentrate which was stockpiled for potential use during the war (5). The Seven Devils Mine on the southern Oregon coast (figure 2) contains an estimated 480,000 tons of chromic oxide (8), which is equivalent to more than a one-year supply of chromium for the United States at the present rate of consumption.

Ten modern placer accumulations ranging from 0.1 to 5 million metric tons of placer sand have been identified on Pacific Northwest beaches (7). The formation of mineral deposits is an active process on the Pacific Northwest beaches. Dark-colored heavy minerals (black sands) are separated from the even more abundant white-colored light minerals by currents and wave action and concentrated into 1- to 8-meter thick placer deposits.

Heavy mineral placer deposits are also believed to occur on the adjacent continental shelf and they should contain the same minerals and metals that are found on beaches today (11, 12, 13). The shelf extends seaward from the shoreline to a water depth of about 180 to 200 meters. On several occasions during the glacial ages, sea level was about 125 meters lower than at present. Coastal streams flowed across the now submerged shelf carrying minerals and metals. Beaches formed each time sea level stabilized, providing a high energy environment to concentrate the heavy minerals into placer deposits. The valuable minerals and metals of the southern Oregon shelf originally eroded from ore bodies located in the Klamath Mountains of southwestern Oregon and northern California were carried to the ocean by coastal streams during the past several hundred thousand years.

Several fundamental questions need to be answered.

(1) Are there economically and strategically important mineral and metal deposits on the continental shelf of the Pacific Northwest? If so, what is their distribution?

(2) What research activities are needed to document the occurrence of subsurface placer deposits on the shelf and to encourage their industrial exploration?

(3) What effects would the exploration and mining of these placer deposits have on the living resources of the shelf?

(4) Who has the responsibility for managing the allocation and extraction of these mineral resources?

The Nature and Geographic Distribution Of Potential Mineral Resources

Several well-defined heavy mineral concentrations (specific gravity greater than 2.96) occur in the unconsolidated surface sediments on the continental shelf off the Pacific Northwest (figure 3). Significant concentrations of heavy minerals (5 to 42 percent) are present in these surface sediments in limited areas of the inner shelf off northern California. Much larger patterns of heavy mineral concentrations (10 to 56 percent) were discovered in the surface sediments off southern Oregon (12). They are frequently aligned parallel to the present shoreline, indicating possible ancient beaches which are now submerged and buried. They cover between 10 and 200 square kilometers of the shelf off Oregon and exceed the largest surface area of any placer deposit yet observed in the modern beaches or in the ancient coastal terraces in the area (7, 8, 12). Farther to the north, mineral accumulations of heavy minerals are centered around the mouth of the Columbia River and along the inner shelf off central Washington.

An analysis of the heavy minerals in the opaque mineral fraction (specific gravity greater than 4.3) of the sands shows the geographic distribution and relative abundances of titanium and chromium in coastal rivers and beaches and on the continental shelf (figure 4). Titanium-bearing ilmenite is the major metal deposit north of 43° N latitude off northern Oregon and southernmost Washington, while chromium-bearing chromite generally dominates over ilmenite south of 43° N latitude off southern Oregon and northernmost California. Titanium and chromium concentrations on the shelf follow a similar regional pattern. Titanium drops dramatically from greater than 20 percent south of the Columbia River to less than 10 percent near the mouth of the river. The Columbia River has diluted the marine placers of southwest Washington with magnetite, which is the least important placer mineral. Significant amounts of chromium and titanium overlap between 42.7° N and 43.2° N latitude in southern Oregon. In addition, the mineral garnet, which is used for abrasive materials, and zirconium-bearing zircon are present in these coastal and shelf deposits.

Trace concentrations of gold locally occur in the sandy surface deposits of the inner continental shelf off southern Oregon and northern California (14). Gold particles in economic concentrations are also present in both modern beach and terrace placers in the adjacent coastal regions, which suggests that significant gold is also present in the subsurface deposits of the shelf. Recent work by the U.S. Bureau of Mines in the coastal terraces identified the presence of the platinum group of metals in the terraces and river deposits of southwestern Oregon; they may be present on the shelf in conjunction with the gold.

Magnetometer surveys of a well-defined modern beach placer from central Oregon (Otter Rock beach) and of coastal terrace placers from southern Oregon (Seven Devils and Eagle Mines) show that the magnetic minerals in the placers produce magnetic anomalies that help outline the width and length of these mineral deposits (7, 15). The beach placer extends about 1,000 meters alongshore and 100 meters across-shore and ranges from greater than 1.5 meters to less than 0.1 meter in thickness. This elongate and lens-shaped placer contains about 80×10^3 cubic meters of sediment with more than 50 percent heavy minerals. In the mines the black sand placers occur beneath a sediment overburden ranging from a few meters to about 20 meters as identified in drill holes along the survey traverses. Recent studies of the magnetic susceptibility of placer sands along the coast show that all of these placers have sufficient magnetic material (magnetite) to generate detectable magnetic anomalies.

A reconnaissance magnetometer survey made on the continental shelf with a ship off the Rogue, Sixes, and Coquille rivers over surface concentrations of heavy minerals suggested the existence of possible placer accumulations (figure 5). Magnetic anomalies are associated with the heavy mineral concentrations in the surface sediments indicating probable submerged ancient beach placers elongated parallel to the shoreline. The largest observed magnetic anomalies are off the mouth of the Rogue River while less prominent anomalies have been observed off the Sixes River and in the Cape Blanco area. Modeling of the magnetic anomalies suggests that the magnetic bodies are produced by magnetite-bearing

placers of about the same size as the black sand deposits in the modern beaches and elevated terraces onshore (figure 6; 11).

Future Research Exploration

To assess the economic and strategic importance of the potential heavy mineral and metal placer deposits on the Pacific Northwest shelf, we propose a plan for future exploratory research. The plan has three main stages. The first stage is to identify potential mineral resources on unexplored portions of the shelf and their onshore sources. The second is to conduct a ship or airborne magnetic survey of heavy mineral concentrations to locate and define the dimensions of possible placer bodies on the shelf. And the third stage is to core the magnetic anomalies with a vibrating tube (vibra core) to confirm the type of minerals and metals, dimensions, and probable economic value of the placer deposits.

The recent discovery of abundant titanium-bearing ilmenite in the opaque mineral fraction of the surface sediments on the shelf off central and south-central Oregon (13) should be followed by a detailed study of the distribution, abundance and economic grade of ilmenite on the shelf off northern California and from central Oregon to northern Washington. Onshore sources of ilmenite should be located in the Coast Range to determine where higher grade mineral sources might have supplied coastal placers in the geologic past. Several hundred existing surface samples from the continental shelf in the Oregon State University and University of Washington geological archives need to be analyzed for their heavy mineral concentrations and ilmenite content. The northern California shelf should be studied in a similar fashion to define the chromite, zircon, and gold content of the shelf deposits. Onshore sources of these minerals and metals in northern California are well known, but their offshore distributions are not known.

A detailed magnetometer survey should be conducted of the major heavy mineral concentrations on the continental shelf (that is, off the Rogue River, Cape Blanco, Umpqua River, and Columbia River areas) to demonstrate whether magnetic anomalies actually define buried placer deposits. A vibra corer can be operated from a ship to obtain sediment samples up to 10 meters long and 4 inches in diameter. The samples can be analyzed in the laboratory onboard the ship or in an onshore laboratory for their mineral and metal content to obtain an estimate of the economic value of the deposit. In addition, these samples will provide essential information about the origin of the deposits (that is, ancient buried beach sands or river channel sands and gravels) and their geological history for the prediction of the locations of similar deposits elsewhere on the shelf.

Future Industrial Exploration of the Shelf

The aforementioned research studies should determine which concepts and technologies are the most cost effective techniques for the exploration of the continental shelf off the Pacific Northwest. Land use planners need to identify the areas of potential conflict between the "hard" mineral and living resources to make informed decisions about the environmental impacts from mineral extraction. Large areas of the shelf need to be surveyed, and areas where minerals are concentrated need to be mapped rapidly and accurately.

Several types of surveys, in addition to the magnetometer surveys, are needed to conduct a detailed commercial exploration program of the mineral resources of the shelf. Swath mapping bathymetry (highly accurate mapping of offshore topography) was initiated on the shelf by the National Ocean and Atmospheric Administration and will shortly be declassified by the U.S. Navy. It will be most useful in locating the remnants of ancient headlands. Peterson et al. (8) showed that the heavy mineral placers on the coast tend to accumulate along the south side of these promontories. High-resolution side scan sonar can be used to image the seafloor to locate possible remnant sea cliffs associated with buried shorelines as well as the headlands. High-frequency, high-resolution seismic reflection tools will determine the thickness and geometry of the unconsolidated deposits on top of bedrock. Finally, vibra core drill holes will be required to prospect the deposits to determine the economic value and geometry of specific placers prior to any offshore mining.

These detailed prospecting surveys are essential for future mining activities on the northwest Pacific shelf because (1) the highest grade deposits must be identified for the profitable recovery of the desired mineral and metals; (2) the precise location of the placers is needed to determine any potential environmental conflicts with living resources in the target areas; and (3) the mineral and metal extractions need to be confined to relatively small areas of the shelf to restrict the adverse

effects of sediment removal and disposal at the mine site. Careful prospecting often means the difference between success and failure in a mining operation, especially in the ocean environment. Given the present mineral studies and prevailing prices of the economic minerals and metals, more than one mineral or metal is probably required in the placer deposit if offshore mining is to be profitable.

Future Mining Activities

While several different types of offshore mining vessels are currently in use around the world, the most suitable one for the Pacific Northwest appears to be a trailing suction dredge (16). The principal components of this dredge are a suction device and a suction line (pipe) mounted on a vessel. This dredge line extracts a slurry of unconsolidated sand and gravel along a narrow, well-defined path on the seafloor, using a powerful mechanical pump or airlift. The sediment is pumped into screening and gravity separation devices, such as cones, jigs, spirals, or a large sluice box, sitting on the deck of the vessel. As the seawater flushes through the devices, gravity separates the economic heavy minerals and metals from the light minerals. No chemicals are used in this operation at sea. With some modification to the dredge, the spoils (light minerals) could be piped or dumped back to the seafloor. There are no at-sea processing plants exactly like the one described, but development of the system is believed to be feasible and might not require additional major costs beyond those experienced by other offshore dredging technologies (16).

A probable mining scenario using this type of trailing suction-head dredge was recently proposed by Ritchey (17), U.S. Bureau of Mines, for the recovery of heavy mineral and metal placers off southern Oregon. The material would be screened and concentrated onboard the vessel, which would reduce the original volume of dredged material to about 50 percent and allow the collective recovery of about 90 percent of the desired heavy minerals. The mineral concentrates can be either placed in the hold of the dredge, called a hopper dredge, or piped into a barge or other vessel for transport to a suitable port for processing. Because of the adverse weather conditions (for example, large waves and accompanying high winds) from about November through April on the Pacific Northwest shelf, mining activities probably will be restricted to about six months of the year.

Onshore processing facilities are needed to further concentrate the heavy mineral deposits initially processed at sea and to separate such economic constituents as chromite, ilmenite, rutile, zircon, gold, platinum, and garnet. The type of ratio of various minerals and metals present in each concentrate will vary with location. Present research studies suggest that chromite, zircon, gold, and platinum should be more abundant off the Rogue River area and south into northern California. Ilmenite, garnet, and zircon are likely to be more abundant off central Oregon and ilmenite and zircon off Washington. Virtually all the economic minerals and metals discovered to date are believed to occur in the vicinity of Cape Blanco and the Sixes River off southern Oregon.

Several factors, such as the grade of the ore deposit, the annual mining capacity, and the distance from the marine placer deposit to the onshore processing plant, must be considered in a cost analysis of a potential offshore mining operation, as Ritchey had point out (17). His analysis shows that the estimated cost of capital equipment for the seagoing dredging and processing of materials ranges from $28 to $85 million. Marine operating costs are estimated between $5 and $8 per short ton. The size of the placer deposit, the grade of the ore, and the length of the operational schedule will be important to the economic viability of the mining operation.

The ore grade and trace element composition of these marine minerals is critically important to the economic viability of the mining operation. For example, a high chromium: iron ratios (greater than 1.5:1) in chromite increases the value of this mineral for the smelting of ferrochrome products. Likewise, high TiO_2 grades (greater than 49 percent by weight) in ilmenite increase the value of this mineral for use as direct feedstock in titanium dioxide pigment production. However, trace contaminants such as manganese, chromium, and vanadium in ilmenite reduce the economic potential of the marine placer minerals.

Management of the Ocean Resources

There has been considerable industry interest in the exploration of the shelf placer deposits off Oregon during the past four years. Legislation was passed in 1987 by the Oregon legislature to allow the exploration of hard mineral deposits in the submerged lands of the continental shelf (Senate Bill 606) and to establish

the Oregon Ocean Resources Management Task Force (Senate Bill 630). The task force is currently developing a management plan for the use of both renewable and nonrenewable resources. (California and Washington are considering similar plans.) The task force submitted an interim report to the Joint Legislative Committee on Land Use on July 1, 1988 as required in Senate Bill 630. The final plan must be submitted to the Joint Legislative Committee by July 1, 1990. The management guidelines eventually formulated in this plan and their relationship to present regulations already established by legislation in the State of Oregon hold the key to future placer mining activities on the Oregon continental shelf.

The Oregon Division of State Lands (DSL) is responsible for developing rules and regulations for granting leases that allow the exploration of hard minerals within the three-mile territorial sea off Oregon. DSL needs estimates of the economic value of the potential heavy mineral placers and their probable location on the continental shelf for designating the lease tracks and administering the leases. Unfortunately, only about 25 to 30 percent of the Oregon shelf (southern Oregon, 42-43° N latitude) has been studied in enough detail to determine the probable locations of the placer deposits. No detailed placer studies are available on the placer mineral composition for the northern California or Washington shelf although a large number of surface sediment samples are available in academic and government archives. The type of research studies described previously can provide the best assessment of the value of the potential placer deposits on the shelf prior to the leasing of tracks for commercial exploration. This research should be an ongoing activity geared to the progressive exploration of the shelf. At present, private industry lacks the essential information on the potential economic value of the shelf placer deposits to secure funding from investors for detailed exploration. The future of offshore mining on the northern California and Washington shelves is unknown at present.

Government, academia, and industry are vitally interested in the geographic compatibility or incompatibility between the heavy mineral placers and the fisheries resources of the shelf. How do we determine where conflicts may arise? The authors of this paper are amazed at the amount of multidisciplinary information that currently exists about the ocean off Oregon, but are equally dismayed by the dearth of studies that summarize and integrate this information to address these potential conflicts. One example of multidisciplinary data integration is the comparison of commercial fish catch data, compiled by the Oregon Department of Fisheries and Wildlife, with the locations of potential heavy mineral placers, defined by offshore heavy mineral concentrations. Such studies will help to determine if there are conflicts, on the one hand, and, on the other hand, to ascertain precisely where conflicts might occur. Multidisciplinary data collection, integration and interpretation are among the most cost effective and vital research activities that can be conducted on the continental margin during the next two decades.

Potential Offshore Mining Impacts

Commercial exploitation (mining) of the placer deposits will require a certain amount of disturbance of the sediments composing the seafloor. The suction dredge mining techniques should minimize the disturbance to the surrounding area. If the shelf placer deposits are as well defined and highly concentrated in relatively thin layers as they are in the modern beaches and coastal marine terrace placers, there should be minimal disruption to the seafloor. In many shelf areas of the world, heavy mineral placers occur in relatively low concentrations (that is, 3 to 10 percent) and are disseminated over a wide area (for example, the shelf off northern Mozambique, 18), greatly increasing the area of the seafloor subject to mining. The Pacific Northwest may be fortunate in this regard. Good definition of the exploration targets should help minimize the degree of bottom disruption.

The continental shelf off the Pacific Northwest is by nature a very dynamic and unstable environment. The high energy wave conditions that affect the coastal region during the winter will be beneficial in returning the mining site to its more natural state. Long period waves (greater than 12 seconds) touch the sea bottom to water depths of 125 to 150 meters (19) and stir up the sandy sediments which are then transported along the bottom in an offshore direction by strong unidirectional currents (20). Several studies show that the natural turbidity extends some 10 to 20 meters above the seafloor during the winter. This zone of high turbidity shifts inshore during the summer and does not extend to water depths greater than 90 meters (21). Careful monitoring of the recolonization of benthic communities disturbed by mining op-

erations will establish their recovery rates, which can be used to determine the appropriate mining rates to minimize effects on benthic communities.

The environmental effects of a mineral processing plant onshore will depend upon the type of minerals (mainly chromite and ilmenite) available to the plant and the specific techniques used to further concentrate the minerals extracted in the mining operation. The type of processing plant needed in the future may be quite different from the ones currently in operation. In some cases it may not be economically feasible to construct a plant in the coastal region of the Pacific Northwest. Although this topic is beyond the scope of this paper, it is probably the most important one for potential environmental conflicts.

Conclusions

Strategic and economic minerals and metals are present in placer deposits along coastal beaches and in ancient marine terraces of the Pacific Northwest. Well-defined heavy mineral concentrations are also found in the surface sediments on the adjacent continental shelf. Preliminary studies show that the heavy minerals chromite and zircon and the metals gold and platinum group most likely occur from the Rogue River area off southern Oregon, southward into northern California. Chromite, ilmenite, gold, platinum group, garnet, and zircon are present in the vicinity of the Cape Blanco and Sixes River area off south-central Oregon; this is the most diverse mineral and metal assemblage studied to date in the Pacific Northwest. Ilmenite, garnet, and zircon are present off central Oregon, and ilmenite and zircon occur off Washington. The future economic value of these minerals and metals largely depends upon the following: (1) the grade and concentration of chromite and ilmenite ores in the marine placer; (2) the abundance of associated minerals and metals which makes the extraction of lower grade ores more economically viable; (3) interruptions or depletions in foreign supplies of strategic minerals; and (4) the type of ilmenite (titanium) extraction and refining technologies developed in the near future in onshore processing plants.

Additional research exploration is required to confirm the subsurface occurrence of these mineral and metal deposits in the form of placers. The most cost effective exploration technique for locating these subsurface placers appears to be detailed magnetometer surveys of the existing heavy mineral concentration zones identified on the shelf followed by vibra coring of the magnetic anomalies. Further research is needed to determine the ore grade, distribution, and coastal sources of the ilmenite, garnet, and zircon over large unexplored areas of the continental shelf, extending from central Oregon to northern Washington. The exploration models and technologies being developed for the Pacific Northwest region can be used for the exploration of other coastal and shelf placers of similar composition in the Pacific Rim region.

If current geological sampling and remote geophysical survey technologies are used for commercial exploration of the potential placer deposits on the shelf, there should be no adverse effects upon the environment. Because of the concentrated nature of the minerals and metals into placer deposits (1 to 10 meters thick), detailed exploration can accurately outline the economic targets and minimize the amount of sediment that must be extracted by a suction dredge during an offshore mining operation. Existing data bases (for example, minerals, fisheries, oceanographic parameters) need to be integrated, interpreted, and summarized in a multidisciplinary fashion within the next several years to determine where there are potential conflicts between the hard minerals resources and the living resources on the shelf. Once the areas of conflict are identified, we can make an assessment of the environmental and economic impacts in each area.

The State of Oregon is formulating a management plan for its offshore resources, which will set priorities in dealing with these areas of conflict. However, it appears that only a small portion of the available offshore data is going to be used in the development of the plan by 1990 because of the limited financial resources within this relatively short time frame. Considering the broad scope of the "hard" mineral and living resources, the ever changing oceanographic conditions, and the large geographic area of the continental shelf, there must be an ongoing multidisciplinary research effort on the shelf off the Pacific Northwest during the next several decades and certainly well into the twenty-first century.

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Table 1. Heavy minerals and metals in marine placers of the Pacific Northwest, U.S.A.

Native Metals	Formula	Density (g/cm^3)	Economic Value
gold	Au	17-19 (+Ag)	precious metal
platinum	Pt	14-19 (+Fe)	precious metal
Economic Heavy Minerals			
magnetite	Fe_3O_4	5.0-5.2	iron, vanadium
ilmenite	$(Fe, Ti)O_3$	4.7-4.8	titanium
chromite	$(Fe,Mg)(Cr, Al)_2O_4$	3.8-5.2	chromium
zircon	$ZrSiO_4$	4.6-4.7	zirconium, hafnium
garnet	$(Fe,Mg,Ca,Al)_5(SiO_4)_3$	3.6-4.3	abrasive

Table 2. Foreign sources of selected placer minerals

Material	Uses	Foreign Sources	Mineral/Metal Substitutes
rutile	pigments titanium alloys	Australia (64%) R. South Africa (14%) Sierra Leone (14%)	In alloys: synthetic rutile TiO_2 slag ilmenite
ilmenite & TiO_2 slag	pigments synthetic rutile titanium alloys	Australia (63%) Canada (26%) R. South Africa (13%)	In pigments*: rutile clay, carbonate zinc oxide
zircon	foundary sand refractories ceramics zirconium alloys	Australia (63%) R. South Africa (27%)	In foundary sand: chromite In ceramics: titanium, tin In alloys: titanium stainless steel
chromite	stainless steel plating refractories pigments	R. South Africa (61%) Turkey (10%) Zimbabwe (10%) Yugoslavia (5%)	In alloys*: boron In plating: nickle In pigments: iron
garnet	abrasives filtration	Australia (100%)	In abrasives: diamond silicon carbide aluminum oxide In filtration: ilmenite magnetite

*At present there are no cost-effective substitutes for titanium dioxide in pigments or for chromium in stainless steel production. (All data from [1])

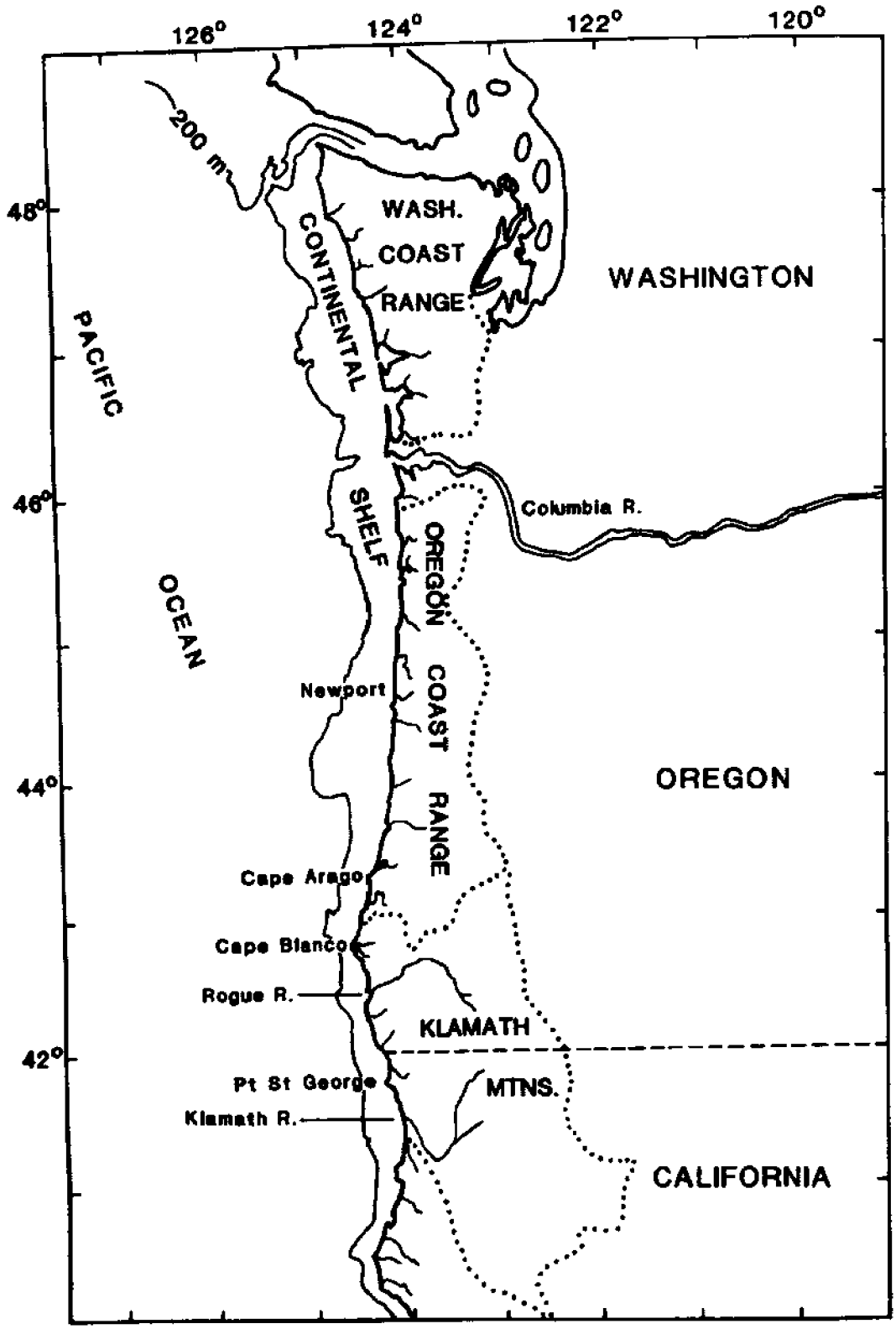


Figure 1. Regional map of the Northwest Pacific showing major coastal rivers, present shoreline, and continental shelf to a water depth of 200 meters offshore northern California, Oregon, and Washington.

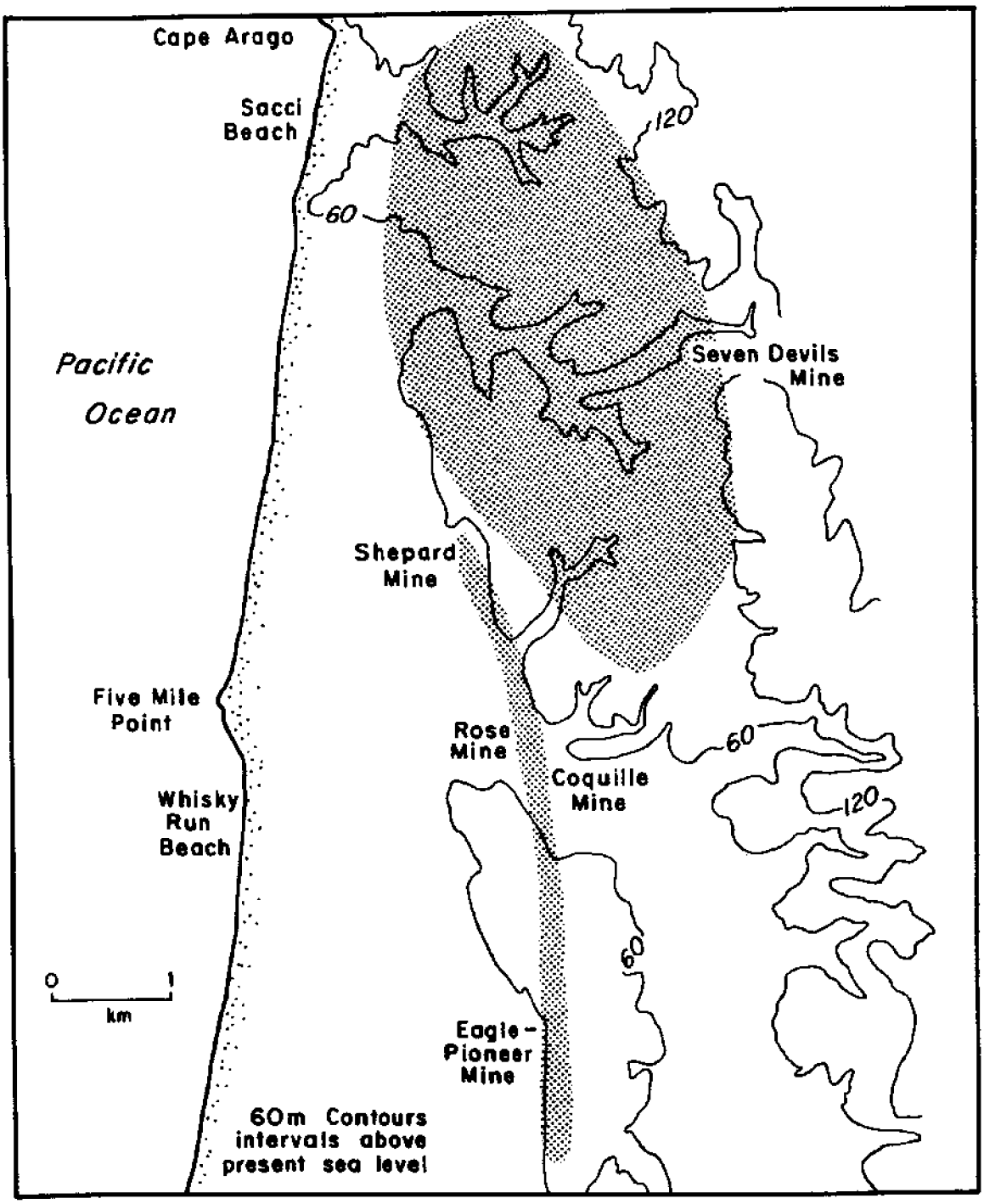


Figure 2. Location of ancient marine placers south of Cape Arago, Oregon (see figure 1 for location). The Seven Devils and Eagle-Pioneer placers are formed on adjacent uplifted coastal terraces (after 8). The lower Pioneer placer was extensively explored and mined for gold.

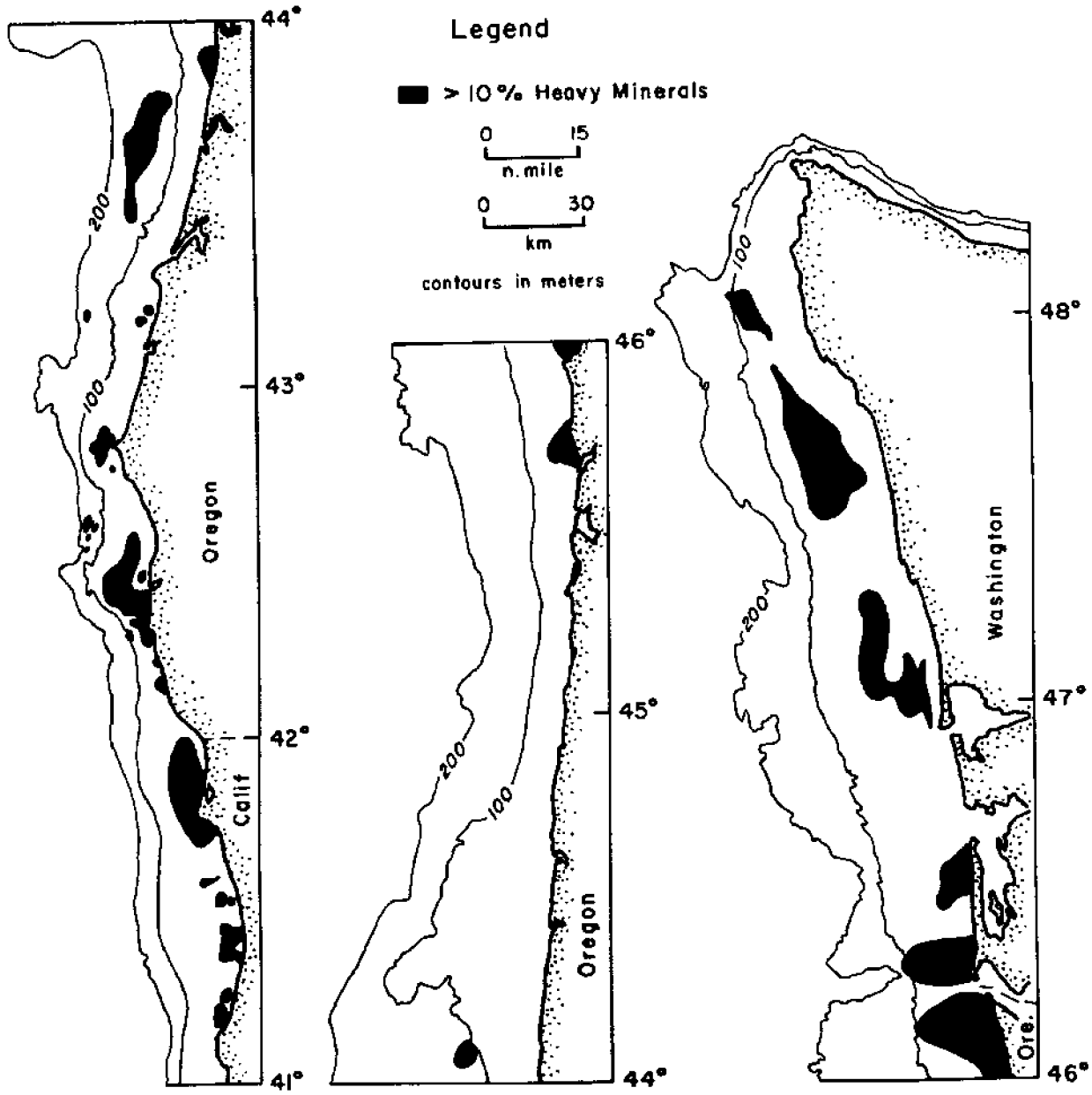


Figure 3. Heavy-mineral concentration map of continental shelf off Washington, Oregon, and northern California (Pacific Northwest). Patterns indicate heavy-mineral concentrations greater than 10 percent of the sand fraction in surface sediments of the shelf (after 9; data from 12 and unpublished).

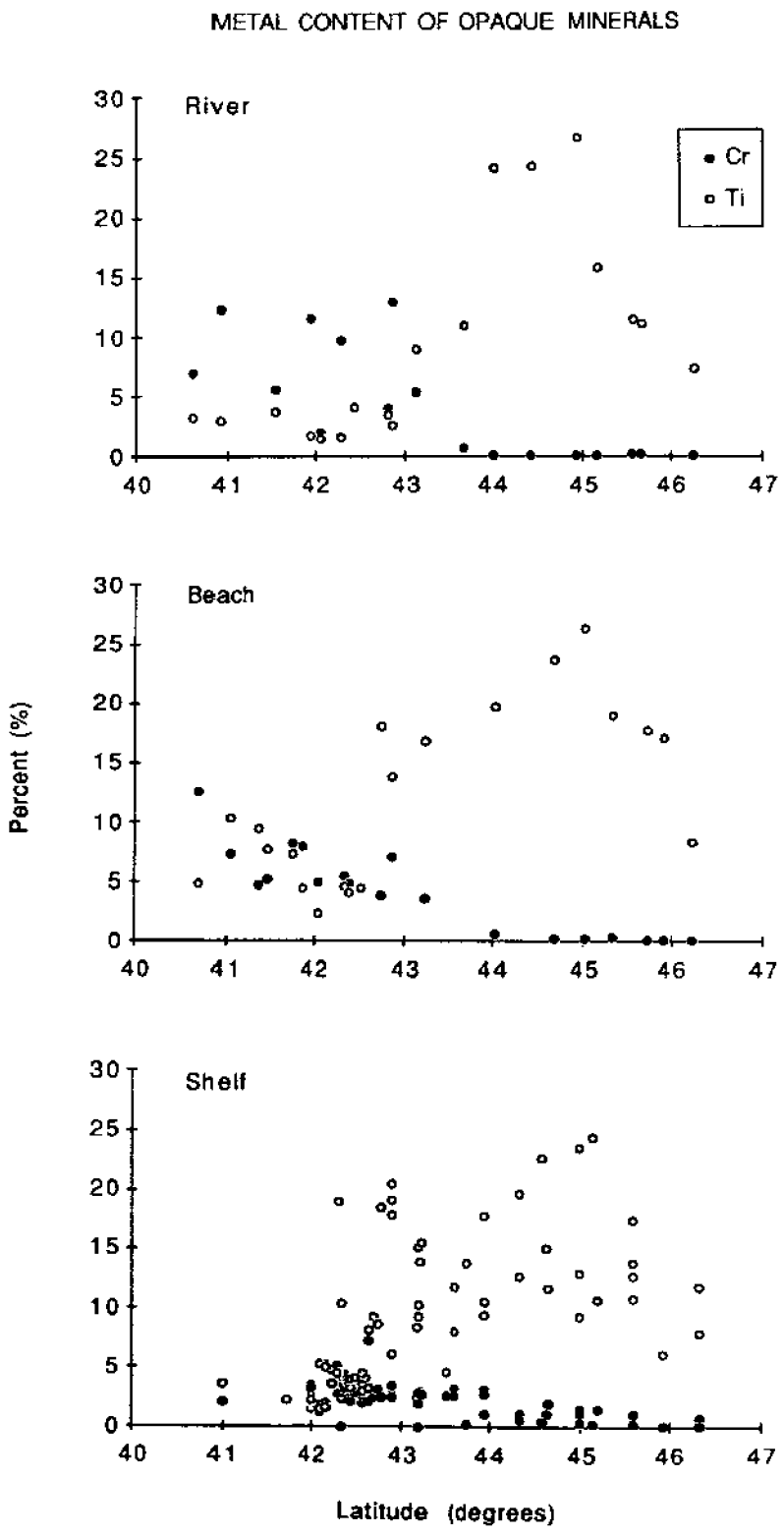


Figure 4. Distribution of elemental titanium and chromium in opaque mineral fraction (density greater than 4.3 grams per cubic centimeter) from (a) coastal rivers, (b) coastal beaches, and (c) continental shelf surface sands of the Pacific Northwest (after 9).

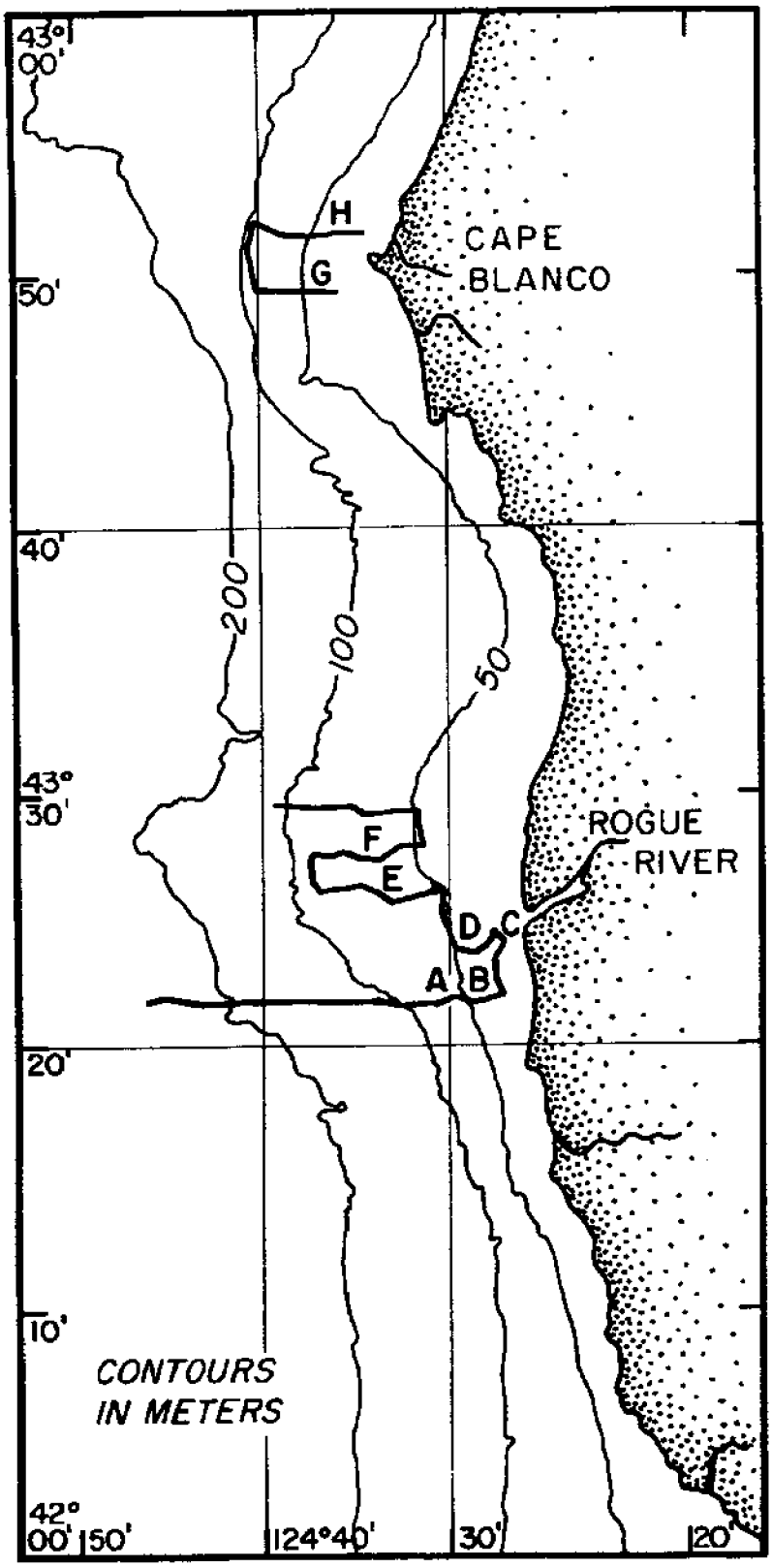


Figure 5. Magnetic survey conducted off southern Oregon.

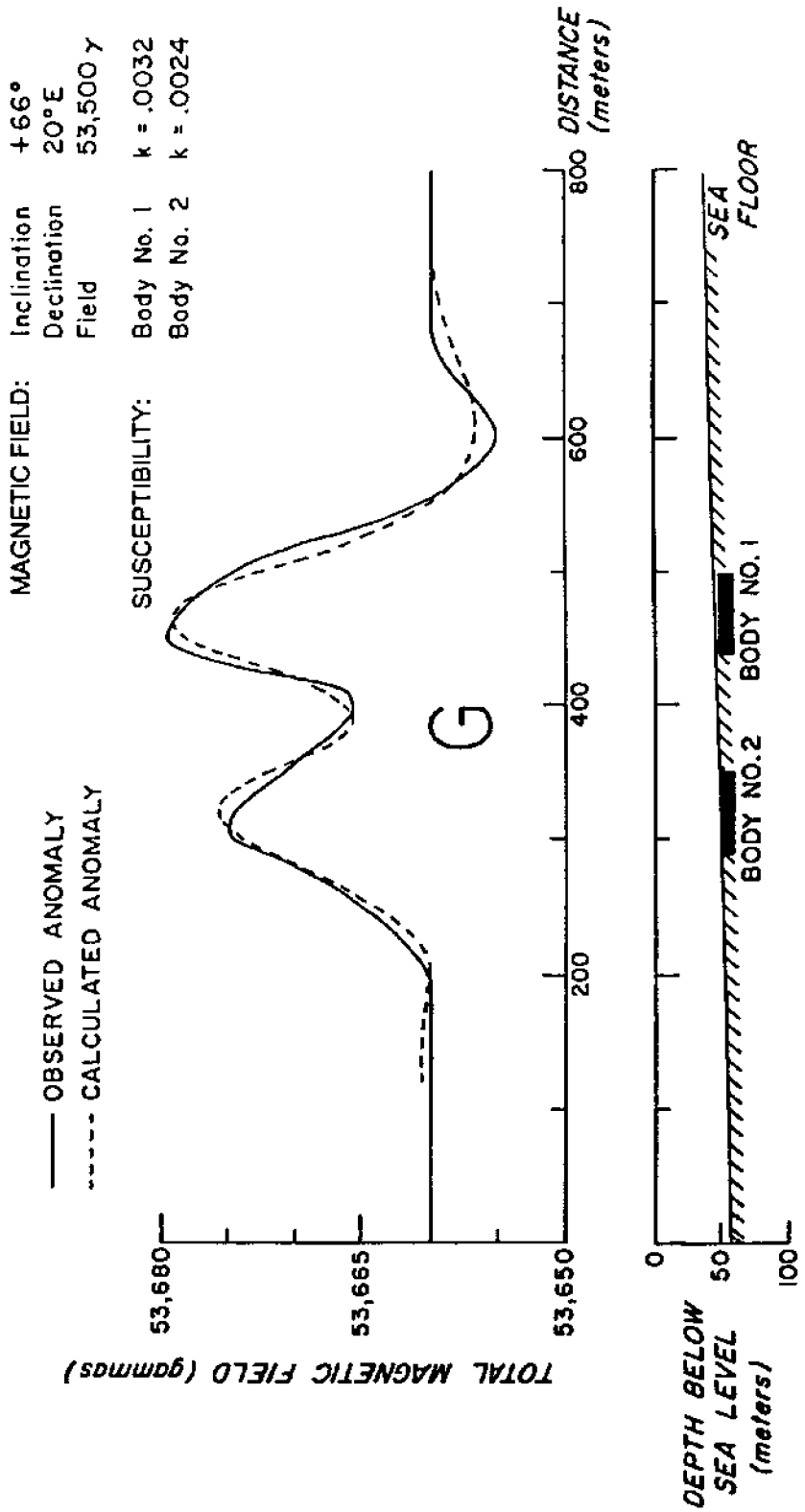
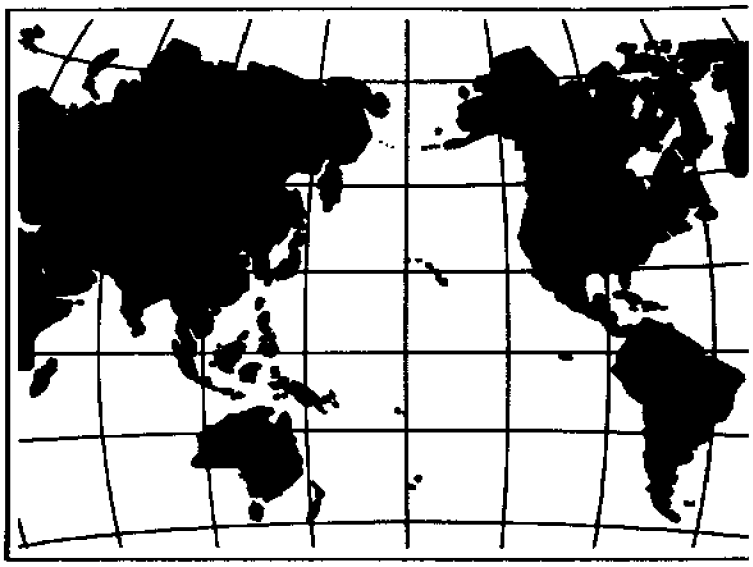


Figure 6. Magnetic anomaly profile over a heavy mineral concentration located off Cape Blanco. Two positive magnetic anomalies (15 to 20 gammas) may define buried marine placers rich in iron-bearing minerals such as magnetite, chromite, and ilmenite (after 11, 12).

Fisheries



Fisheries Resources and Management in the Twenty-First Century

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Introduction

Barring a major nuclear war or other catastrophic events, we must presume that fish, fishermen, and fisheries managers will coexist in the next century. However, correctly forecasting the state of fishery resources and the character of management in the twentieth century is about equal to one's chances of winning a state lottery.

I am reminded by my colleagues of those fisheries "seers" who were courageous enough to forecast the developments of the groundfish fisheries off Alaska about 10 years ago. Even the most optimistic projections,which included those of my firm, Natural Resources Consultants, underestimated the rate of development and maturation of this fishery and failed to predict the economic shifts which would stimulate U.S. development of the groundfish fisheries in the Gulf of Alaska and Bering Sea.

The Alaska Example

Before looking into the twenty-first century, let me reconstruct the significant events affecting the history of the groundfish fisheries off Alaska in the 1980s.

At the beginning of the 1980s, U.S. fisheries in and off Alaska were dominated by the traditional high-value salmon and crab operations. The only U.S. high seas groundfish fishery of any significance was the halibut line fishery, producing a paltry 12,006 metric tons of fish a year (1). The extensive groundfish resources of the region—about 2 million metric tons—were being harvested largely by Japanese, Soviet, and Korean fishermen.

The major concerns of U.S. fishery managers working with the resources harvested in the U.S. Fishery Conservation Zone (FCZ) were focused on encouraging the rational use of the fishery stocks and limiting the impacts of foreign fisheries on traditional U.S. fisheries. The efforts of U.S. fishermen and processors were largely dedicated to finding an economic or political lever to eliminate foreign fisheries and replace them with U.S. counterparts. Their goal was full Americanization of the U.S. Exclusive Economic Zone (EEZ) off the Pacific Northwest and Alaska.

Now, in the late 1980s, the traditional U.S. salmon, crab, and halibut fisheries of the region are augmented by a U.S. high seas trawl and line fleet that harvests all of the available 2 million metric tons of groundfish in the region. Furthermore, it also appears that we will be processing all of the fish caught from the 3-to-200-mile zone off Alaska by 1991. The fish will be processed into fillets, blocks, surimi, and a number of headed-and-gutted products. An industry that was nonexistent a decade ago will generate annual sales in excess of a billion dollars.

Quite a success story. But let me complete this picture.

It is now apparent that not only have we Americanized the fisheries of the region in the last ten years, but we have also already overcapitalized some elements of this fishery. By 1990 we will have at least 52 factory trawlers (including 6 motherships), 100 catcher/trawlers, 20 freezer long-liners, and over 1500 catcher long-liners in the fleet. We are in the process of significantly overcapitalizing every sector of the catcher fleets. Line fishermen are at odds with trawl fishermen over resource allocations. Crab, salmon, and halibut fisheries claim that incidental catches by trawlers are severely reducing their harvesting opportunities. Inshore fishermen are disturbed over the escalating levels of offshore fishing. Alaska's fishermen are unhappy with the intrusion of distant water fishermen from Oregon and Washington. Shortened seasons, by-catch limitations, gear restrictions, and area restrictions have become integral components of management of a fishery that was nonexistent only a few years ago. And all of these measures operate, directly or indirectly, to increase fishing costs. Add to all this a growing international fishery adjacent to the U.S. EEZ in the Bering Sea on stocks considered to be a transboundary resource indigenous to the U.S. 200-mile zone, and we have a camera snapshot of northeast Pacific whitefish problems.

These sorts of problems are, of course, not unique to the Pacific Northwest and Alaska; they are global phenomena. A great deal has been written about the explosive growth of fisheries and the ensuing management problems which followed World War II, and it is not my purpose here to recast global ocean developments during this era. It seems sufficient to note that during the 38 years of my career, the oceans have been portrayed by the optimists as the earth's last frontier—a reservoir which would provide protein for the expanding world populations, a region of our sphere less understood than the moon's surface, a further energy source to augment dwindling fossil fuel supplies. The pessimists, on the other hand, point to a global cesspool for medical and other wastes and a dying biological system whose resources have been contaminated, overexploited, and depleted, with more and more species threatened with extinction.

It is hard to believe that these different views could develop and coexist in such a relatively short time span. These disparate expressions might be discarded as reflecting either people's romantic view of the oceans or their pessimism and cynicism about all human activity. This is, however, an overly simplistic dismissal of conflicting views concerning the status of the ocean environment and its biota. Some of this confusion can be traced to overt distortions of facts designed to achieve the narrow interests of commercial, recreational, and environmental groups. But of greater importance has been the rate of change in the use of ocean resources, coupled with our inability to monitor effectively the consequences of the accelerated use patterns.

The problems associated with an accelerated change are clearly stated by, Sir Solly Suckerman, a former advisor to the British government:

> We live in a period of uncontrolled and accelerated change, an age in which technology has raced ahead and in which hallowed social values have tumbled . . . .We live in an age of paradox: an age in which the politician has been straining after the scientists and technologists, and in which the latter have been trying to understand the social consequences of the innovations to which their work has led. The world is clearly living through a period in which the aims of politics and the outcome of scientific endeavor appear to clash.

With these sobering thoughts, I will surround myself with crystal balls, Ouija boards, astrological charts, and Jean Dixon predictions, and, foregoing the analytical methods for short- and long-term forecasting, fall back on simple intuition in dealing with the twenty-first century. In order to provide something of more lasting value to this volume, I shall initiate my discussion with a short review of the state of the world's fisheries and fisheries resources and management. This will provide us with a launching platform from which to visit the future.

Current State of World Fisheries

The world harvest of finfish and shellfish during 1988 (figure 1) is expected to approach 100 million metric tons (round weight), or about 20 kilograms (44 pounds) for each man, woman, and child living on our planet (2).

This harvest includes aquaculture production from both fresh and marine species. It is interesting to note that world harvest, which dipped somewhat in the early 1970s following the collapse of the Peruvian anchovy fishery, has continued to grow and has reached a level that the skeptics doubted could occur and the optimists have found disappointing.

Of the approximately 38 million metric tons increase in the world harvest of fishes which has occurred since the early 1970s, a considerable portion can be traced to the significant growth in the production of pelagic species—in particular herrings, sardines, and anchovies (figure 2). Of the top 20 species listed for 1986, nine were herring-like species (table 1). The large increase in pelagic species production was spurred by major growth in Japanese as well as South American pilchard catches.

The most recent review of the status of world fishery resources states that "some of the major changes occurred in the catch of the shoaling pelagic species which seem particularly liable to long-term natural changes. The causes of these natural changes are seldom clearly known or understood." One of the most dramatic has been the increase in catches of the Japanese sardine in the coastal water around Japan. The catch of this species was down to around 9,000 metric tons in the mid-1960s but exceeded 5,100,000 metric tons in 1984 (2).

World production of species classified as whitefish (cods, hakes, redfishes, and so on) has risen from about 16 metric tons in 1970 to about 23 million metric tons in 1986. Much of this increase can be traced to the growth of the Pacific pollock fisheries in the north Pacific,

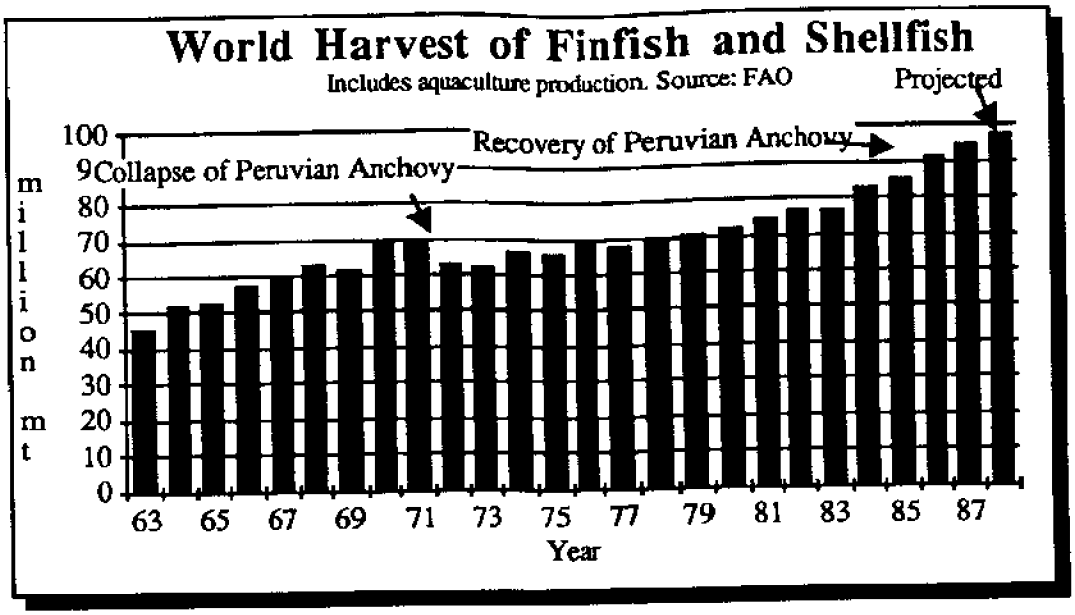


Figure 1. World harvest of finfish and shellfish (includes aquaculture production. Source: (2).

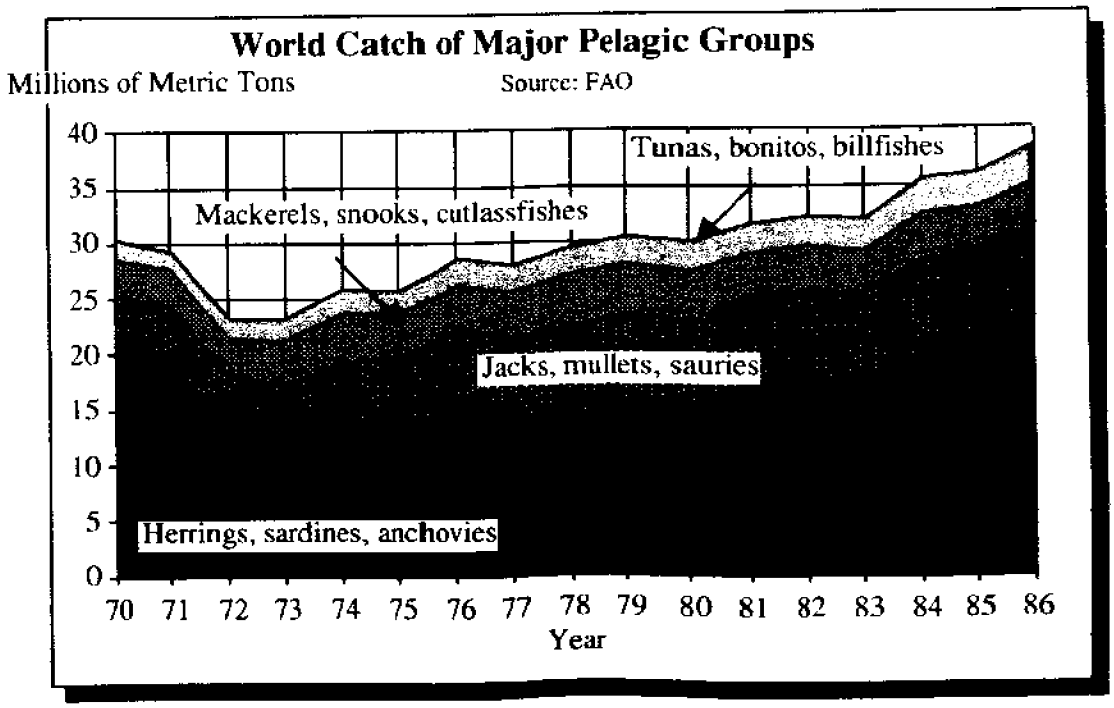


Figure 2. World catch of major pelagic groups. Source: (2).

which skyrocketed from about 2.5 million metric tons in 1970 to over 8 million metric tons in 1987. Most of this catch increase represents new production from the northwest Pacific region (figure 3), which has shot up from about 1.5 to 7 million metric tons in the past two decades. By contrast, catches of Atlantic cod declined over this period.

The harvest of various shellfish groups has also grown significantly since the early 1970s, buoyed by the increased aquaculture production of these species. This is particularly evident in world shrimp production which has about doubled since 1970, from 1 to 2 million metric tons. However, since 1980 all of the growth can be traced to aquaculture production (figure 4). Harvests of other major shellfish groups are shown in figures 5a and 5b.

The development of the fisheries for finfish and krill in the southern oceans continues slowly and is dependent on large vessels from a few countries. Although the fishery for krill expanded rapidly after it started 10 years ago and reached over 500,000 metric tons in the 1981-1982 season, recent catches have been less than half that amount, possibly reflecting the decreasing demand for krill. However, several countries have reported recent success in preparing krill products, and the reported catch in 1985-1986 increased to 430,000 metric tons. Catches of finfish have remained fairly constant over the past few years. Antarctic icefish at present dominates the catches, but in general these slow-growing fishery resources are fully exploited or overexploited.

All of this, of course, tells us very little about the economic state of fisheries (most of which are overcapitalized) throughout the world, but does tell us that world fish production has continued to creep upward towards the 100 million metric ton level. Information on world aquacultural production is not adequate to accurately differentiate between levels of increased fish and shellfish from natural production and from that of aquaculture. It is evident, however, that world aquaculture production nearly doubled between 1975 and 1983 (4,974 to 8,107 thousand metric tons) (table 2), and we must presume that it will continue to grow at a rapid geometric rate.

The State of World Stocks

The state of world fisheries is reviewed by the United Nations Food and Agriculture Organization of the United Nations (FAO) every two years. For many of the world stocks there is very little information; thus the state of the resources is largely unknown. However, for those resources for which information is available, I have somewhat subjectively grouped the FAO world state of resources classification into four broad categories: underexploited, moderately exploited, fully exploited, and overexploited. Of the 186 stocks or stock groups for which information was available, 10 were underexploited, 43 were moderately exploited, 89 were fully exploited, and 44 were overexploited. If this is representative of the many stocks for which we have no data, it seems that about 25 percent of the world fish stocks are overexploited.

If we examine the FAO report from the standpoint of regional impacts, it seems that the northeast Atlantic is in the worst shape. Eleven out of 19 stocks in the region are reported as overexploited. The eastern central Atlantic also comes up with bad scores, with 9 out of 18 major stocks noted as being over-exploited. These two areas account for 43 percent of the stocks reported as being overexploited. Other regions having poor marks include the northwest and the southeast Atlantic.

The 44 stocks reported as overexploited in 1987 represent a major increase over the 23 for the previous two-year period (1985). It is difficult to tell, however, whether the report reflects a deterioration in the state of world fisheries or improved reporting by the participating countries. What is apparent is that the number of underexploited stocks in the *State of World Fisheries Resources* reports has steadily declined, dropping from 20 to 10 between 1985 and 1987.

In summary, it appears that although there has been a continued growth of world fisheries in recent years, much of this growth has resulted from species diversification, aquaculture, expansion opportunities beyond 200 miles, the overexploitation of stocks in some traditional fisheries, the use of unconventional species, and the resurgence of the abundance of several small pelagic species. The great geographic expansion of fisheries which marked the 1960s and 1970s appears to have largely run its course, although further development of the resources beyond national jurisdiction is likely to occur. More and more species are moving into the fully exploited and overexploited categories. The FAO reports do not differentiate between effects associated with natural fluctuations and those associated with fishing and deterioration of the environment. I must, nevertheless,

Table 1. Top 20 species, 1984-1986. Source: (3).

SPECIES	CATCH (METRIC TONS) 1986	1985	1984
Alaska pollock	6,758,902	6,132,334	5,986,318
Japanese pilchard	5,191,036	4,733,862	5,156,086
Peruvian anchovy	4,945,315	986,796	93,654
South American pilchard	4,324,924	5,814,448	5,361,326
Chub mackerel	2,004,701	1,738,033	2,215,965
Atlantic cod	1,995,764	1,956,710	2,013,385
Chilean jack mackerel	1,957,658	2,148,841	2,324,010
Atlantic herring	1,536,291	1,431,619	1,203,654
Capelin	1,461,094	2,262,712	2,595,128
Skipjack tuna	1,084,193	889,547	1,065,926
European pilchard	934,930	919,084	911,548
Gulf menhaden	828,503	983,514	982,888
Blue whiting	809,915	665,995	611,220
Yellowfin tuna	774,362	705,590	614,450
Largehead hairtail	667,223	710,270	693,397
European anchovy	665,716	597,669	836,159
Atlantic mackerel	611,582	599,883	653,597
Pacific cupped oyster	568,537	562,851	525,441
Cape hakes	539,998	541,815	493,204
Common carp	507,040	479,525	459,681

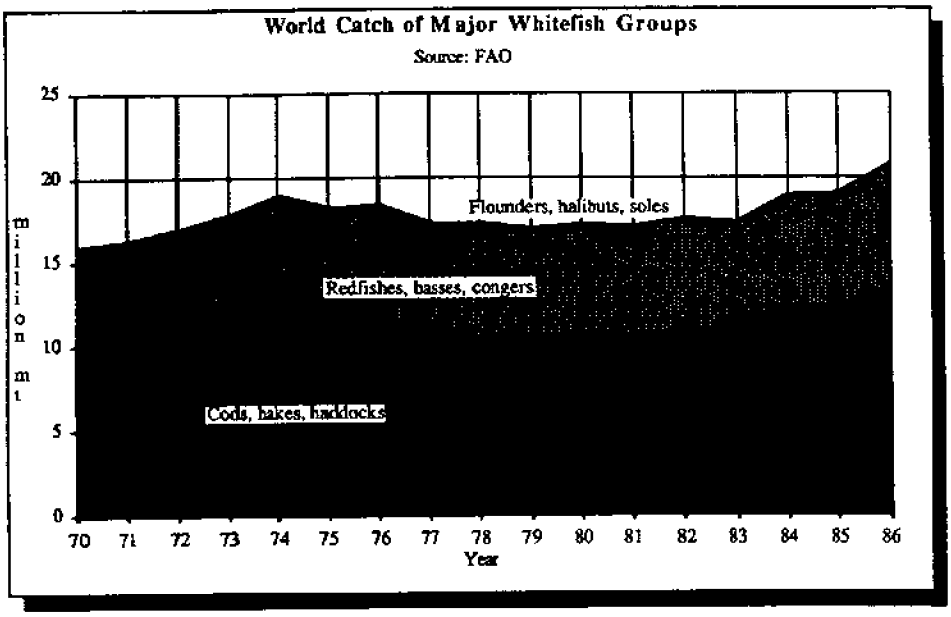


Figure 3. World catch of major whitefish groups. Source: (2).

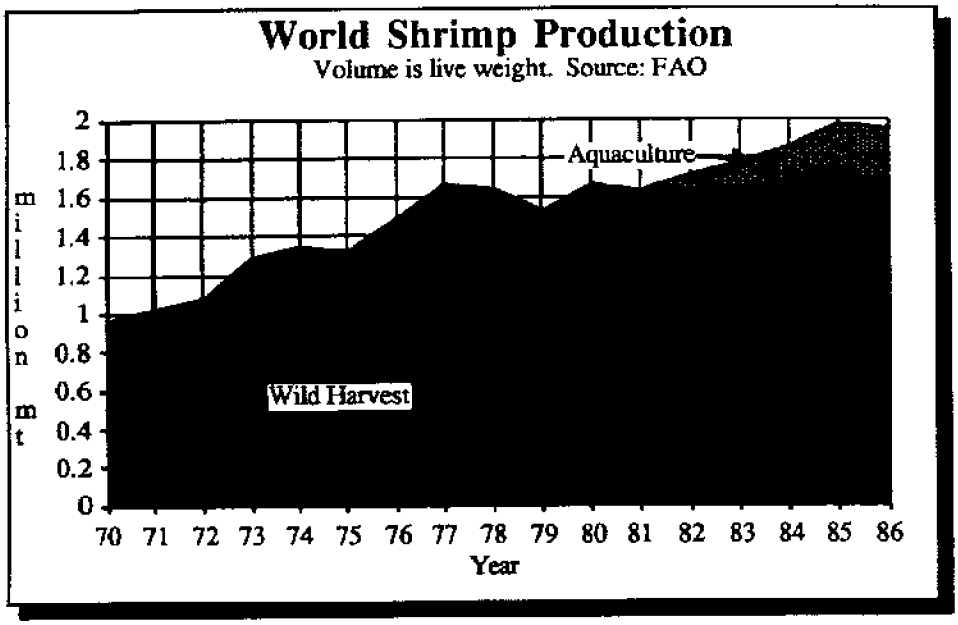


Figure 4. World shrimp production. Source: (2).

conclude that most of the world's great fish stocks (herring, cod, and tuna-like species) are now subject to relatively intense fishing activities and that a number suffer from misuse in terms of optimization of yield per recruit. Further, I surmise, but cannot document, that a fair number of stocks also suffer from overexploitation of the parental stocks.

The State of Fishery Management

Management of the world's fisheries underwent a major change following the extension of national jurisdiction which occurred in 1970. A number of the world's international fishery bodies involved with the management of international fisheries ceased to exist or had their charters sharply modified. Coastal nations inherited the jurisdiction of the vast majority of the fish stocks which inhabited waters over the continental shelf areas of the world oceans.

Although the vast majority of the world's coastal states supported extended jurisdiction, many were unprepared to take over the caretaker role of the adjacent fishery resources or to enforce fisheries measures on their citizens, much less those of other states. The situation was perhaps not much better in many coastal developed nations of the world who, without access to previously available resources, committed only meager funds to managing and monitoring fish stocks in regions beyond their area of national jurisdiction.

How much progress has been made since the extension of national jurisdiction? The FAO notes that "the majority of stocks are regularly monitored only in a few areas such as in the northern parts of both the Atlantic and Pacific. There remain many areas with important fisheries not yet satisfactorily covered . . . . The problem is particularly acute in sub-regions where resources are shared and where little progress towards coordinated management will take place until some equitable distribution of understanding and competence has been achieved" (2).

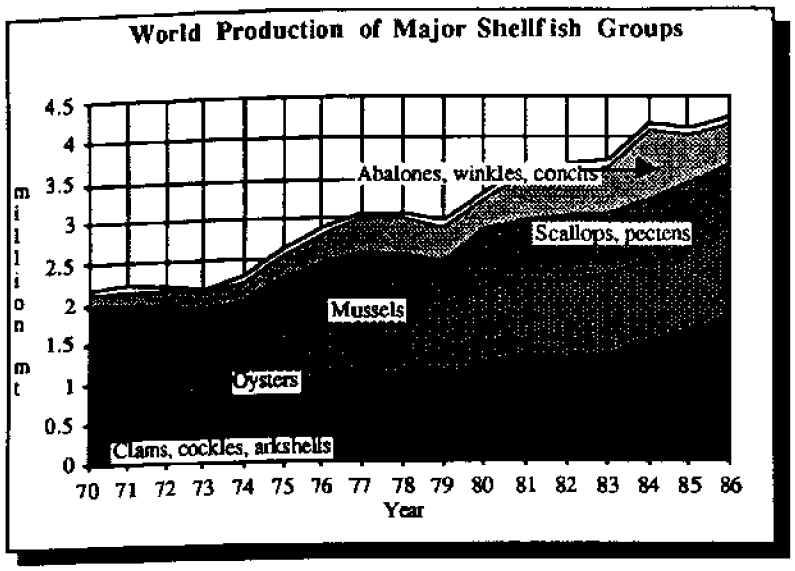
From the perspective of FAO, developmental expenditures far outweigh those for management. I strongly suspect this is the case because, over the past decade, loan and aid agencies have been more receptive to development proposals than to those concerned with management. However, this has not necessarily been all bad as it relates to promoting fishery management skills.

The extension of national jurisdiction encouraged many developing countries to believe that they could achieve a certain amount of economic rent, if not added animal protein supply, from the fishery resources adjacent to their coast. From the world catch statistics, it appears that some developing nations have been relatively successful in increasing fish production. In those areas where development has been successful, it is apparent that it also has initiated the process of institutional development and resource management.

On the other hand, the rate of success in fishery development projects in many areas of the world has not been very impressive. The basis for failure of many fishery development projects has been the subject of recent debates; frequently, a number of culprits are identified, one being the lack of information on the fisheries of concern before the project starts. The argument is rather a "Catch 22" in that it is difficult for developing countries to give priority to establishing fishery management institutions and monitoring systems without the existence of a major fishery. On the other hand it doesn't make good sense to invest in development without knowledge of the available fishery resources of the region.

For reasons entirely extraneous to extended jurisdiction and the rate of fisheries development, the capacity to manage the ocean's living resources in many developed countries probably eroded during the 1980s. The great enthusiasm for ocean exploration and development which accompanied the growth of oceanographic and fisheries science during the 1960s and early 1970s has wavered. The bloom is off the rose and governmental policymakers are beset with a host of other problems that are more glamorous or that address more compelling needs. In general, governments in the developed world have become stingier in their allocation of funds among competing users, and hence fisheries have suffered along with many other competitors for the available dollars.

This is perhaps best exemplified by the decrease in national funding committed for fisheries research in the northeast Pacific, where a major new U.S. fishery has come into being. The developments to date have been exciting and must be recognized as one of the great success stories in United States' fisheries. Within this decade, U.S. fishermen and entrepreneurs have marshalled a fleet which is now capable of harvesting the entire optimum yield established for the Bering Sea and most of the resource potential in the Gulf of Alaska. During the next two years they will be processing the



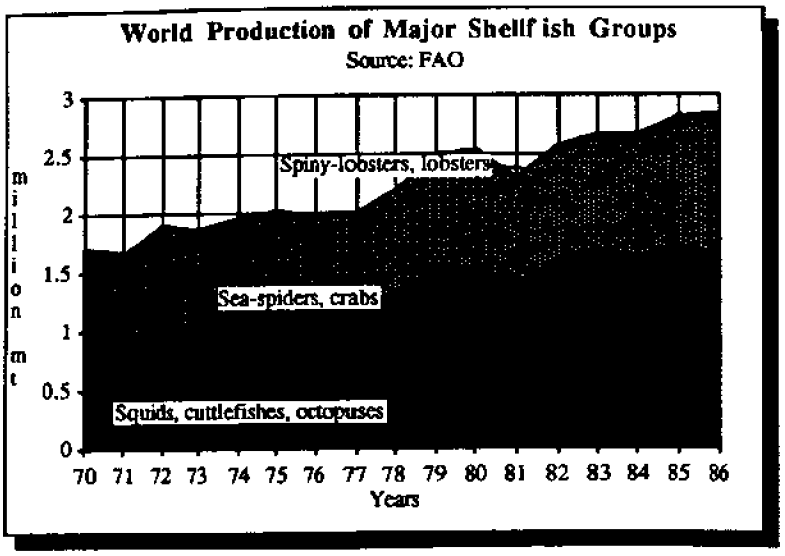


Figure 5a. World production of major shellfish groups (molluscs). Source: (2).
Figure 5b.World production of major shellfish groups (crustacea). Source: (2).

Table 2. Reported ('000 tons) of aquaculture production for freshwater and marine finfish, molluscs, and crustacea.

	1975	1980	1983
Africa	107	4	4
America N.	158	140	316
America L. & Caribbean	97	71	219
Asia & Pacific	3,720	5,135	6,250
Europe & USSR	892	1,141	1,278
Total	4,974	6,491	8,107

vast majority of the yield potential of the region. The trawl and longline groundfish fisheries of the region will by this time have a combined wholesale value of about $1 billion.

There is, however, increasing evidence that the viability of this industry may deteriorate rapidly over the next several years, leading to a much less competitive position. The major change which will affect the industry's competitive position in the early 1990s will be the reduction in annual fishing time available to catcher vessels resulting from the continued expansion of fishing and processing capacity.

The array of national and international policy issues confronting the growing groundfish industry must be addressed by the North Pacific Fishery Management Council (NPFMC), state and federal agencies, the Bush administration, and Congress. Unraveling the conflicts, however, will be more difficult than the goal of Americanization, as alternative solutions will be confused by the conflicting arguments of the battling user groups. The only real, cohesive, industry support for congressional and NPFMC actions for problem resolution may target on eliminating foreign fishing from the doughnut region of the Bering Sea and high seas legal and illegal salmon fishing. Enthusiasm of managers, policy makers and politicians to deal effectively with the mundane issues of by-catch, user group allocations, and/or over-capitalization seems much more remote.

The ability of the NPFMC to deal with the growing issues of user group allocation is clearly undermined by the failure of NOAA, Department of Commerce, to establish clear allocation procedures and criteria and its reluctance to perform its task as a national caretaker of the Magnuson Fishery Conservation and Management Act (MFCMA). The NPFMC's performance and ability to deal with these matters is further diminished by a continually deteriorating information base, a situation caused by the lack of an alternative information retrieval system to replace the foreign fisheries observer program which is being phased out. The U.S. fisheries conservation zone off Alaska will be fully Americanized by 1990 and the available funds to conduct research and information retrieval will only be a fraction of those available when the fishery was totally foreign, producing an unacceptably low national commitment to essential data collection, resource management, and resource conservation.

This story is by no means unique to our part of the world and in various verse and form is repeated by fishery managers throughout the world.

The Twenty-First Century

It is time now to fasten our seat belts, leave the comfort of our mundane surroundings, shift into "warp" drive, and turn our clocks forward to the next century. Of course, the beginning of this time envelope is a mere 11 years away and presumably within this group of reasonable projections.

Let us start the journey into the future with a few assumptions. (1) Barring a natural catastrophe or a major war which eliminates a significant part of the world's population, the twenty-first century is likely to see an increasingly crowded world. Presumably most people will be hungry, all will continue to generate waste products, and all will continue to compete for available space and resources. (2) Production from world natural fish stocks is not likely to increase significantly in the next generation and hence will not contribute significantly to world food requirements. (3) The use of ocean space for recreational purposes, aesthetic values, transportation, and extraction of nonliving resources will increase in an exponential manner. (4) The rate of technological development associated with communications, space monitoring of terrestrial and ocean activities, transportation, genetic engineering, and medicine will accelerate. (5) Government spending to support fishery science and management is unlikely to increase significantly during the remainder of this decade.

Of course any or all of these assumptions may prove faulty, but I have chosen to use them as a basis on which to formulate the scenario below.

1. The state of world fisheries in the twenty-first century in terms of their contribution to world protein supply is likely to continue to increase with production in the next century, exceeding 150 million tons. However, only marginal increases can be expected from the harvest of conventional species, and production from the world's oceans is unlikely to exceed 100 million tons. Thus most of the forecasted growth is likely to occur from aquaculture activities, greater use of unconventional species, and use of species now considered as having little or no commercial value.

2. With most world fish stocks being moderately to fully developed and world population increasing, demand will outstrip production. Competition for conventional species will increase, leading to further overcapitalization of the world's fisheries, a greater incentive to fish illegally, underlogging, and so on. Higher by-catch mortalities will occur and there will be a greater likelihood of resource waste and biological overfishing.

3. Before the onset of the next century, managers will be frustrated by inadequate funding and the inability to effectively monitor fishing activities; and they will be beset with increasingly serious allocation conflicts among the various fishing groups. In order to deal with increasing overcapitalization problems, managers will use a variety of conventional techniques including shortening of seasons, gear restrictions, and quota management, most of which will drive up the cost of fishing and demand greater funds to monitor increasingly complex management systems.

4. Multi-user conflicts between commercial and recreational fisheries, conservation and environmental groups, and other ocean-oriented users will escalate, particularly in the developing countries, making managers' jobs more difficult.

5. Despite this range of difficulties and conflicts, the long-term productivity of world fishing resources is unlikely to be significantly affected by resource extractions resulting from fishing.[a] This does not suggest that the significant wastes and overfishing will not occur—it most likely will, particularly early in the century—but that whatever damage has and will occur will likely be reversible. Unregulated and wasteful fishing practices have been in vogue for the greater part of this century and will persist into the next century. Nevertheless, most of the world's fish stocks have shown tenacity and a capacity to rebound—they are perhaps more robust in the face of fishing than many of us are willing to concede.

6. Despite increases in world fish and agriculture production and improved food distribution systems, world population growth will outstrip increased food supplies, particularly in developing countries. Thus in the next century overpopulation will become of increasing concern to the global community and constitute a threat to world peace. However, the development of synthetic proteins and reconstituted protein foods will enter the food stream in significant quantities in the latter half of the next century and alter world food shortages. Fish will become increasingly a luxury item rather than a significant component of the animal protein supply available to the general population.

7. From my vantage point, the managers of the twenty-first century will ultimately come to grips with the folly and waste associated with massive overcapitalized fleets, resource waste, user group allocations, and effective monitoring of fishing vessel activities. Common sense and the evolution of a much broader political constituency involved in fisheries and environmental ocean management decisions will ultimately dictate a controlled entry system—perhaps into both sport and commercial fishing activities. Effective monitoring will be significantly enhanced by technological developments concerned with remote position and on-board monitoring systems.

Hence, my greatest concern for the twenty-first century is not that uncontrolled fishing will decimate ocean resources and that managers will be unable to cope with overcapitalization or multiple use conflicts. The more appropriate question is whether we will be able to effectively deal with waste disposal and hence contamination of the ocean environment. We have a great deal more to worry about in terms of the future of living resources productivity from habitat degradation than we have from overfishing.

In this century we have managed to pollute a number of our harbors, bays, inlets, and freshwater sources. We have, of course, over the past decade greatly increased our sensitivity to environmental issues and have made some local gains. On the other hand we must face an ever increasing world population with concomitant demands on food and other resources. These demands will place a further burden on the environment. Waste disposal and maintenance of our global environment will be the one issue of greatest concern to society in the next century.

Fisheries managers must metamorphose into environmental and living resources managers, and fisheries management institutions must be recast to consider ocean resource management in terms of the collective activities affecting the ocean environment and its inhabitants. In the U.S. this will lead to a new look at the structure and membership of the current fisheries management councils. The existing councils' mandates will be modified or new institutions will be created having broader management author-

[a] Excluding anadromous and some long-lived species.

ity. Benefit-cost evaluations of management may ultimately force more simplistic management strategies. There is nothing unscientific about the question "How little do we need to know to reach sensible and timely management decisions?"

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Enclosing the Ocean Commons: Fishing Rights in the Twenty-First Century

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As the twentieth century draws to a close, many nations appear to be adopting radically new approaches to fishery management. Or are they? In this paper, I argue that they are blending old, traditional, and accepted techniques with stronger property rights.

The extension of fishing jurisdiction by coastal fishing nations can be traced to a declaration of maritime sovereignty by President Gabriel Gonzáles Videla early in 1947 and to the Santiago Declaration of 1952 (1). Why did 35 years elapse between Chile's proclamation of a 200-mile zone and the closing of the Conference of the Sea and the opening for signature of a new law of the sea in which all nations now recognize extended coastal fishery jurisdiction? The sad answer is that the momentum for a new regime did not gather until many valuable fishery stocks were greatly depleted. Assigning property rights, both to nations and to citizens of those nations, has been considered a radical change and has met strong opposition.

Just as farmers do not wish to eat their seed corn, fishermen do not wish to deplete spawning populations. Many changes in fishery management, including license limitation, were introduced in the wake of the collapse of a valuable fish population. Recognition of this primacy of resource conservation as a management goal provides a useful perspective in assessing the economic, social, and political aspects of fishery management.

Widespread adoption of extended jurisdiction was largely an event of the 1970s and paralleled the growing consensus in discussions associated with the Third United Nations Conference on the Law of the Sea. Although restrictive licensing programs can be traced far back in time, the number and sophistication of these programs also began to expand gradually in the 1960s, grew rapidly in the 1970s, and are continuing to evolve today. How can the timing of these changes be explained?

To an economist, the answer lies in the concepts of supply and demand. At any given time, a larger supply of fish can be provided at higher and higher prices. If fish stocks are managed to avoid their depletion, the supply can rise over time as technology evolves in harvesting, processing, and moving the product to the consumer. Technology can also provide more and better fishing experiences to recreational anglers. Although fish supplies increased worldwide, many species became fully used, and often overharvested, in the 1960s. The supply of the most valued species increased gradually over the course of the past two decades; further increases will come only at steep costs.

The demand for fish products and marine angling opportunities, on the other hand, grew rapidly in the 1960s in response to information suggesting that some kinds of seafood may reduce heart disease and the incidence of other diseases such as cancer. Demand also responded to the improved quality of fish made possible by new processing techniques and techniques for maintaining high quality during long-distance transport. With demand growing more rapidly than supply, fish prices rose faster than other food prices. Rising scarcity led to heavier fish harvests and growing conflict and may have triggered the desire for new and stronger property rights to help allocate resources.

Since the principal rationale behind the establishment of extended fishery jurisdiction was to reverse trends toward depletion of fish stocks, setting limits on total allowable catch became an important part of fishery management. In fisheries dominated by a single species, such as skipjack tuna, the level of maximum sustainable harvest can be estimated using simple population dynamics models. In other fisheries, biologists can advise managers about the dangers of various fishing mortality rates, even though they cannot recommend a particular catch level. Whenever biological advice is provided, two major decisions must be made: how to divide the catch among nations and how to divide the catch among people within each participating nation. Before turning to particular management approaches, consider these two actions briefly.

Extended fishery jurisdiction was a response to the inability of nations to allocate fish stocks.

Although substantial progress has been made under the new international fishery management regime, the scarcity of fish stocks and the limited number of development alternatives for distant-water fishing nations have continued to pose new and difficult challenges.

Consider the development cycle. Before the extension of fishery jurisdiction, coastal nations watched enviously as distant-water fishing nations harvested large volumes of fish from areas close to their shores. What mistakes were made immediately after extended jurisdiction took effect? In fisheries that had already been exploited by the coastal nations, excessive optimism and misguided programs for fishery development expanded fishing fleets far beyond an economically viable size. After a period of apparent profitability and growth, the fishing industry experienced wave after wave of bankruptcies.

The pressure to find new opportunities for the overbuilt fleets combined with the frustration over the fact that distant-water fishing fleets were still found offshore pursuing species which were not fully used by the coastal fishing nations. The response in the United States was active expansion of joint fishing ventures. Newer, larger, and more modern fishing vessels were built to operate farther from shore, capture large volumes of trawl catch, and deliver the catches over the side of the vessel to processing vessels operated by distant-water fishing nations. As large fortunes were made, the seeds for future hardship were planted. Recently, new domestic catching and processing vessels have been built. Just as joint ventures have priority over foreign fishing operations, so totally domestic operations have priority over joint ventures. The expensive and sophisticated joint venture vessels are being forced to turn to those same domestic fisheries where bankruptcies were experienced not long ago.

What should we conclude? Extended fishery jurisdiction and related events, rather than leading to a golden era for the fishing community, have led to intensified problems of excess fishing capacity and increased concern over domestic allocation. The displacement of distant-water fishing nations occurred quickly in the Gulf of Alaska and more slowly elsewhere. Many nations need to reduce fishing capacity without discouraging technological developments in processing and harvesting that would help them in global markets. The number of fisheries in which license limitation has been discussed is now much larger, but these are troubled fisheries with difficult futures.

As coastal nations asserted stronger claims on fishery resources in coastal waters, groups of fishermen in those countries worked for stronger claims to shares of the fish catch. In some countries, the groups with the greatest success were aboriginal members of their countries: Maoris in New Zealand and Eskimos and Indians in North America.

Many countries have followed the ancient practice of comanagement. One helpful definition of comanagement is the sharing of management responsibility between the national or state government and a group of fishermen. Examples include the delegation of selected management responsibilities to native American fishing tribes in North America, the assignment of fishing rights to local cooperatives in coastal Japan (2, 3), and the involvement of fishermen in fishery enforcement in the Canadian province of Ontario (4). Comanagement has social and economic appeal, but it also has an economic basis. Fishery management, especially enforcement, has become increasingly costly. To the extent that comanagement reduces public costs and to the extent that it increases the share of costs paid by local groups and governments, it reduces a substantial burden upon the public.

Limiting the number of people who may participate in a fishery is one of the oldest fishery management tools used. It is also one of the most unpopular approaches. Fishery managers often begin such programs with a moratorium on new entry, hoping without any concrete evidence that their problem is a short-term one only. As the problem lingers and perceptions about new entry alter, the moratorium often changes into a permanent limited access system.

In retrospect, too much was expected from license limitation. Each program that has been adopted has been flawed in some respect. On the other hand, many fishermen and fishery managers accept the inevitability of these programs. In some countries, restrictive licensing is being integrated with other, more indirect methods for controlling fishing mortality. Consider, for example, the Australian northern prawn fishery.

Having carried out many license limitation programs in other parts of the nation during the 1960s and 1970s, Australia responded to overcapacity in her northern prawn fisheries with a limited entry management regime in 1977. Liberal qualification criteria and an

ineffective boat replacement policy were overwhelmed by other government programs that subsidized capital investment in northern Australia for the purpose of economic development. By the early 1980s total fleet costs exceeded total fleet earnings, with approximately 55 percent of participating boats unable to make a positive return to capital (5).

After extensive consultations between industry and government, a northern prawn fishery management plan was developed to reduce fleet capacity over time. At the heart of the plan is the concept of "boat units." Having decided that the problem was an increasing ratio of fishing power per boat, the planners responded by limiting the ability of boat owners to increase this power. Restrictions on the amount of hold capacity and the amount of horsepower permit the fishing fleet to adapt to new technology and circumstances without rapidly increasing the effective rate of fishing mortality (6).

Although other restrictive licensing programs have incorporated requirements relating to vessel capacity and have used other rules to limit increasing fishing power as boats are replaced, the Australian program is unusual in that it attempts to use the market to aid these measures. A fisherman can replace his vessel with a more powerful one, if he can buy boat units from someone else. Whenever a fisherman wishes to leave the fishery, he can receive funds from a compensation fund, which is maintained through an annual levy on members of the fleet.

Australia was not alone in dealing with a fundamental and difficult issue: Restrictive licensing is rarely embraced until the fleet capacity has grown substantially larger than can economically operate on the available fish stocks. Excessive capacity often leads to flexible criteria to qualify for a license. Combine this tendency with the speculative motives of those who see a scarcity value in qualifying for access, and fleet capacity often increases, rather than decreases, immediately after the program comes into effect. If the goals of the restrictive licensing program are to be met, the number of active licenses must then be reduced by some combination of qualifications on transfer of licenses from person to person, boat replacement policies that will decrease fleet fishing power as individual vessels are replaced, and fleet reduction programs.

On many occasions, managing agencies have introduced restrictive licensing programs with great hopes for fleet reduction, only to discover that the programs were more expensive than were anticipated and that shifting social and political priorities reduced the availability of public funds in later years (7). Other programs ran into legal problems and are still being redesigned (8). Although few fleet reduction programs have committed substantial funds, programs in Japan and Norway are noteworthy exceptions. Each has addressed major domestic problems and has made modest, but realistic, gains (9,10).

Among the oldest, most effective, and most widely accepted management tools are selective time and area closures. The area licensing program for roe herring in the Canadian province of British Columbia is a good example of a reasonable modification to a restrictive licensing program based on an emerging wasteful practice (11). The modification was to identify a restricted license with a specific open fishing time and area, but also to maintain a certain amount of flexibility needed to pursue successfully this highly variable fishery resource.

British Columbia is not the only place where area licensing has been used. It is, for example, a cornerstone of restrictive licensing for salmon fishing in Alaska. Area licensing can improve management capabilities and provide more orderly fishing, as appears to have been the case in British Columbia. On the other hand, in some fisheries, it may increase the need for surveillance and enforcement. Restricting fishermen to specific areas also conflicts with the flexibility of fishing operations, the lack of which could increase costs and lower productivity. Although the potential value of this tool should not be overlooked, it should be carefully reviewed for adoption in local circumstances.

A very old method for rationing a reduced fish population among a group of fishermen is the method of lay-ups. Each fisherman may voluntarily stay in port for a certain number of days between trips to rest and repair his vessel and gear. This historical practice was the basis for regulations limiting the number of trips any individual could make during some time period. Sometimes a catch limit or quota also was set on the total amount of one or more species that could be landed at the end of a particular trip. Since losses under these types of program are larger for vessels with more fishing power, different trip limits have been assigned to large vessels than to small vessels. Differences are also found between offshore and inshore operators and between operators with histories of large landings and those with less active his-

torical participation. The question is, What do you get when you combine trip limits with restrictive licensing, call the privilege to land a certain amount of fish a right, and then allow fishermen to trade their assigned rights to land quota? The answer is an individual, transferable quota, or rights-based approach. In other words, what appears to be a dramatically new management tool is a modification of approaches used in many countries for a long time. Since restrictive licensing, catch quotas, and market processes vary greatly from country to country, rights-based approaches should also be expected to vary.

Two recent fishery management programs should be followed closely. The single program gathering most attention around the world is the individual transferable quota program adopted in New Zealand (12). Why is this program so uniquely market oriented, and why is it so different from programs in most other countries? Part of the answer lies in the fact that extended fishery jurisdiction occurred soon after exploitation of offshore stocks was initiated and at a time when the fishery was harvested exclusively by foreign fishing fleets. New Zealand found a rights-based approach to be helpful in encouraging joint ventures between foreigners and New Zealanders. The process by which allocations to joint ventures were assigned, including greater preference to joint ventures that had a greater percentage of involvement of local interests, became a model for resolving other disputes over fishery allocation, especially those in a highly chaotic nearshore groundfish fishery.

The New Zealand program is young and all countries are watching it closely. It has had difficulties. It had to address an unexpected claim for resource right by the aboriginal population of Maoris. The country had a major catastrophe when it allocated quota in numbers of fish as opposed to shares in a quota. When managers learned that either they had overestimated the abundance of an important fish stock or the stock had declined, they then had to face the problem of an oversubscribed quota system. In spite of favorable reviews for this innovative program, changes are likely to come with time.

In stark contrast to the complexity of the New Zealand program is the program adopted in the Australian southern bluefin tuna fishery. The process by which individual transferable quotas were adopted for southern bluefin tuna is striking (13, 6). A rapidly developing Australian tuna fishery, added to a mature and powerful distant-water Japanese tuna fleet, sharply reduced the average size of tuna captured. Biologists also began to worry about the possibility of a recruitment failure because of overfishing pressures. In this state of crisis, Australia, Japan, and New Zealand agreed to set total catch quotas for the fishery and to allocate the catch among the participating countries.

Coming as it did at the peak of expansion of Australia's tuna fishery, the program forced Australia to face the prospect of management measures which were likely to bankrupt all their fishermen. They needed to reduce fishing effort sharply; they lacked funds to undertake a major fleet reduction program; and they wished to treat their fishermen equitably. Their solution was to allocate shares in the tuna fishery and to allow fishermen to trade these shares on the open market. Fishermen remaining in the fishery could expect a gradually improving catch and improved prices through the sale of large fish for raw consumption on the Japanese market. Fishermen leaving the fishery would receive payment by trading off their shares, and they could still enter some other fishery. A side note of concern is that this emergency change in the tuna fishery did redirect a portion of the fishing fleet to other fisheries which were already fully exploited.

Fishery management in the twenty-first century is likely to have many of the characteristics of emerging programs around the world. Public budgetary concerns will continue to create pressure for more and higher taxes and fees on the groups harvesting fish. As commercial and recreational fishermen pay a larger share of the public cost of managing fisheries, they will press for small, efficient, and responsive programs. After a few experiments with naive property-rights-based approaches to management, programs that integrate these approaches with older forms of management are apt to evolve.

Market-based decision making will become more widely accepted within fishery management. In fisheries with a small number of fishermen sharing common backgrounds and interests and using similar technologies, these methods should improve economic and social well-being and reduce conflict in the very near future. In other fisheries, problems will continue into the next century. For example, allocating fishing opportunities between recreational and commercial fishermen is bound to be a source of strife for many years. Even here, market-based approaches have been evolving

and will play increasingly important roles. Although my central argument is that the increasing reliance on these new methods is inevitable throughout the world, the well-being of fishermen, associated industry, and the public at any given time and place will be strongly influenced by men and women in government and industry. Creative and adaptive leadership can and will make a difference in many places. Will the United States be a leader or a follower?

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Fishery Management and Seafood Markets: Interdependencies and Challenges[a]

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What is government's role in fishery management? This is a question whose answer has eluded the most imaginative and skilled investigator, from practicing fisherman to ivory tower philosopher. In the spirit of trying to contribute to the search, this paper has as its modest objective the explicit introduction of market considerations into the discussion. Specifically, the paper argues that efficient use of the ocean's fisheries requires attention to market conditions but that exploitation of those conditions may generate costly inefficiencies. This will be the case even if the markets are international markets.

The paper begins with a discussion of competitiveness in international trade, explores the relationship between competitiveness and efficiency, looks at agriculture for empirical evidence, and concludes by raising some questions about the future of successful fishery management.

Competition in Seafood Markets

According to a venerable principle of international trade, countries will tend to specialize in the production and exportation of those goods which, relative to other goods, they produce most efficiently and to de-emphasize those in whose production they are relatively inefficient. This principle helps to explain why countries export some goods—those in which they have a "comparative advantage"—and import others. At its core the principle is simply a reflection of competitive market conditions, which lead individual producers to respond to price signals by moving resources to their most productive uses. Thus if it is to the advantage of a country's producers to export a particular good, they will, in response to the cues provided by competitive markets. Capitalizing on comparative advantage requires no deliberate action by governments.

In the case of a country's fisheries, however, public management at the harvesting level may increase economic efficiency in production, as discussed elsewhere in this paper.

[a] I am grateful to Bruce Rettig, Sandy Ridlington, and Court Smith for helpful comments on an earlier draft of this paper.

Through government action at this level, then, the country may uncover a latent economic advantage in producing the products of that fishery. The consequence could be increased exports of seafoods or reduced reliance on imports, or both. Thus, there is an intimate link between international seafood trade and fishery management.

But this raises a question. If competitive conditions lead to determination of a country's most advantageous trade position, and if these conditions do not require government involvement, why, in the case of fisheries, does public management play a role in uncovering economic advantage in seafood trade?

To address this question it is helpful to consider in more detail the basis of the notion that a country's most favorable trade position is uncovered by competition, indeed, that gains from trade cannot be improved beyond those generated by competitive market conditions. It is instructive to contemplate the matter through comparing market conditions that prevail in the fishery with those that characterize another food-producing sector: agriculture.

Fishery Management and the Agricultural Mode

Consider the farmer who is making decisions about what crops will maximize his returns, how much labor to hire, when to harvest, and whether to buy or sell land. These decisions will be made after consideration of the expected prices of his output, wage rates, and costs of other inputs. Whether to invest in additional land or to sell off existing land will be determined by a comparison of land prices with expected returns to land. By making decisions that maximize his own income, the farmer will allocate resources to uses that generate the greatest returns to himself. In so doing, he will be making the same decisions that a government would make if it were allocating society's resources so as to maximize the benefits to society's members. This is because product prices represent what the products are worth to the society, at least at the margin, while input prices represent what the inputs could earn if

employed most productively. Thus the farmer who allocates resources so that they maximize returns to himself is allocating them such that they also maximize society's returns.

At least that's what Adam Smith argued. More recent social scientists have pointed out that this coincidence of private and public interests rests on some crucial assumptions. At least one of these assumptions is violated in the fishery: namely, that private decision makers can buy and sell inputs and outputs so that returns are maximized. Satisfying such an assumption would imply that resources are privately owned, a condition not met in the fishery for a critical resource: the ocean. Unlike the situation for agriculture, where the basic resource, land, is or can be privately owned and earns an economic return, the fishery's basic resource, the ocean (or lake or river) is not privately held but is open to access by anyone. Thus bits of the ocean cannot be bought and sold in response to changes in economic opportunity and, indeed, the ocean is used as if its price were zero. Furthermore, complementary resources, including capital and labor, are employed less productively in fishing than they would be if the basic resource were privately owned. The consequence is too many fishermen chasing too few fish, an example of the "tragedy of the commons" (1).

Here, then, is where the government may play a role. While questions have been raised about the appropriateness of public intervention (2, 3), the prevailing view is that the benefits exceed the costs. It is important to recognize that it is social, not private, costs and benefits that are at issue here. These will coincide if the government is able to generate results that are identical to those that would prevail if resources were privately owned and the markets for all inputs and outputs were perfectly competitive.

This point is crucial. The goal of fishery management is not simply to improve the well-being of fishermen and other participants in the fishery (see Scott [4]). Rather, it is to increase the contribution of those participants to the entire economy. Indeed a major policy objective of the U.S. Magnuson Fishery Conservation and Management Act of 1976 is the realization of that yield from each fishery which "will provide the greatest overall benefit to the Nation" (7).

Thus the goals of fishery management and of many farm programs are quite different. Suppose, for example, it were decided to restrict entry into a fishery. The expected consequences would be twofold: (1) a more efficient fishery (and an accompanying greater contribution to society at large) and (2) more productive use of those resources removed from the fishery. The situation is different from that in agriculture. In that sector, entry restrictions are designed to improve the income position of existing farmers. While restricting the number of farmers in a society could *reduce* agriculture's contribution to that society, restrictions on the number of fishermen in an "open access" fishery could *increase* the social contribution of that fishery.[b]

Thus, restrictive policies in a fishery may lead to increased efficiency while similar restrictions in agriculture may reduce efficiency. Such policies may uncover comparative advantage opportunities in seafood while masking them in agriculture. The difference is that government management policies in a fishery may, at least in principle, move that sector closer to the conditions of perfect competition while those in agriculture may move that sector away from the conditions of perfect competition.

Market Information and Efficiency in the Fishery

Will any government action in the fishery increase efficiency? Hardly. What, then, are the features of a government fishery policy that will increase economic efficiency? What is required is a most demanding balancing act. Essentially, the policymaker is required to make decisions that in settings such as agriculture result from the independent actions of many individual farmers, wholesalers, processors, retailers, and consumers. For example, suppose that, for a particular fishery, the policy instrument were individual transferable quotas assigned to fishermen, each quota pegged at a fraction of an overall harvest level, established annually. Suppose, further, that this harvest level were set after consideration of prevailing (and expected) biological, ecological, and economic conditions. Such a procedure would make sense if, as stated above, the objective were to approximate what would occur if the common property resource were privately owned and competitive economic conditions prevailed.

[b] This is not to say that public programs designed solely to assist fishermen do not exist in open access fisheries. Income maintenance programs exist in many coastal communities under the name of regional development. Such programs are seldom justified on the grounds of economic efficiency, however.

Assessing biological and ecological conditions is difficult at best. Assessing economic conditions is overwhelming. Selection of an appropriate target harvest level requires, at a minimum, estimation of the ex-vessel price level associated with the selected harvest quantity. But the price level is also determined by exchange rates and other conditions in foreign and domestic markets. Thus the fishery manager must be in touch with a changing global economic environment.

Consider the consequences of not being in touch. Suppose that, for some fishery, utilized by both commercial and recreational users, the ex-vessel price for the commercial catch were at an all-time high, perhaps because of strong demand abroad. If the fishery resource were under private ownership, commercial fishermen would be able to bid fish away from recreational users. Thus, the fishery manager could appropriately reason that, for this year, an increased share of the harvest should be assigned to the commercial fleet and away from the recreational fleet.[c] Now suppose that a shift in exchange rates depresses the demand for seafood exports, resulting in a lower ex-vessel price. If resources were privately held, this would lead to a reallocation of their use from the commercial to the recreational sector. In the fishery such a switch is made by the fishery manager. But, presumably, similar switches are being made in all fisheries, leading to further changes in the ex-vessel price. Furthermore, economic conditions are constantly changing, generating both upward and downward pressure on prices. If management's authority permits within-season adjustment, the fishery manager can adjust both harvest levels and the allocation of that harvest[d] on an on-going basis. However, a more likely approach is to forecast the economic environment at the beginning of each season, when harvest levels are set. Either way, it falls to the fishery manager to have an appreciation of the relationship between market—including international markets—conditions and management decisions. To do otherwise is to run the risk of experiencing unexpected, and potentially costly, consequences of those decisions.

[c] See Rettig and Johnston (6) for an expanded discussion of this issue. A theoretically attractive means of addressing part of the problem is to have individual quotas transferable between recreational and commercial fishermen. This raises conceptual problems of its own, however, including those of where to set the overall harvest level, and would spawn large problems of implementation.

[d] In practice, though, this is generally permitted only for changes in biological or ecological—as opposed to economic—conditions.

Understanding Markets Versus Manipulating Markets

Understanding the close link between management decisions and market conditions may lead to decision making that more closely approximates that in the agricultural sector, where resources are privately owned. With those tools currently available to public managers, fishery management decisions require sensitivity to how those decisions affect market conditions and vice versa. However, this does present the manager with a dilemma: how to account for changing market conditions without manipulating them. Reducing harvest levels in response to lower prices is the expected behavior of a competitive market and, thus, an appropriate action by a fishery manager. However, additional reductions may, themselves, affect prices. But controlling supplies deliberately to affect (that is, increase) prices is the technique of the monopolist, not of the competitive market. Its consequence is decreased, not increased, economic efficiency.

Again, the perspective is society's as a whole. Competition leads to low consumer prices and least-cost production. The individual producer, however, has a different perspective. This individual has an incentive to seek private gain, perhaps at the public's expense. Such a producer would be no different from producers in other industries. Witness the calls for protection from foreign competition in many industries. And agriculture, the model for fisheries managers, has long been one of the most vocal of all. Indeed, one of the most contentious issues facing negotiators in the current round of trade negotiations under the General Agreement on Tariffs and Trade (GATT) is how to deal with the trade distortions associated with the agricultural policies of the GATT member countries, including subsidies, price supports, and input controls (7). With calls for government interference to stabilize or raise farm prices, maintain the family farm, manage supply, and reduce risk, the agricultural sectors around the world are awash in complex programs that serve selected groups but run counter to economic efficiency (8). Attempts to dismantle these programs stem from the recognition of how inefficient they are.

Can it be expected that pressures in the fishery sector differ from those in agriculture? When resources are removed from a fishery or additional fishing resources are barred from entry (through quota schemes, restrictive entry

programs, and so on) there are strong incentives to tilt these barriers so that they favor some groups at the expense of others, an argument made by Guilio Pontecorvo in 1977 (9). Criteria include gear types, race, and residence. Efforts to use management instruments to exclude participation in a fishery on noneconomic grounds may have an ally in management itself. Government managers often involve industry groups in decision making because of the sensible view that those in the industry may be best able to advise regulators how to move to a new structure in a way that minimizes the private (and personal) costs of adjustment. If their role goes beyond this, however, the consequence may be restrictive policies with no economic payoff to society at large. Such practices would be similar to prohibitions placed on land ownership in agriculture and would have the same results: reduced economic efficiency.

For the fishery, the irony is that, as fisheries become more efficient at the harvest level, economic gains there may be offset by inefficiencies at the market level. This may be a particular problem if public policy leads to a reduction in the number of participants in the fishery with commensurate ease of getting together. In addition, because of the involvement of industry groups in fishery management, the industry may be seen by managers as their constituency. Thus actions designed to improve the economic efficiency of the fishery may be confounded with actions to improve the economic lot of those in the fishery. Private costs and benefits mask as public costs and benefits. For example a government-mandated quota program designed to rationalize a particular fishery might become, perhaps unintentionally, a quota program that manages supply and, like a monopoly, raises prices in the market, as suggested above. This was recently illustrated by a reduction by the North Pacific Fishery Management Council of the total allowable catch of Alaska tanner crab. The result was higher prices on world markets. The shift from fishery management into supply management could go unnoticed and, to all concerned parties, appear deceptively consistent with the goal of economic efficiency—perhaps even a reasonable extension of fishery management.

Is this an unlikely scenario? On the contrary. Indeed, the evidence suggests that it is already occurring. Witness policies by many countries to require that fishermen deliver their harvests to domestic processors. If foreign processors are more efficient than their domestic counterparts (and pass this efficiency on to fishermen in the form of higher ex-vessel prices), such restrictive policies are difficult to justify on the grounds of economic efficiency. One version of this practice is the prohibition on the exportation of unprocessed selected fish and shellfish; another version prevents foreign buyers from traveling to the domestic fishing grounds to purchase fish. The former may generate public concern because it is a clear restraint on trade; the latter, however, is just as restrictive but may go unchallenged because justification may be offered on alleged management grounds. Other examples include restrictions on fish imports and restrictions on some business forms, including joint fishing-processing ventures with foreign partners.

The list could go on. It is worth noting that, where restrictive policies exist efforts may be made to substitute other practices for the restricted ones. Thus, where foreign buyers are denied access to a country's harvest, the foreigners may purchase ownership (invest) in processing facilities within that country. This has certainly occurred in the U.S., where Asian, European, and Canadian ownership of U.S. seafood processing and marketing facilities is, at least in part, a response to trade restrictions. Sometimes viewed with alarm by those concerned with "foreign domination," this phenomenon may, in fact, lead to the restoration of some of the economic benefits (to the domestic country) lost through the restrictive trade practices.

Conclusion

It is to the credit of fishery managers that they consider economic factors, including market conditions, in setting management policies. Having in place the structure to manage the fishery for society's well-being, these managers must now guard against slipping from serving public to serving private interests. If they relax their vigilance, they run the risk of facing a central fisheries challenge in the twenty-first century: that of dismantling government programs gone awry. This is a current preoccupation of the agricultural sector. Fisheries has learned much from that sector already. Now is the time to benefit from yet another lesson.

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Aquaculture and Salmon Ranching

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Introduction

The global harvest of fish and shellfish has increased twice as fast as the population of humans in the last four decades. The supply-and-demand relationship for seafoods has, therefore, favored consumers. But can this favorable relationship be sustained?

The biomass of harvested seafoods has, on the average, been doubling every 20 years since World War II. A closer inspection of harvest trends reveals three periods where geometric growth of harvest has changed (figure 1). The first, lasting through the 1960s, was characterized by sustained rapid growth of 6.0 percent per year. Growth stalled (0.3 percent per year) in the 1970s, but resumed at an intermediate rate of 3.0 percent per year in the 1980s. Lack of growth in the 1970s may be a warning that hunting fisheries are approaching a limit. Resumption of growth in the 1980s may indicate a transition to aquaculture.

Overfishing resulting from intense competition for wild stocks stimulated coastal sovereignties to restrict harvest and reallocate fishery resources in the 1960s and 1970s. Most coastal states declared exclusive jurisdiction over marine resources to 200 nautical miles seaward of land before the end of the 1970s. Harvest quotas were established for many wild stocks to avoid depletion, and participation of foreign fishers in many fisheries had been greatly reduced or prohibited by the early 1980s.

Aquaculture emerged as a significant growth industry by the 1980s, contributing about 11 percent to the global harvest in 1983. Aquaculture's contribution is projected by some analysts to increase to as much as 23 percent by 2000. It appears that if the most recent trends of world harvest of fish and shellfish continue well into the twenty-first century, aquaculture will contribute a larger biomass to the global supply than natural production sometime between 2025 and 2040. Even though a transition to aquaculture appears to be well under way, there is uncertainty about our ability to sustain increased global per capita supply of aquatic foods.

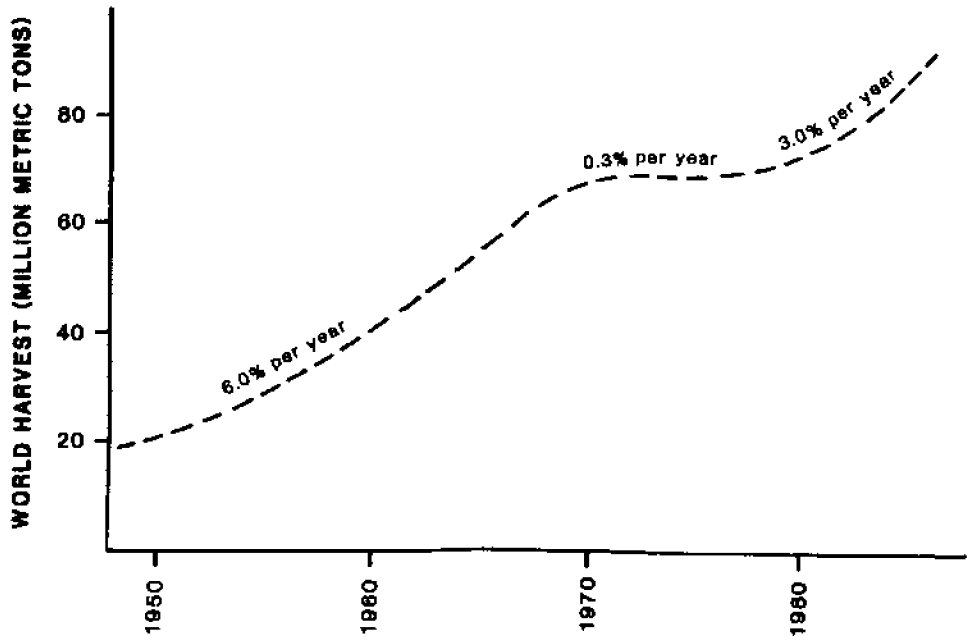


Figure 1. Observed trends in the world harvest of fish and shellfish.

Aquaculture is practiced in all nonpolar marine basins. Aquaculture involves a variety of practices, which may include (1) artificial propagation throughout the life of a species, (2) collection of wild seed stock for artificial propagation during later life stages, and (3) artificial propagation during early life for stocking natural

waters. An example of this last practice is salmon ranching, where juveniles are released from hatcheries to feed and grow to maturity in marine waters.

Salmon Ranching

It has long been known that salmon return as maturing adults to freshwater hatcheries. Our ability to ranch salmon was expanded significantly in the 1970s with the demonstration that salmon could also be conditioned to return to saltwater release facilities located in estuaries and on the open coast. Because of their self-herding behavior, salmon are ideal for ranching. There is a strong economic incentive to ranch salmon because they rank very high among preferred seafoods. Salmon are ranched in the north Pacific, south Pacific, and north Atlantic oceans, but the north Pacific now produces more than 95 percent of the global supply of ranched salmon.

At present, salmon make up about 3 percent of the total biomass of fish and shellfish harvested from the north Pacific. Because production of juvenile hatchery salmon for ranching has continued to double each decade since the 1950s, the overall abundance of salmon in the north Pacific has increased in recent years and is probably near historic high levels. I estimate that at least 300,000 metric tons of ranched salmon were harvested from the north Pacific in 1985.[a] This would constitute about 35 percent of the combined harvest of wild and ranched salmon in 1985. Geometric growth of ranching suggests a prospect for significant future competition for food and space to grow salmon in the north Pacific. Should the number of hatchery juveniles released into the north Pacific continue to double per decade, about 10 billion are projected to be released in 2000 and 20 billion in 2010. Such numbers probably exceed historic high levels of wild juveniles.[b]

Assume that wild salmon harvested from the north Pacific have stabilized and vary around the 1985 level of about 600,000 metric tons. Further assume that the production of ranched salmon continues to double every decade for the next three decades. The projected harvest of ranched salmon will, under these assumptions, equal the projected harvest of wild salmon by 1995, double the harvest of wild salmon by 2005, and quadruple its production by 2015 (figure 2). Regardless of assumed scenarios about the growth of salmon ranching, questions related to the capacity of the north Pacific to grow salmon will, in all probability, assume economic and political significance in the near future.

The Capacity of the North Pacific to Grow Salmon

Should numbers of ranched salmon continue to increase rapidly, it seems reasonable to anticipate one or more of the following three responses:

1. Survival will decline due to the increased natural mortality related to density-dependent factors (for example, increased incidence of disease, increased predation and cannibalism, increased competition for food).
2. Body growth will decline due to increased competition for food.
3. The abundance of certain nonsalmonid species will decline due to competition with salmon for forage and predation by salmon on nonsalmonids.

Should the primary response be the decline of nonsalmonid species, the increasing proportion of salmon in the total biomass of fish and shellfish harvested from the north Pacific is projected in figure 3 based on the following assumptions.

(1) The total harvest of all food fish and shellfish combined approaches a maximum of about 30 million metric tons (approximately 10 percent more than the harvests of all species combined recently reported by the Food and Agriculture Organization). (2) The biomass of salmon will increase in direct proportion to the increased numbers of salmon juveniles released for ranching.

Admittedly, these assumptions are highly speculative, but they are offered to emphasize potential trade-offs between assumed lower volumes of nonsalmonid seafoods and assumed increased production of salmon. Whether or not these assumptions are correct, important questions need to be addressed. Are we approaching

[a] Japan reported a harvest of 168,000 metric tons of ranched salmon in 1985 from the release of 2.0 billion hatchery juveniles. Hatchery juveniles released from other countries (the U.S.S.R., Canada, and the U.S.) totaled 2.4 billion, but statistics on the harvest of ranched salmon are incorporated in the combined harvest of ranched and wild fish (about 635,000 metric tons) from countries other than Japan. The 300,000-metric-ton estimate for all ranched salmon is believed to be conservative.

[b] For example, 14 billion wild juveniles would be calculated by assuming (1) 350 million adult salmon harvested (an observed historic level), (2) 50 percent of total adults harvested, and (3) 5 percent smolt-to-adult survival.

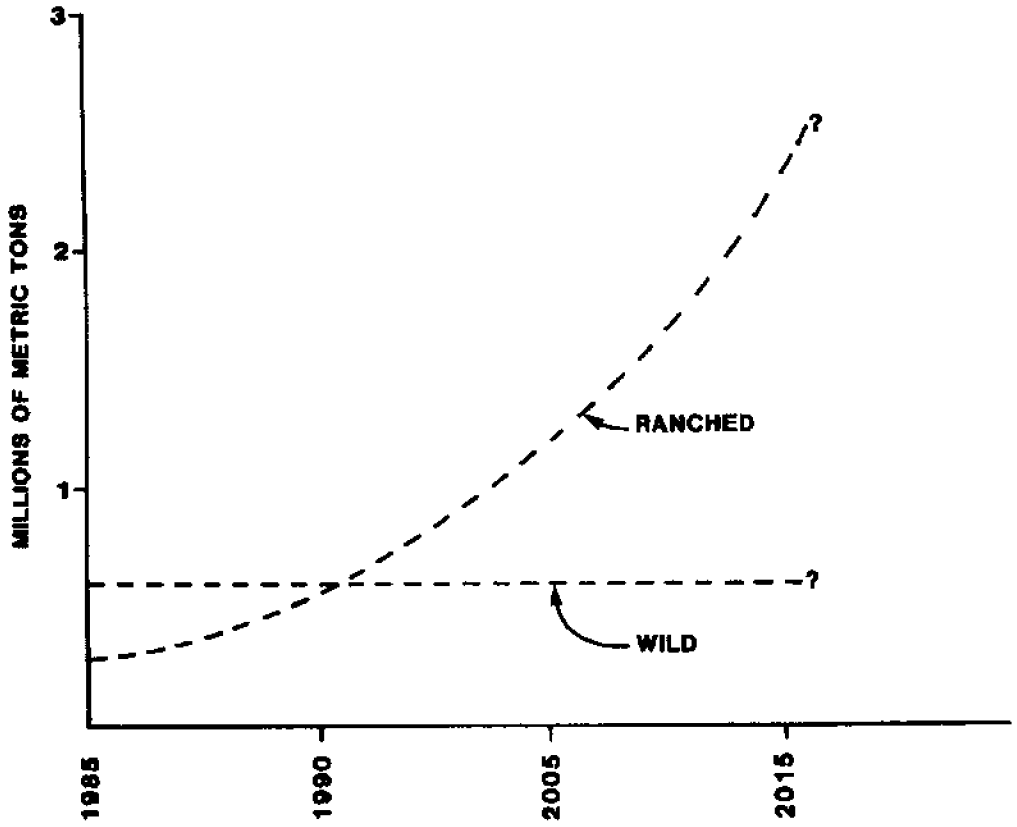


Figure 2. Projected trends in the harvest of wild and ranched salmon from the north Pacific Ocean.

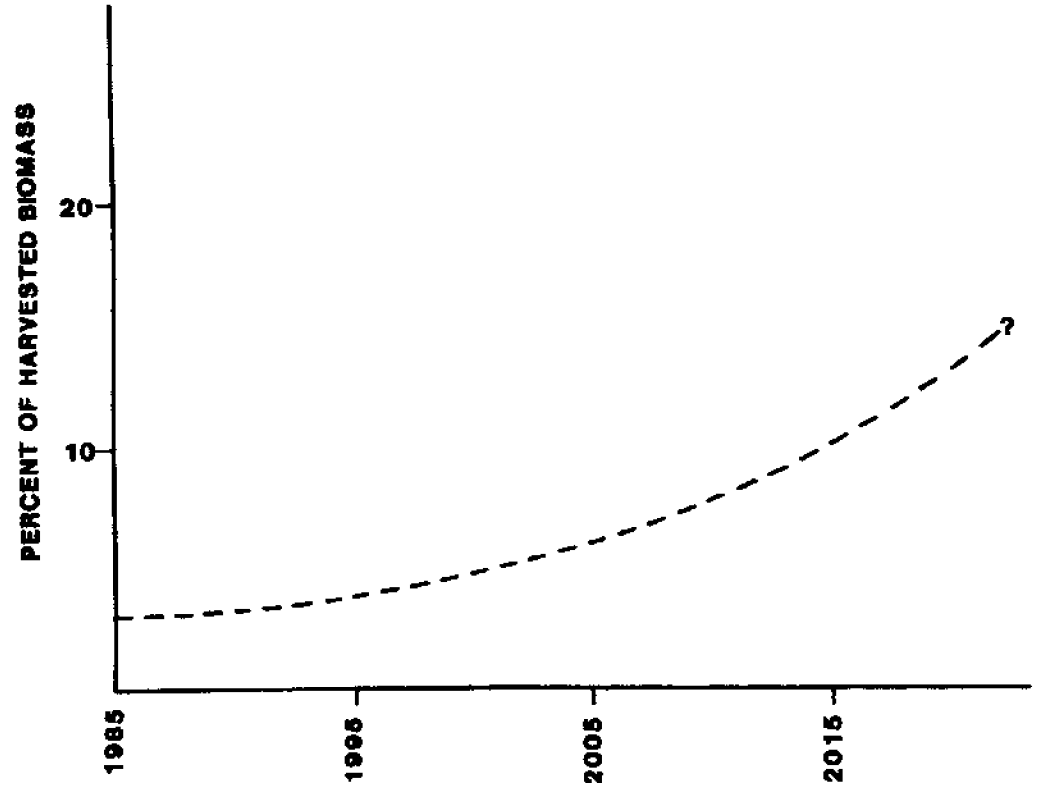


Figure 3. Projected proportion of salmon in total biomass of fish and shellfish harvested from the north Pacific Ocean.

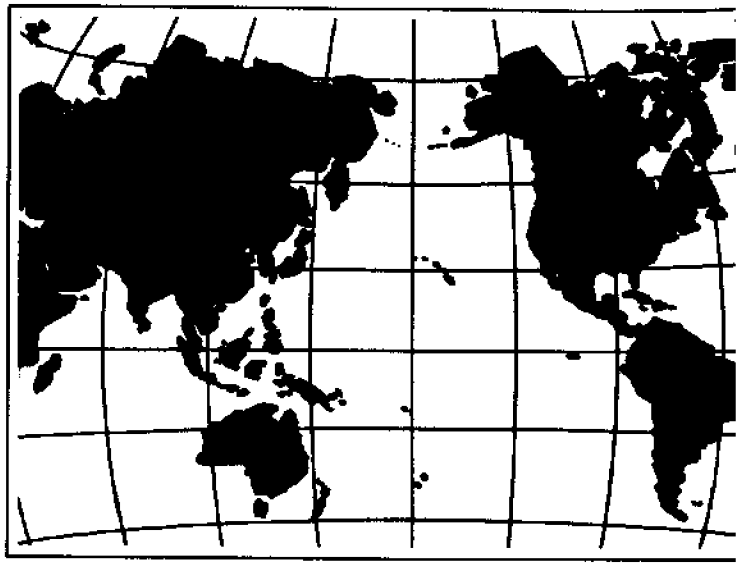
a point where intensive industrial ranching of the north Pacific with salmon will significantly reduce the production of other species which may compete with salmon for forage or become forage for salmon? Will the abundance of salmon be self-regulating through density-dependent mechanisms that limit the growth and survival of salmon? Or will new technology enable us to circumvent these and other limitations?

Some Conclusions and Implications for the Future

Aquaculture has recently entered a phase of rapid industrial- scale growth following centuries of little growth. The transition from hunting to husbandry in aquatic ecosystems is currently proceeding at a rate where aquaculture should dominate hunting fisheries sometime in the first half of the twenty-first century. Aquatic ecosystems will increasingly be controlled and intensively managed for food production, as terrestrial ecosystems have been. This seems especially inevitable if the world's population of humans continues to grow in the foreseeable future and if living standards should improve, especially in developing countries. It is becoming more and more evident that salmon and other seafoods provide dietary benefits, and per capita demand for seafoods is likely to increase. Economic incentives to increase production of food from aquatic ecosystems are expected to remain strong under any projected scenario of human population growth and living standard.

Aquaculture is an ancient human activity which dates back thousands of years; but in terms of contemporary societies, aquaculture is an emerging industry. Significant changes in institutional infrastructures for aquaculture are anticipated along with technological changes in the way people manage and develop food production from aquatic ecosystems as large as oceanic basins. The emergence of salmon ranching in the north Pacific is one early, but important, example of changing trends in the way we are is likely to turn increasingly to technology to intensively manage aquatic ecosystems for production of food in the twenty-first century.

Marine Products



Drug Discoveries from Marine Organisms

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To date, only a fraction of the some one million species of plants, animals, and microorganisms from the world's oceans have been examined for their potential uses in medicine or agriculture (1, 2) (see figure 1). The incredible diversity of marine organisms represents an irreplaceable "storehouse" of new chemical ideas. Several very important and valuable chemicals currently come from marine organisms. In these times of drug-resistant pathogens and newly emerging diseases, we need new drugs of novel chemical structure and pharmacological action. We can expect an even larger array of useful products with the application of new biotechnologies using marine organisms in the twenty-first century.

However, future efforts to use the world's marine biota are threatened in three ways: (1) the decline in support for the traditional natural sciences, especially systematics; (2) the destruction of species-rich marine habitats; and (3) the lack of cooperation between industry and universities. First, I will give a few examples of how drugs from the sea currently contribute to medicine and agriculture. Next, I will describe likely developments in the next decade. Finally, I will give my vision for discoveries in the next century.

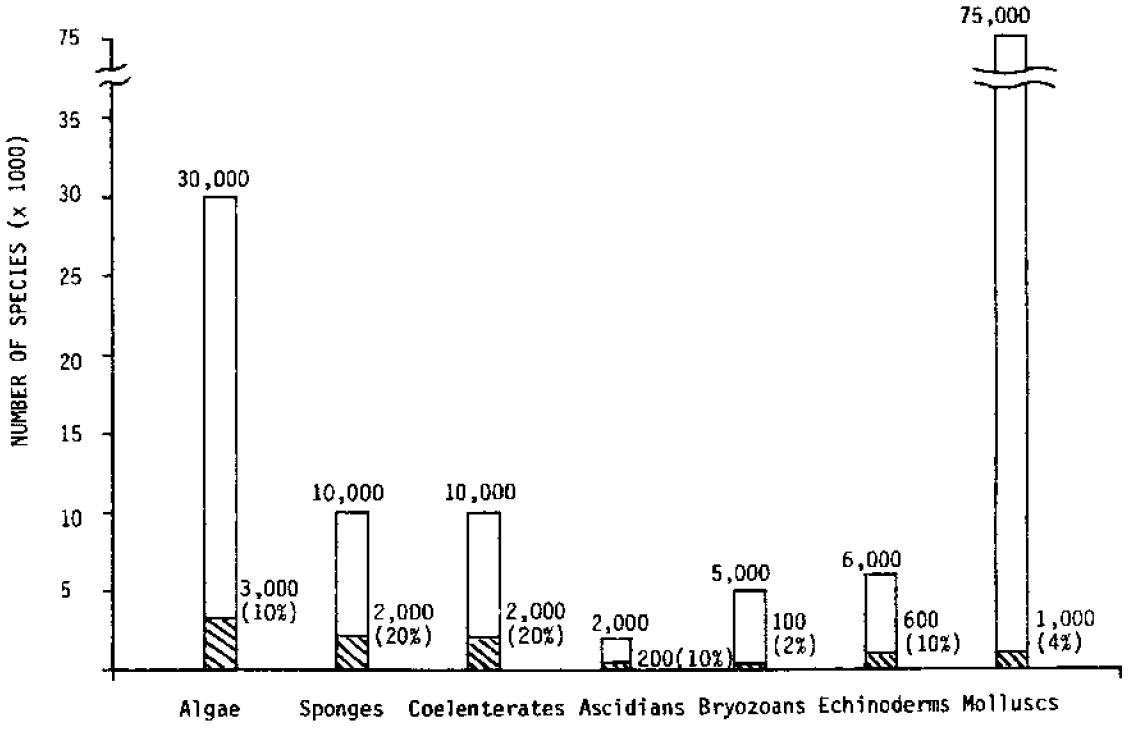

Figure 1. Estimated percentages of marine species worldwide that have been investigated to date for potential biomedicinal agents (1, 2, and 23).

Drugs From The Sea To Date

At present, the sea is a valuable source of several pharmaceuticals and agrichemicals (3). The anticancer drug cytarabine, or Ara-C (1), which is used in combination with other agents to treat leukemia, owes its development to accidental discoveries made by Werner Bergmann about a Caribbean sponge in the 1950s (4) (figure 2). In Japan, the $200 million per year commercial insecticide Padan owes its origin to a molecule isolated from the marine bait worm, *Lumbriconereis heteropoda* (5). Japanese fishermen have long known that chemicals given off by these worms kill insects that happen to land on them. In the 1950s, chemists isolated and identified a simple sulfur heterocycle, nereistoxin (2), as the active insecticide in the worm (figure 3).

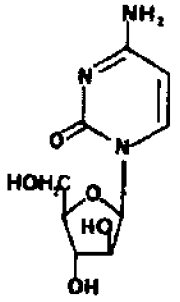

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Figure 2. Structure of cytarabine (1), a synthetic anticancer drug patterned after a sponge metabolite.

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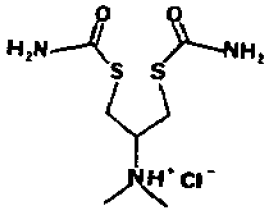

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Figure 3. Structures of nereistoxin (2), an insecticidal natural product from a Japanese marine worm, and Padan (3) a commercial insecticide developed by the synthesis of nereistoxin-like molecules.

Chemical synthesis of this and analogous molecules ultimately led to the production of Padan (3). A third example comes from a sewage outfall on the coast of Sardinia, where the fungus *Cephalosporium acremonium* was first isolated and cultured. This fungus yielded the very important class of antibiotics known as the cephalosporins (6).

The Rinehart group in 1981 isolated another potential anticancer agent from the marine tunicate, *Trididemnum* sp. (4) (figure 4). It shows antiviral, anticancer, and immunosuppressive activities (7). The National Cancer Institute is developing this agent, which in clinical trials successfully treated colorectal cancer (8).

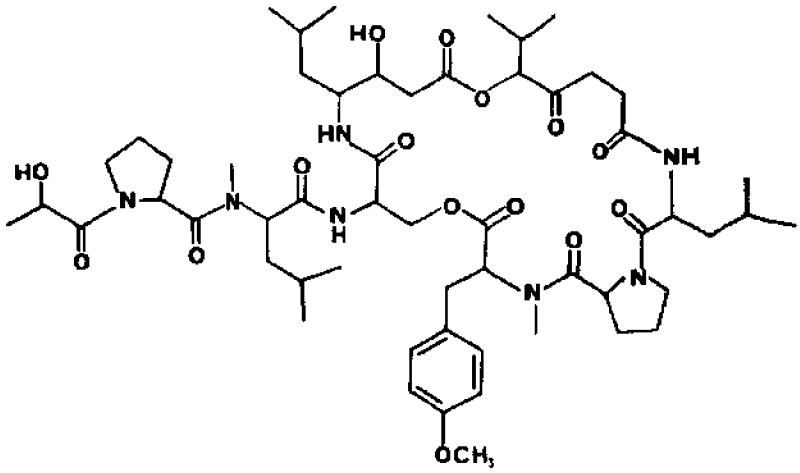

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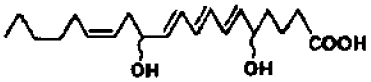
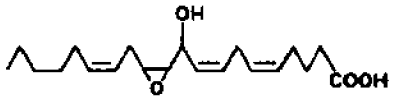
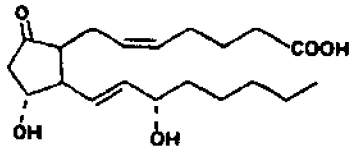
Figure 4. Didemnin B (4) is a complex peptide natural product from a Caribbean "Sea Squirt" or "Tunicate," which is showing promise in early clinical trials for the treatment of colorectal cancer.

Another new product, fish oil (eicosapentaenoic acid), shows potential for reducing the risk of heart disease. The first indication of potential health benefits from fish oil came with the recognition that Greenland Eskimos have a much decreased risk of coronary heart disease (9). A long-term epidemiological study in Denmark substantiated the value of fish oil, and fish oil is now a popular dietary supplement (10). Clinical studies show that diets rich in fish oils decrease serum cholesterol and triglycerides by altering the composition of blood lipids (11). Physicians call for fish oil supplementation only in the treatment of abnormalities in lipid metabolism (hyperlipidemias), because other metabolic problems can develop.

Recent work with marine algae gives some clues about how fish oils bring about these health benefits. Red algae metabolize fats in ways directly analogous to how humans do, and this leads to the production of an important class of hormones known as "icosanoids" (12-15). Icosanoids (table 1) are collectively responsible for the symptoms and underlying causes of such diverse processes as inflammation, allergy, asthma, coronary heart disease, athero-

sclerosis, and even some cancers. The algae are a very rich source of these valuable biochemicals, and their increased availability from these life forms may aid in developing a clearer understanding of their physiological roles in the human body.

Table 1. Mammalian icosanoids isolated from seaweeds to date, their physiological properties in humans and their approximate market values (24, 25).

STRUCTURE	NAME	PHYSIOLOGICAL PROPERTIES	VALUE
	12-(S)-HETE	Chemotactic for PMNL's Antiproliferative	$3000-4000/mg
	12-(S)-HEPE	Chemotactic, Inhibitory to Platelet Aggregation	$3000-4000/mg
	6-trans-LTB_4	Chemotactic to PMNL's	$2000/mg
	Hepoxillin B_3	Insulin Release from Pancreas	$2000-3000/mg
	PGE_2	Smooth Muscle Contraction Immunomodulating	$20/mg

The ocean's marine flora are a valuable source of gelling agents, including agar and carrageenan from species of red algae and alginic acid from brown algae. These marine biopolymers have diverse applications in microbiological gels and media, ice cream and shampoo thickeners, foam stabilizers in beer, emulsifiers, laxatives, and even as a component of antacid formulations (16, 17). Supplying the raw material for these biopolymers supports an important cottage industry in developing maritime nations of the Pacific. Biotechnological advances have stimulated efforts to culture certain of these plants at such places as Oregon State University, the University of Washington, the University of Hawaii, Israel, and elsewhere. Some of these efforts are part of larger programs aimed at employing waste nutrients from fish or poultry growing and processing to enhance the growth rates of these cultivated seaweeds.

The Next Decade—1990-2000

In the next decade, we can expect the development of 5 to 10 new and clinically useful drugs. Most will be used for the treatment of cancer and viral diseases; for the improvement of cardiac functions; and as antibiotic, anti-inflammatory, and serum-lipid-lowering agents.

Agrichemical research is currently centered on the discovery of new herbicides and insecticides, and we can expect new marine-derived products here as well. While the discovery and development of new drugs will be initiated as a result of work with natural substances, the compounds actually used will probably be of synthetic origin, but patterned after the natural product, as is the case of the insecticide Padan. Cultivation of the source organisms for most of these discoveries is limited by the lack

of a biological, in some cases even taxonomic, understanding of them.

Of equal significance, roughly 10 to 20 useful pharmacological probes of various biochemical systems will be developed in the next 10 years. In fact, several are in the preliminary stages of development (18). These chemicals will command a very high price in a limited research market. Some will have clinical utility for diagnostics. Pharmacologists will use these probes to learn about biochemical pathways and, hence, the molecular mechanisms of disease and drug action. A classic example of this comes from the Japanese seaweed *Digenia simplex*, or in Japanese, "kainos" (19). This seaweed had been used for centuries to eliminate intestinal worms. Some years ago, Japanese chemists isolated the active principal, "kainic acid" (5) (figure 5). Kainic acid is unique in its selective action at the glutamate receptor

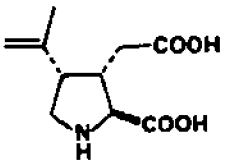


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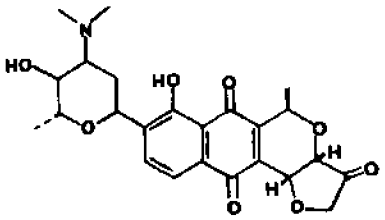
Figure 5. Kainic acid (5) is the active anthelminthic principal in a Japanese red algae which has a long history of use for its deworming properties. The pure substance is invaluable in neuropharmacological studies as a molecular probe.

and is a standard tool of modern studies of the nervous system. Much of our understanding of nerve conduction and drug effects comes from work with kainic acid, and this has provided valuable insights into various disease states.

Another exciting area of development to be anticipated in the next decade is the application of recombinant DNA technologies to marine-derived substances. The current state of the art allows the production of so-called "hybrid antibiotics," but only from the best understood microorganisms (figure 6). Hybrid antibiotics combine structural units of two distinct antibiotic molecules with resulting new activities and specificities. An example is given by the recent and very elegant work of Floss et. al. at the University of Washington in which features of two antibiotics, medermycin (6) and actinorhodin (7), are combined by the microorganism *Streptomyces* sp. (20) into a single molecule, mederrhodin A (8). In the next decade, we will see application of recombinant DNA techniques to some of the simpler and best studied of marine microorganisms, such as the blue-green algae (cyanobacteria).

Finally, in the next decade we will see some progress made towards understanding the how, what, where, when, and why of secondary metabolite production in select groups of marine organisms. This progress will occur only in those groups of organisms for which there is sufficient economic motivation, that is, those in which useful chemicals are found in abundance. The answers to the above questions will also be further limited to those promising organisms for which adequate biological understanding exists. In some groups, such as the sponges, bryozoans, and tunicates, many years of basic biological study will precede further advances.



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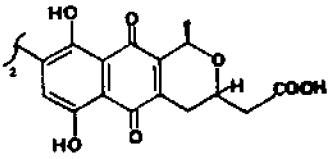

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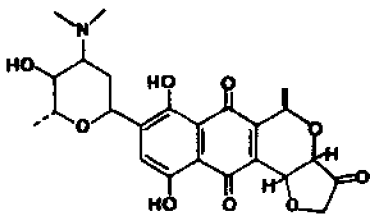

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Figure 6. Mederrhodin A (8) is produced by a genetically engineered microorganism and is an example of a "hybrid antibiotic." Features of two naturally occurring antibiotics, medermycin (6) and antinorhodin (7), have been incorporated into its structure by recombinant DNA techniques.

The Next Century—2000-2100

What technological developments and societal forces will guide and shape efforts in the next century? Where will the challenges, pitfalls, and potential shortcomings occur?

First, we can look forward to tremendous successes in the actual discovery of useful drugs and agrichemicals from marine organisms. This prediction comes from the current and projected level of effort in this field, the number of emerging successes, and the number of unexplored marine species and habitats (table 1). Advances in the techniques for the isolation and determination of molecular structure will make these processes routine. "Intelligent" machines may completely automate the process. As a result, the emphasis for chemists in this field will become increasingly focussed on molecular biology. Among other things, these techniques will be applied to the study of how new compounds interact with receptors to elicit biological responses on a molecular level, and will be directed towards understanding phenomena relevant to medicine, agriculture, and ecology.

The need for new drugs in the next century will come from our recognition of the complexity of cancer diseases, the emergence of new viral diseases, and the continued development of resistant strains of pathogenic microorganisms. Further, greater contact between peoples in developed countries and those in underdeveloped ones will call for the production of drugs to fight what the World Health Organization calls the "great untreated diseases"—malaria, schistosomiasis, river blindness, and elephantiasis. These diseases collectively afflict nearly a billion people worldwide and cause incalculable suffering and loss of life. The absence of drug development programs aimed at treating these diseases remains one of the most abhorrent omissions of the modern world. Some treatments to correct this in the twenty-first century will come from the marine environment. Indeed, it is hoped that recent advances in the drug treatment of river blindness (avermectin, Merck, Sharpe, and Dohme) herald future progress in the treatment of these other diseases as well (21).

The most pressing scientific need relative to drug discovery in the next century is improved economic support for the basic field of systematics—understanding the taxonomic classification of organisms (1). While our understanding of molecular biology has been a boon to science in general, an unfortunate consequence has been to make traditional scientific pursuits, such as systematics, less desirable and poorly supported. The reason is principally economic. Reallocation of positions in science towards individuals pursuing molecular biology leaves fewer practicing systematists, fewer students entering these fields, and fewer positions for newly graduating systematists. Part of the reason for this reallocation is that federal funds for molecular biological research are relatively plentiful whereas funds are virtually absent for taxonomic research. Consequently, individuals entering systematics find it difficult to advance in their careers. Throughout the world's universities, positions traditionally slotted for systematists and natural historians are being filled by individuals with molecular biology interests. This is a snowballing situation which ultimately leads to natural product chemists identifying complex molecular structures and recombinant DNA biochemists cloning genes from taxonomically unidentifiable organisms.

Without firm taxonomic assignments the value of these findings is lost as the discoveries become virtually nonrepeatable. Currently, a substantial proportion of the source organisms for newly isolated marine products are described only to the genus level. Some are even reported as coming from an "unidentified" sponge, tunicate, or related type of organism. Further, while the determination of the molecular structure from a sponge can in some cases take a year, getting a firm taxonomic identification from one of the world's 16 sponge taxonomists can take three to five years. With the current negative economic incentives, we can expect the situation to worsen. The time to reverse this trend is now while there are still trained taxonomists to teach a new cohort of young systematists.

Second, recombinant DNA technologies make every species, each with its unique DNA encoded gene bank, of incalculable potential value to humankind. Methodologies of the next century will be able to extract any desired gene from the DNA content of any organism. Procedures will allow insertion of this gene into an easily grown and controlled microorganism and will produce the desired gene product in commercial quantities. With this technology, maintenance of a large and diversified planetary gene pool is essential. A "self-preservation" attitude towards maintenance of the planetary gene pool will, it is hoped, provide the motivation for a redoubling of efforts to reduce the extinction rate of species.

Despite impressive advances in molecular biology and chemistry in the latter half of this century, our understanding of the basic natural history and biology of marine organisms is very limited. We know even less of their ecology. The potential for the unwitting destruction of many species is enormous. This is particularly true in tropical reef systems where species diversity is greatest. The development of oil port facilities in underdeveloped tropical maritime countries, such as in the South Pacific, has been viewed by many as unwise due to the profound consequences of a catastrophic event (for example, a ship grounding). In the twenty-first century, we must be prepared to adopt an attitude towards the protection of marine species that is similar to that being developed towards species in tropical rain forests (22). Such an attitude will require greater understanding of the basic biological, taxonomic, and ecological features of organisms and is a prelude to enacting sound environmental legislation. We must be prepared to support research into these areas of basic science while recognizing that these efforts will not necessarily have a short-term application and economic payoff.

Finally, successes resulting from marine drug discoveries will need to be translated into actual commercial products and will require increased levels of interaction between academic science and industry. Several problems exist in this interaction at present and these must be dealt with for efficient technological transfer to occur in the twenty-first century.

The development of a new drug, from the time of initial discovery, through description of pharmacological properties and dosage forms, to long-term toxicological studies, takes an estimated 10 years and up to 100 million dollars. Current patent laws are archaic and need revision, particularly in the area of the 17-year patent lifetime. The long development period markedly reduces the time of effective patent protection. For this reason, drug companies delay application for patents for as long as possible. This means that initial efforts must be carried out in complete secrecy. Such an attitude is at complete odds with the objective of academic research which requires active communication and publication for advances. Extending patent lifetimes to perhaps 25 or 30 years would help obviate industry motivation to work in secrecy.

Currently, academic research into drug discovery is supported by grants from the public domain. Once a discovery is made, support can be obtained from industry through licensing fees and patent royalties. Industrial support comes after the fact. As successes from the marine environment mount in the coming decades, we should see an increase in basic research support of these academic efforts by industry. We need to develop new mechanisms for industry financing, mechanisms which provide early support but still allow freedom and flexibility in research direction normally associated with academic efforts. It will be a serious problem if universities cannot continue basic research and become "contract research institutions" as the result of too great an emphasis on dollars available for applied research.

Conclusion

The marine environment, with its incredible diversity of chemically rich organisms, will be an important source of new drugs, agrichemicals, and molecular pharmacological probes in the coming century. As techniques continue to develop for the manipulation of genetics of marine life forms, we will begin to tap a new potential inherent in this biological diversity. We must fully recognize the consequences of current actions which decrease species richness. Furthermore, in the next century, our ability to accurately identify the organisms we work with will be severely compromised unless talented individuals are encouraged to enter the fields of natural history and systematics. Transfer of technology from academic drug discovery programs to industry in the next century requires improved interactions between these counterparts, including recognition of the important contributions of the basic biological and chemical sciences to drug development and updated patent legislation.

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Seafood Processing and the Engineer

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Sea-fresh Condition

It was a time of some excitement for the seafood industry, which had been handed a series of breakthroughs that appeared to solve its fish-quality problems once and for all. New equipment, invented by a young engineer named Kolbe and some others, was producing good-looking, quick-frozen products. It also solved what one article described as "the economic problem of glut and scarcity" (1). Another article touted the new "frosted fillets" that the Birdseye plant was cranking out (2). These "were capable of traveling thousands of miles inland without danger of spoilage." "Ice fillets" described in a third article "will serve to demonstrate the fallacious nature of the old idea that all frozen fish is inferior fish . . . . By virtue of this method of processing and handling marine products, lovers of seafood in inland Canada should soon be able to obtain all kinds of fish in their original, sea-fresh condition" (3). And, as described in a fourth report: "The placard—'COLD STORAGE GOODS SOLD HERE'—is no longer necessarily a sign of a market where fish of doubtful quality are sold" (4).

These articles did not appear in the latest issue of *Frozen and Chilled Foods* or *Seafood Leader*. They appeared in a 1930 issue of *Food Industries Journal*. Unfortunately, 60 years after Robert Kolbe and Clarence Birdseye applied their new freezing systems to fish, our success in finding high quality at the restaurant or grocery store remains a hit and miss proposition at best. What happened?

"What happened" relates to how this new system of seafood preservation, packaging, storage, and marketing was developed and used. A full and successful development of such a new technology requires long-term, sustained coordination of effort among engineers, scientists, industry, and public institutions in an environment whose barriers to change are ready to budge. It is similar in that respect to other past and present multidimensional seafood processes: the manufacture of surimi and its analog cousins; the production of fish protein concentrates; aquaculture and the supply of fresh (unfrozen) salmon; fish oil production and utilization. An engineer tends to define the problems and their solutions in terms of mechanisms, methods, and productivity; a food scientist in terms of biochemical and microbiological changes and their influencing factors; an economist in terms of profits in relation to international prices and consumer behavior.

But this is an article about engineering and its support of seafood process development. In the following sections, we suggest conditions under which engineers can better help to develop new seafood processes and solve old but continuing problems.

A Systems Approach

"Systems approach" is a term that was used often in the 1960s. It describes the many complex interactions of tasks and machines that, among other accomplishments, put a man on the moon. A more recent expression, however, might also sound familiar: "If we can put a man on the moon, why can't we . . . . (fill in the blank)?"

Apply these notions to the fish business. A process that will enable us to find consistently tasty, nutritious, reasonably priced fish at the grocery store requires a systems approach. Each contributor must have an understanding of the capability and role of the many contributors who are indispensable to the full development of such a process. We must prepare engineers (and others for that matter) first, to be technically competent and, second, to solve problems in close cooperation with colleagues in science and other disciplines.

In the marketplace today, we can find high-quality frozen seafood, the production of which, we would argue, results from a coordinated interplay of disciplines. The United Kingdom's freezer-trawler program of the 1950s and 1960s was just such an effort. The manufacture of products of high quality from North Atlantic whitefish, frozen at sea and processed at home, required a coordinated development by engineers, food scientists, economists, fishermen, processors, cold storage operators, truckers,

and retailers, among many others. The process was successful—at least until the environment changed. That was when all countries took control of their 200-mile fishery zones, effectively shutting others out of traditional resources.

High-quality frozen seafood can be found in the U.S. industry as well. That is, for certain species and markets in which biochemical change mechanisms are understood and controlled, suppliers are steady and are compensated for product care, handling is well managed, and consumers and retailers are aware of the need for proper care and preparation. The recent effort to develop the flatfish industry in Alaska appears to be one example where a coordination of disciplines with funding from both industry and public agencies is heading toward success.

The production, distribution, and retail system breaks down if one component doesn't function or focus on the common goal—if the fisheries managers forget about seasons and schedules that influence quality; if the fisherman is not compensated for taking known measures to ensure the quality of the landed product; if the design and management of the cold storage rooms are not properly understood or implemented; if the fish market operator neglects to control the temperature or product turnover in the display case. These system components must be understood and controlled in light of various environmental influences or constraints to produce consistently high-quality products.

Resources

Research, technology development, and design which lead to new seafood processes are costly, particularly so where engineering considerations, equipment development, pilot plant trials, or process scaleup, are involved. And, depending on the degree of risk or the size of a private company's budget, public funds and resources often play a key role. An example is the manufacture of surimi in the United States—not the outcome of a large food company's R&D program but the result of long-term government and university research, technology transfer (largely from Japan), and public and industry funding. It resulted from some clever contributions and hard work (both of which continue today) from individuals in all sectors—private industry, the federal government, and universities.

Surimi is washed, minced, fish protein to which preserving agents have been added to maintain its quality in frozen storage. When later thawed, mixed with salt, and heated, it gels into a firm material from which various analogs (for example, crab, shrimp, or scallops) are manufactured. In the early 1970s, the National Marine Fisheries Service reviewed and described surimi, a traditional Japanese process, which developed on a large scale after 1960 (5). It was about 1980, however, before a small Alabama company produced surimi from croaker in a project supported in part by Saltonstall-Kennedy (SK) funds and by some research at North Carolina State University (6). In 1983, the Alaska Fisheries Development Foundation (AFDF) committed its entire allotment of SK funds to a multi-year project seeking to demonstrate that surimi could be successfully produced onshore from Alaska pollock. This effort, under the energetic coordination of AFDF, hinged on effective contributions of resources from industry, government, and universities. While some may argue that all components of the project didn't mesh as nicely as they could have, the venture was enormously successful. At the end of 1988 there were four shore-based surimi production plants and ten surimi factory ships operating in Alaska; projections are that Alaska surimi productions will reach 100,000 metric tones in 1989 (7).

This demonstration project, which lasted five years, leads us to recognize three "corollaries" to the present argument that seafood process development takes money. The first is that it takes time. Industry, in requesting assistance from engineers and scientists for new process development, must understand that often, proven results will evolve in months or years. On the other hand, engineers and scientists, particularly those in public institutions, must understand that industry decisions are often scaled to weeks or to a single season.

The second corollary is that "success" for the various disciplines is often measured with different yardsticks. Engineers and scientists in public institutions are often reviewed and rewarded in relation to their publication record. Industry "success" appears at the bottom of the profit-and-loss statement and may even require that detailed publications be avoided. Effective collaborative projects will require an agreement up front to resolve this dichotomy.

The third corollary relates to economic viability. Would Alaska surimi production have taken off during the days when energy costs

were high? when Alaska King crab was abundant? before the 200-mile limit was established? before U.S. fishermen developed midwater trawling skills and gear during the "joint venture" operations? before the U.S. public began to develop a taste for "artificial crab"? What engineers might have found unfeasible in 1960 could be feasible today. Processes must be reviewed again and again as the "environment" changes. What is the current profitability in view of changes in energy costs, consumer value judgments, international exchange rates, the prices of competitive products (like soya and fishmeal), the status of international trade agreements, and subsidy programs?

Continuity

One wonders how many wheels have been reinvented during the last 60 years of quick-frozen seafood technology development. Engineering contributions to seafood processing in the near future will depend less on "gee whiz" inventions than on sound, long-term design, development, and technology transfer. A good example of this is the ongoing Americanization of surimi—a continual redesign and optimization of various steps in the traditional Japanese process. Good progress over the next 20 years or so, most notably in the lesser developed countries, will depend largely on increased application of the more basic "best present practices" rather than "advanced" methods not yet introduced widely or yet to be developed.

Such an approach, however, requires not only innovation but also people whose judgment and actions are based on knowledge, experience, and access to information. Engineers, if they are to have a feel for seafood science and technology and an appreciation of the interaction between essential disciplines, must be able to depend on a stable, continuous environment. The organization needed for this could be housed in the public or private sector. But it must provide stable funding; welcome and cultivate a continuing influx of young engineering and food science colleagues; operate without connection to others whose mission is surveillance and regulation; maintain a technology library of international dimension; encourage and support professional development; and recognize and reward interdisciplinary research, extension activity, and industrial success.

We once had organizations like that. Their contributions brought vast improvements to the seafood industry, particularly during the years 1950-1970 (8). The old U.S. Bureau of Commercial Fisheries (later, the National Marine Fisheries Service) contributed much to the technology of seafood catching and processing. The United Kingdom's Torry Research Station was internationally acclaimed for its work on freezing at sea, drying, smoking, cold storage, and other processes. Refrigerated seawater (RSW) systems, developed for the onboard refrigeration of large volumes of fish, resulted from the sustained effort of government engineers and scientists working with industry through the Canadian Federal Fisheries Laboratory in Vancouver, B.C. (9). Sea Grant engineering effort at universities such as Oregon State has carried this work on RSW and slush ice (chilled seawater) to the U.S. industry through extension and demonstration programs.

And where are we today? The National Marine Fisheries Service gear programs have virtually disappeared; fish utilization programs are a fraction of what they were at one time, now involving a diminishing number of people working with an even more rapidly diminishing budget. The Torry Research Station has lost many of its personnel, operating today at a level which is roughly half that of 1968. The federal Canadian laboratory in Vancouver closed about seven years ago; so did the Atlantic lab in Halifax. And the U.S. National Sea Grant Program has been slated for elimination from the federal budget for the last eight years.

A few emerging organizations have included programs to carry on seafood process development in North America. One is the Fishery Industrial Technology Center (at the University of Alaska in Kodiak); another is the Canadian Institute of Fisheries Technology (located at the Technical University of Nova Scotia in Halifax). Both are committed to close association with the industrial sector; both are struggling to secure funds, facilities, and continuity. Without commitment from government and industrial funding sources, seafood process development will be a matter of "boom and bust," with emphasis on the latter. Without continuity, activity and facilities cannot be sustained, expertise cannot be regenerated, costly duplication and wheel re-inventing cannot be avoided.

The Future

Overriding Issues

Some of the conditions essential to the success of seafood process engineering are outlined above. And if these conditions are met, what

then? What are some important issues that need to be addressed in the next 20 years? A few have overriding importance; their solutions will require worldwide technological and political teamwork if they can be found at all. One, of course, is pollution of our oceans; another is pollution and attendant global changes in the environment. Assuming progress in these areas, as we must, we'll conclude this article with a few more specific needs in which engineers can play a major role.

High-Quality Frozen Fish

Air shipment and improved retail procedures have given us access to some high-quality unfrozen products in the marketplace. But neither Ronald McDonald nor Mrs. Paul will care to wait around until the weather clears and the boats get out. The production of consistently high-quality frozen seafood will remain an important mission. The commercial cold store, the retail market, and the home continue to be notorious stations where product abuse occurs. We must be able to place a value on quality loss, to manipulate those factors of temperature, treatment, or packaging to control this loss, and then to educate the users and consumers who, in fact, have the ultimate control.

Energy Efficiency

We haven't waited in gasoline lines for some time. The Department of Energy meanwhile assures us that the "Strategic Petroleum Reserve" will give this nation a 90-day supply in case of total interruption (10). Ninety days! Politics, growth, and the inevitable resource depletion will return the energy issue to the top of the agenda, certainly within the next 20 years.

What will this do to the seafood processing industry? Lorentzen has shown that, if energy efficiency were the sole criterion, we would put all of our effort into industrial fishing and the manufacture of by-products, notably fish meal (11). The consumer views fish as food, however, not energy! The engineer will continue to address issues of productivity and efficiency in existing processes to ensure the supply of products of high quality. But the engineer must also analyze and identify options for industry and public decision makers. Fishing methods, processing options, and the role and direction of aquaculture must be continually evaluated in light of changing environmental and economic factors.

Waste Utilization

Productivity means, in part, decreasing waste. It can also mean using waste for a product of some value. The anticipated full U.S. utilization of the Pacific whiting resource off the U.S. West Coast is a case in point. Something on the order of 175,000 metric tons are available for annual harvest (12); of that, around 130,000 metric tons are "waste," or, to give it a more rational term, "by-product potential." The engineer has an important role in the design, analysis, and application of processes to use this potential. Fish meal or silage for animal or aquaculture feeds, protein concentrates for human nutrition, and oils and other components all involve processes to be reviewed, applied, optimized.

Nonfrozen Options

The public interest in seafood products of all kinds has risen dramatically in the past few years. After staying for years at 12 pounds, U.S. per capita annual consumption has recently increased to 15 and is expected to reach 20 by 1991 (13). Nutritional value is seen as a significant factor. The engineer must continue to review and develop new seafood preservation and processing operations that will provide high-quality, highly nutritive, valued products to the consumer. Refrigeration, icing, and chilling will continue to play a major role. These and other means of preservation must be developed continually for application in both developed and "developing" areas of the world. Packaging and retortable products; blanching, cooking, and preprocessing of fish portions; drying; and other methods of handling and processing are important areas for continued study and education.

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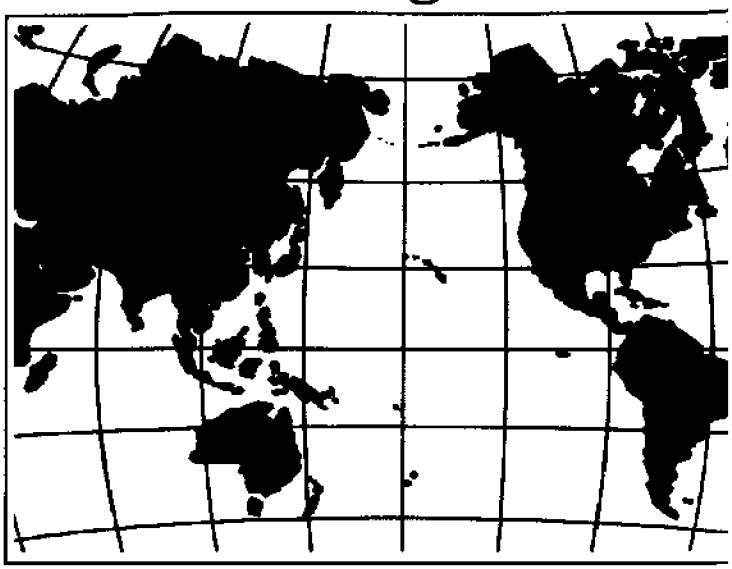
Coastal Management



The Oregon Coast in the Twenty-First Century: A Need for Wise Management

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Introduction

European exploration of the Pacific Northwest coast began in the sixteenth century with the Spanish sailing along our shores. However, permanent settlement did not take place to a significant degree until the past 100 years. For example, attention was first drawn to Yaquina Bay in 1852 when the schooner *Juliet* was wrecked on the nearby ocean shore (1). Subsequent attempts at rescue dramatized the potential for the bay as a harbor. However, settlers were slow in coming to the area, so it was not until 1875 that the first plat was filed for the city of Newport, covering a small area along the water front of Yaquina Bay (the present-day "old town").

In those formative years, day-to-day activities centered on the bay. This was true all along the coast, not just in Newport. However, as early as the 1860s "summer people" were attracted to the coast, arriving either by boat or by wagon along muddy roads that crossed the Coast Range. As today, these tourists were drawn to the ocean beaches, and in those early years they set up tents and stayed for much of the summer. In the Newport area, this camping activity was centered at Nye Beach (figure 1). Completion of the railroad in 1885 between Corvallis and Yaquina City, with ferry service to Newport, greatly increased the number of summer people.

This growing interest in beach recreation inevitably led to the construction of permanent buildings along our ocean shores. The tents at Nye Beach gave way to cottages and cabins, and stores appeared to serve the growing community. In 1901 a bath house was built close to the beach, and the next year a sanitarium was constructed with facilities to provide hot seawater baths (1). And so went development all along the Oregon coast.

The processes of ocean-wave erosion were readily apparent in those early days of settlement. An interesting example was the progressive loss of the Jump-Off Joe promontory and sea arch. Located immediately north of Nye Beach, Jump-Off Joe was repeatedly photographed by tourists over the decades, yielding nearly a year-to-year documentation of its attack by ocean storms (figure 2). Such erosion processes were bound to conflict with the growing pressures to develop the lands adjacent to the beaches. Houses, hotels, and roads inevitably were lost to the waves of winter storms. Although coastal erosion is a natural process, it did not fit in with human plans, and accordingly became "a problem."

Our usual reaction to coastal erosion is to build some type of defense structure. On the Oregon coast this takes the form of seawalls or riprap revetments, a loose pile of rock armored by large stones. In recent years there has been an accelerated use of such structures, even in areas where there has been little or no erosion.

On the Oregon coast, we now have the perspective of a century of development and what it has brought us. This is a good time, therefore, to reflect on what our coast will be like in the twenty-first century. At this stage we have a much better understanding of the processes of coastal erosion than did the first settlers. Is it possible to use that information to make management decisions that might limit the impact of erosion on human activities along the coast? Are midcourse corrections needed or possible so that we can avoid the proliferation of seawalls, revetments, and other engineering structures found on so many other coastlines?

Morphology and Erosion of the Oregon Coast

One of the earliest, and still most dramatic, examples of erosion and property losses on the Oregon coast was that at Bayocean Spit, the sand peninsula which separates Tillamook Bay from the ocean. In 1906, the real-estate promoter T.B. Potter arrived from Kansas City and was impressed by the beauty of the Oregon coast. He vowed to develop the "Atlantic City of the Pacific Coast," which he subsequently named Bayocean Park. His vision was to lead to disaster, first in the economic problems of the development, and eventually in catastrophic erosion which led to its ultimate destruction (2, 3, 4).

Potter's plans included a natatorium that housed an indoor swimming pool with heated salt water and an oscillating paddle to create surf. Potter advertised lavishly, and lots sold well (some 2,200 at a gross income of more than $1 million [2]). Houses appeared on the spit, a few elegant in their designs and reflecting the wealth of some investors. Most houses were more modest, and there was also a "tent city." Something of a downtown came into being, including a grocery, a bakery, cafes, a rooming house, a hotel, and, of course, an agate shop. There were a sufficient number of year-round residents to require a one-room schoolhouse. The official grand opening of the development took place on June 22, 1912.

In 1911 Congress had approved the construction of a jetty at the north side of the entrance to Tillamook Bay. Work commenced in June 1914 and was completed in October 1917. This "improvement" in the bay entrance caused the destruction of Bayocean Park (2, 3, 4). Changes in the shoreline due to jetty construction were soon evident. Sand accumulated so fast to the north of the jetty that the shoreline moved out almost as rapidly as the jetty was lengthened. The impact on Bayocean Spit to the south was more gradual, and thus it is difficult to establish when erosion first appeared. The impact was extreme by the 1930s; a 1932 photograph reveals that waves were beginning to undermine the natatorium (figure 3). In January 1939, storms combined with high tides to cut temporary gaps through the narrow southerly portion of the spit. The last vestiges of the natatorium were destroyed, leaving only its foundations which could be seen on the beach at low tide (figure 3). Erosion continued through the 1940s with the progressive destruction of the remaining buildings of Bayocean Park. The climax came on November 13, 1952 when storm waves penetrated the already weakened sand spit and quickly cut away a 4000-foot-wide section. The remaining residents of Bayocean Park had to be evacuated by boat.

Similar shoreline changes occurred with the installation of other jetties on the Oregon coast. However, their construction took place early in the century, before extensive development of neighboring lands. Only in the case of Bayocean Park were houses and hotels (and a natatorium) in the path of the resulting erosion.

We now understand, in retrospect, the erosion problems experienced at Bayocean Park. They clearly were associated with the construction of the north jetty (4, 5). The explanation involves the geomorphology of the coast and the resulting movements of sand on the beaches. The Oregon coast is characterized by a series of large rocky headlands which isolate the stretches of beach. However long, the beaches act as pockets between the headlands. When waves reach the coast from the southwest, primarily during the winter, sand moves northward along the beach, but is blocked by a headland at its north end. Waves from the northwest, the summer waves, act to move sand back to the south. The overall effect is a balance such that the *net* sand drift is effectively zero, if averaged over many years. This pattern of reversing sand movements on our beaches explains the effects of jetty construction on the adjacent shorelines, and specifically the erosion of Bayocean Spit. When two jetties are constructed at an inlet, sand tends to accumulate immediately adjacent to the jetties, both to the north and south, so that the shorelines build seaward. That accumulating sand comes from erosion of the beach further away from the jetties, with a resulting retreat of the shore. This was the basic cause of the erosion at Bayocean Park, made more complex in that example by the construction of only a single jetty, one at the north side of the inlet. Sand did accumulate to the immediate north of that jetty, but in the absence of a south jetty, the shoreline there advanced only a short distance. Instead, the accumulating sand formed a shoal at the entrance to Tillamook Bay, and some of it was swept into the bay itself. That sand had been stripped off the beach further to the south, the beach fronting Bayocean Park. This loss of sand reduced the buffering action of the beach in dissipating ocean-wave energy, so that during winter storms the intensified wave swash was able to directly attack the development.

The erosion of Bayocean Spit provides an illustration of man-made developments in the form of jetties altering the natural equilibrium of the nearshore and inducing beach erosion. Although the final demise of Bayocean Park was a result of storm-wave erosion, human activities were the underlying cause. Sand spits are of course inherently susceptible to erosion. When Bayocean Spit was attacked by waves and nearshore currents, its foredunes offered minimal resistance. This susceptibility to erosion is true for all sand spits, irrespective of whether jetties have been constructed on a nearby inlet. Two examples are the erosion problems that have been experienced by home owners on Siletz and Alsea Spits.

The development of Siletz Spit began in the 1960s with the construction of a road along the spit's length and the placement of a number of homes on the foredunes immediately backing the beach. The first major erosion following development occurred during the winter of 1972-73 (6). Storm waves rapidly cut back the foredunes, undermining and destroying one home that was under construction (figure 4). Other houses were saved by the immediate placement of riprap, but erosion continued in adjacent empty lots that were left unprotected. This required that riprap also be placed along the sides of the houses, so that several of them ended up on promontories projecting into the surf zone (figure 4). In subsequent years, erosion of similar magnitude has repeatedly attacked the development (7, 8), and more riprap was placed to protect the growing number of houses. Today the spit has riprap boulders along most of its length (figure 5).

Other sand spits on the Oregon coast were seemingly stable. Alsea Spit had not suffered erosion for many years, and the houses placed on its foredunes seemed secure. However, the 1982-83 El Niño revised that situation when the combined storm waves and temporarily increased sea levels caused significant erosion (9). The lingering effects of that unusual El Niño are still being felt along the Oregon coast, particularly in erosion that is taking place on Netarts Spit where the surf has cut away large sections of Cape Lookout State Park (10).

In these examples of sand-spit erosion, the processes have largely been natural, those of waves and nearshore currents, with high tides and sea levels controlling the position of maximum attack. The role of people has mainly been one of responding to the erosion by constructing seawalls or riprap revetments. However, in the case of Siletz Spit, human activity did contribute directly to the erosion. Between 1965 and 1971, some 110,000 cubic yards of sand were mined from the beach south of the spit (6). That sand removal reduced the beach's ability to act as a buffer between the ocean waves and coastal properties. The operation was stopped by the state in 1971 when its role in augmenting the erosion of Siletz Spit was recognized. Although a contributing factor to the spit's erosion, sand mining cannot have played the primary role because an inspection of old aerial photographs revealed that Siletz Spit had undergone episodes of erosion before mining began in 1965 and before initiation of spit development.

Because of the rapid rate at which it takes place, sand-spit erosion has provided the most dramatic examples of property losses on the Oregon coast. However, the long-term and progressive erosion of sea cliffs threatens a greater number of properties. This is because most of our coastal communities are sited on the nearly level ground provided by marine terraces, former areas of seabed that have been raised by tectonic action. Wave erosion has cut into these terraces, leaving a bluff or high sea cliff, depending on its elevation. In some areas these cliffs are covered with vegetation, so their formation by erosion must have occurred in the distant past. Others are now retreating under continued wave attack. Their rates of retreat are highly variable along the coast, but over the long term average less than half a foot per year (11, 12, 13). Though small, the cumulative retreat now threatens homes in areas such as Lincoln City that were built many years ago (figure 6). Unfortunately, in recent years the practice has been to build motels and condominiums as close to the cliff edge as possible so as to provide an ocean view, immediately placing the structure in danger (figure 6). Relatively little is known about the processes of sea cliff erosion and the causes of its variations along the coast and with time at a specific site.

Abrupt landsliding has been a problem in some areas of sea cliffs (14). The best example of its impact on coastal development is found at Jump-Off Joe in the Nye Beach area of Newport (15). Landsliding there endangered structures as early as the 1920s, but the main activity occurred when a large slump developed over a period of months from late 1942 to spring 1943 (figure 7). At that time the slump affected 15 acres and 15 houses. A few homes rode the slump block down intact (figure 7) and remained occupied until 1966 by which time they were in danger of being undermined by wave erosion and continued slumping and so were intentionally burned.

With such a long history of problems at Jump-Off Joe, one might have expected that developers would be cautious. Unfortunately, this was not the case. In 1980 a local developer graded the down-drop block of the 1943 landslide in preparation for building 39 homes. A storm of protest arose from people living in the Nye Beach area, and several scientists pointed out the idiocy of building atop an unstable landslide. Before the planning commission could decide on that project, the developer suddenly shifted plans to one where condomini-

ums would be constructed on a small remnant of the marine terrace. The danger of that site was also pointed out to the developer and planning commission. It was dangerous because the small bit of terrace was positioned between two major landslides and had the highest rate of erosion on the Oregon coast. In spite of these warnings, approval for construction was granted and work was begun in March 1982 (figure 8). Each unit was to be sold for $250,000, but this was a time of high interest rates and a depressed real estate market. In December, before the interiors were completed, construction was halted. The developer had run out of money and was forced to file for bankruptcy. The contractor, a lumber company, and an insurance company that had insured the project against slippage were also forced into bankruptcy. By 1984, sloughing of the bluff had undermined the perimeter fence around the condominium and slumping had distorted the building to such a degree that the stressed windows shattered (figure 8). In January 1985 the city of Newport ordered the demolition of the structure, so that today only the foundation remains.

Perspectives on Present and Future Erosion

The examples cited above illustrate that erosion has been a problem on the Oregon coast, at least in the eyes of developers or people who have bought beachfront property. The examples may also have left the impression that erosion is extreme along much of our coast and that the construction of seawalls and revetments is warranted to prevent further losses. This is decidedly not the case. In spite of the unusual severity of storm-wave activity off the Northwest coast, beach and coastal-property losses are small in comparison to those of most U.S. shorelines.

There are two main factors that account for the lower erosion rates along the Oregon coast. One is the lack of net sand transport along the beaches. We have seen that jetty construction did cause the erosion of Bayocean Spit, but the patterns of shoreline changes actually represented only local readjustments. In general, the shoreline changes were limited to 10 to 15 years following jetty construction, after which the beach achieved a new equilibrium that accounted for the presence of the jetties. For this reason, jetties on the Oregon coast do not at present significantly affect the beaches and are not causing erosion. This situation contrasts with that in southern California and along much of the east coast of the U.S. where jetty construction acts like a dam that blocks a net longshore sand transport. In such a case sand accumulates on the up-drift side of the jetties, while erosion occurs along an extended length of beach in the down-drift direction. The overall impact is much greater and may continue indefinitely since the beach cannot effectively approach a new equilibrium configuration. On those U.S. shorelines, each year the Corps of Engineers has to pump or truck sand past the jetties so as to re-establish the natural sand movements. If there had been net sand movements along Oregon's beaches, erosion would have been a much greater problem.

The second factor important to limiting erosion of the Oregon coast is its tectonic rise relative to the level of the sea. The floor of the deep ocean west of Oregon is moving eastward toward the continent. Being denser, the ocean crust slides beneath the land. This convergence has slowly pushed Oregon upward, and the extent of the land mass has slowly grown westward. At the same time, the level of the sea has gone up and down due to cycles of growth and melting of continental glaciers. The combination of these processes has yielded stair cases of marine terraces along the coast. Each terrace represents an ancient sea bed, the oldest being the "top step." The last maximum advance of the glaciers occurred about 20,000 years ago, at which time sea level was more than 400 feet lower than now, and the Oregon shoreline was some 10 to 15 miles west of its present position. Except for temporary small reversals, the level of the sea has been rising since that time.

Estimates of average global sea-level rise over the past century, based on analyses of tide-gauge records, indicate that it has been approximately 8 inches in a century (2 millimeters a year) (16, 17, 18, 19). In spite of this relatively modest rate, the rising sea level in conjunction with tectonic subsidence has been extremely important in causing the progressive retreat of the land (erosion) along nearly the entire east and Gulf coasts of the U.S. On the Pacific Northwest coast, however, relative sea-level change at present is near zero (20), suggesting that tectonic uplift is currently keeping pace with increasing water levels. Thanks to our tectonic setting, the worldwide increase in sea level over the past century has not been a major factor in causing erosion along the Oregon coast.

Might any of these factors or processes involved in erosion change during the twenty-first century? The overall configuration of the coast will not be appreciably altered during that geologically short span of time, so that headlands will continue to isolate the beaches. The present condition, in which there is no net movement of sand along the shores, will therefore persist. The intensity of the waves and surf depends on the strength of storm winds, and it is difficult to predict climate changes. It is known that there are natural cycles in the climate, and there is evidence from other coasts for long-term variations in storm intensity and accompanying wave activity, variations that span decades or longer. Therefore, it is possible that the Oregon coast could enter a phase of stronger storms (or equally possible, they might be weaker). To complicate matters, we are beginning to recognize the potential for a warmer climate caused by the greenhouse effect, brought on by human emissions of carbon dioxide and other gases into the atmosphere. Such a general warming could alter storm systems and therefore the energy of the waves reaching our coast. Could such a warming trigger more El Niño events comparable to the one that occurred in 1982-83, each producing a comparable devastation of the coast? We simply do not know.

A potentially greater impact from greenhouse warming could come from increased sea levels. Global temperatures have been predicted to increase from 1.5° to 4.5° by 2050 (21). These predictions in turn have led to a variety of estimates for accelerated sea-level rise, caused by increased glacial melting and thermal expansion of seawater. By the year 2025, the global sea level is predicted to rise 10 to 21 centimeters (4 to 8 inches) (22). Although this may seem insignificant, the effects on sandy shorelines may be magnified 100 times in the horizontal direction, resulting in shoreline erosion of 10 to 21 meters (33 to 70 feet) (23, 24). As the twenty-first century wears on, the rate of sea-level rise is expected to accelerate; by 2100, water levels are predicted to be 0.6 to 3.4 meters (2 to 11 feet) higher than today (22, 25, 26, 27, 28).

There are many uncertainties in these analyses of sea-level rise resulting from greenhouse warming, and the resulting predictions have been controversial among scientists. An important question is whether we can actually measure the increasing rate of sea-level rise. Sea levels are monitored with tide-gauge records. If such a record of hourly water levels is averaged over the entire year, the tidal fluctuations are removed, yielding the mean sea level for that year. Repeating this analysis from year to year yields a measure of the changing level. Unfortunately, it is not quite this simple because oceanic and atmospheric conditions also affect the water-level changes detected by tide gauges, so the resulting measurements are scattered rather than yielding smooth trends. More than a century of past tide-gauge records now exist, but even with this long record, different investigators obtain results for the long-term sea-level rise that range from as low as 1.2 millimeters a year to as high as 3.0 millimeters a year; this range of estimates results from the scatter of the data even though the investigators are analyzing the same measurements (17, 18, 29). However, the question is not whether the yearly rate of 1.2-3.0 millimeters is continuing, but whether greenhouse warming has already caused the rate to increase, say to 5 to 10 millimeters a year (20 to 40 inches a century). Again, different investigators have reached conflicting conclusions, some saying that they see an increase in the rate, while others conclude that they do not (17, 18).

Despite the uncertainties, there is a growing consensus that some increased rate of sea-level rise can be expected in the twenty-first century. This recognition has led to recommendations that future sea levels be given more serious consideration in coastal management decisions (28, 30, 31, 32). Though sea-level changes are not a cause for immediate alarm in the Pacific Northwest, where the impact would be smaller and would come later due to its tectonic rise, it is important that they enter into our coastal management considerations.

Potentially more catastrophic, but even more uncertain than sea-level changes due to greenhouse warming, is the possibility that an extreme earthquake will occur on the Northwest coast during the twenty-first century. Evidence for prehistoric earthquakes has come from investigations of buried marsh deposits in estuaries which suggest that portions of the coast abruptly subside, followed by an extreme tsunami that sweeps over the area (33, 34). The sediment record indicates that six events have occurred in the last several thousand years, at intervals ranging from 300 to at least 1000 years. The last recorded inundation took place between 300 and 500 years ago. Given that frequency of occurrence, there is a reasonable probability that a major earthquake and tsu-

nami will occur during the next century. Studies are still underway that should more fully document the effects of past earthquakes, and after their completion we will be better able to anticipate expected impacts of future events on humans.

Management Choices for the Twenty-First Century

At the root of the coastal erosion problem on the Oregon coast are past and present policies of shoreline development and protection. The threat to older buildings is perhaps understandable, for they were constructed before we knew much about the processes and extent of erosion and before we had established policies to protect such developments from natural hazards. If these old structures become threatened by erosion, in most cases it will be necessary to resort to a seawall or riprap to protect them. However, buildings still are being constructed too close to the edge of retreating sea cliffs and eroding beaches. It is difficult to understand how and why developers continue to build, or are allowed to build, in known hazardous areas that will very soon require seawalls or rock revetments. Are our coastal development policies ineffective? Are there too many loopholes to prevent unwise development? Is it inevitable, then, that the twenty-first century will see the pressures of unwise development and the proliferation of engineering structures on the Oregon coast? Perhaps, especially in areas where development has been long established and erosion is a reality. However, in many areas a midcourse correction is still possible. This will require basic changes in our attitudes toward development, changes in shoreline management policies that incorporate our present understanding of erosion processes and, finally, the courage of public officials to make unpopular decisions.

The first and most obvious measure is to prohibit construction in undeveloped shoreline areas that are known to be susceptible to rapid erosion. We don't need any more Jump-Off Joe fiascos. More uncertain is the development of lands close to cliff edges which may only be retreating slowly. In most cases it is difficult to predict what erosion might be expected in the future, so the best policy is to stay well back. This would involve the establishment of conservative setback lines to insure the safety of the structure for its expected lifetime. Considerations of potential increases in sea levels should be included when drawing setback lines. New structures could also be made more moveable, should erosion be greater than expected.

Setback lines have been used in several coastal states and have actually been established for up to 10 years in many areas of the Oregon coast. Yet, development in hazardous areas has not been significantly curtailed. In rural Lincoln County, for example, about half of the newly constructed oceanfront buildings are located seaward of the 30-year erosion setback. Detailed site evaluations by registered engineers or geologists are required when development is proposed, and they often determine that construction can safely be located seaward of the setback line. This has sometimes had disastrous consequences (35). New construction in Lincoln City also frequently occurs within the setback zone if the engineer or geologist conducting the site evaluation concludes that the property can be adequately "stabilized." Often, stabilization means a new seawall or revetment, whether or not there is any danger from active or potential erosion (36).

Setback lines could also be established for sand spits or other dune areas. In our studies of Siletz Spit, we found from analyses of predevelopment aerial photographs that an erosion event would cut back the foredunes by only 50 feet or less. In subsequent years, drift logs would accumulate in the erosion area, and they would trap blowing sand to reform the dunes. Had setback lines been established on Siletz Spit, they would have kept development out of that naturally ephemeral zone. Unfortunately, studies of the stability of the spit were not undertaken prior to its development, so homes were placed on foredune areas that had eroded away only a decade earlier.

Another wise management measure is to limit construction of sea walls and revetments to areas that are actually experiencing erosion. This again would seem obvious, but it is surprising how often unneeded and expensive structures are being built along the Oregon coast. Two examples are shown in figure 9. In the first, the developer was told to position the home well back from the cliff edge so there would be no danger from erosion. This would have involved a relatively short setback distance since erosion retreat of the cliff at that site had been small. Unfortunately, this reasonable recommendation was ignored, and the house was placed as close to the edge as possible. With its completion, the owner immediately requested permission to build a seawall, and it was granted even though he had ignored

the previous warning and no erosion had occurred subsequent to construction. In the second example, shown in figure 9, construction of a large seawall was granted for a house that had been built some years ago. This was done in spite of the objection of neighbors and the fact that the bluff had not experienced erosion within historic times. This absence of erosion was readily apparent in that the bluff was covered by thick vegetation, including sizeable trees that appear on old photographs of the site. The geologist who undertook the site inspection for the home owner reported that the property was undergoing severe erosion, and evaluated it as two feet per year. It would seem that his conclusions were "tailored" to fit the desires of his client who wanted a seawall even though it was not needed.

Unfortunately, this case is not an isolated example. County commissions and city councils often grant permission for the construction of seawalls whether or not they are needed to halt erosion. Some local governments have also approved new developments in areas of known geological hazards. The best example of this was the development of Jump-Off Joe, where approval was granted even though there was considerable expert testimony documenting the past erosion and likelihood for future problems. The commission chose instead to listen to the developer's geologist whose report downplayed the erosion problems and the site's susceptibility to landsliding. Again, the geologist clearly doctored his report to satisfy the developer, since the erosion rates he gave were substantially lower than those he had found in an earlier study undertaken for Lincoln County (15). He also indicated that landsliding at the site could be controlled by adequate groundwater drainage. The subsequent erosion and slumping of Jump-Off Joe, and the destruction of the new condominium (figure 8), have obviously proved him wrong. That particular geologist did eventually lose his certification, but only after several additional cases of comparable malpractice.

Oregon's Coastal Management Program, approved by the federal government in 1977, requires that local coastal governments and state regulatory programs address such issues. For example, it calls for site inspections and reports from registered geologists when development is proposed in a hazardous zone. In most cases this investigative approach has been successful, but there have been notable exceptions, such as those cited above. The intention was, of course, to establish that sites of new construction are safe from erosion or other geological hazards. Another policy states that seawalls and revetments are not permitted for new development. However, in what turns out to be a significant loophole, "exceptions" to this requirement may be granted, and as noted earlier, structures may even be required to "stabilize" the property before construction. In the case where homes were present before 1977, it is necessary to establish that erosion is occurring and represents a danger before permission is given to construct a seawall or revetment. The loophole here is that some geologists are willing to "document" erosion where it does not exist, and local government agencies are quite willing to accept their findings.

There is some cause for optimism. Oregon state agencies and local governments have come to recognize that coastal land use and seawall regulatory programs are inadequate and outdated and are re-examining shoreline policies. In some cases, they are now turning down permit requests for unwise shore-protection structures. Such was the case with Jump-Off Joe, where the Division of State Lands denied the application for a seawall, stating that it would produce only an illusion of safety in an area of known geological hazards and that there would be no public benefit from its construction (15). It was also recognized that the toe of the landslide failure zone was probably seaward of the proposed seawall, so that its construction would actually increase the instability. The plunge toward unwise development of the Oregon coast can be prevented only by tough management decisions such as this, based on a sound understanding of the physical processes that are responsible for erosion.

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Figure 1: A 1902 sketch of the tent city at Nye Beach in Newport, and a photograph from the 1920s of the same area (courtesy Lincoln County Historical Society and Rose Troxel).

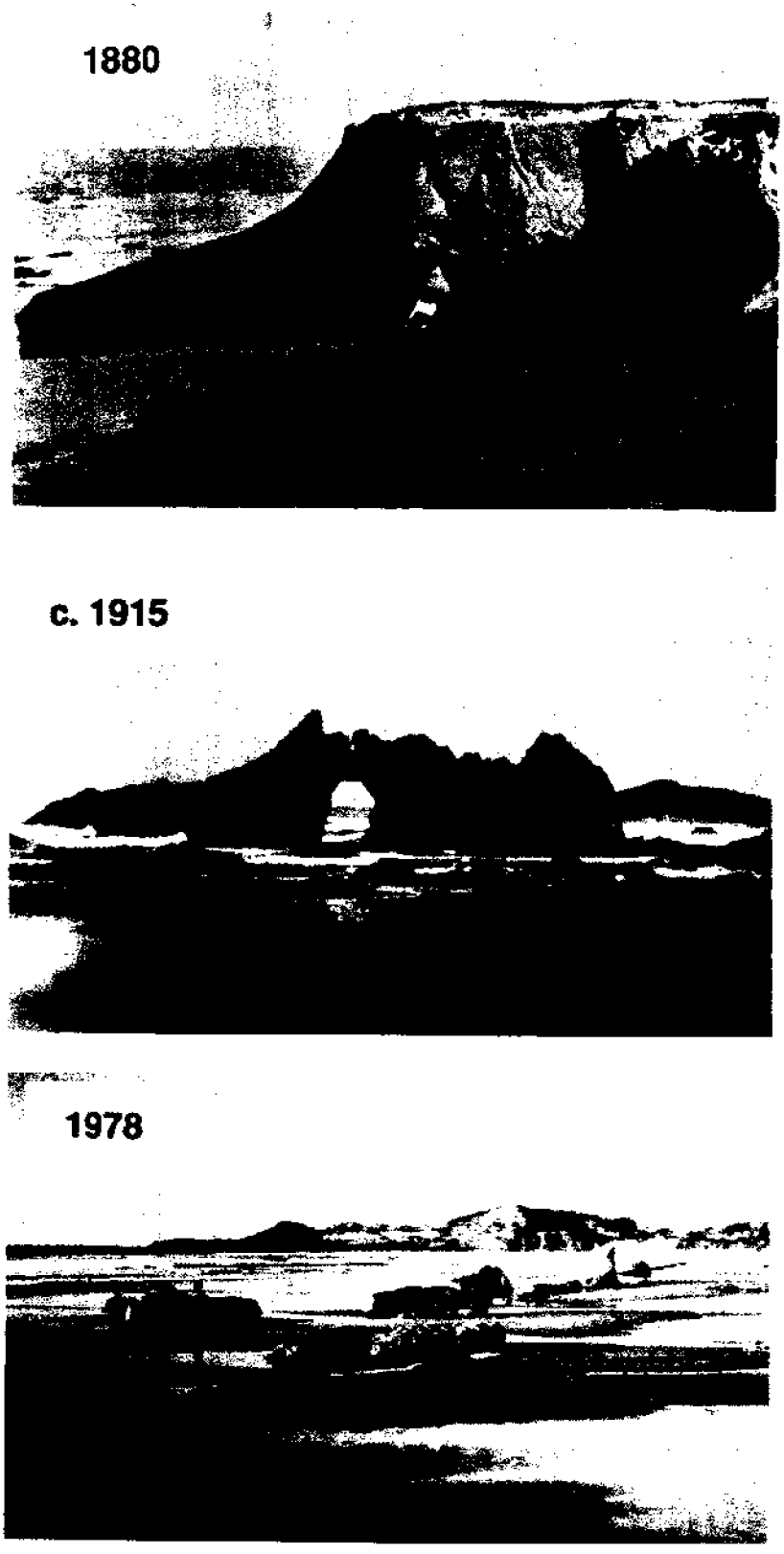

Figure 2: The progressive erosion of Jump-Off Joe at Nye Beach in Newport (from Sayre and Komar [15]; courtesy Oregon Historical Society).

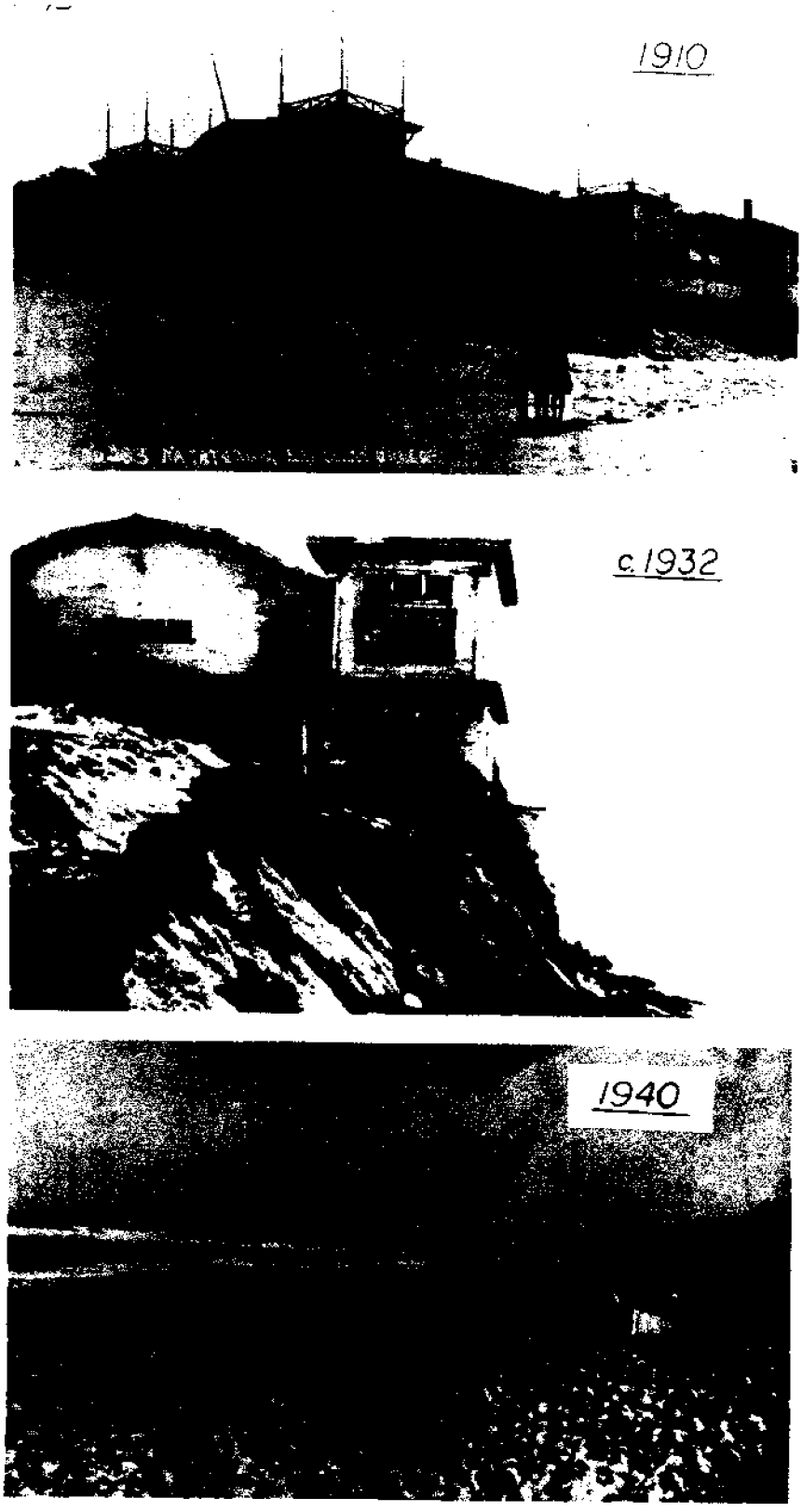

Figure 3: Photographs spanning 40 years, documenting the progressive erosion and destruction of the natatorium on Bayocean Spit (from Terich and Komar [3]; courtesy Tillamook County Museum).

Figure 4: Erosion of Siletz Spit during the winter of 1972-73 (from Komar and Rea [6]).

Figure 5: A large mound of riprap on Siletz Spit.

Figure 6: Sea-cliff erosion in Lincoln City threatening old houses and a new condominium.

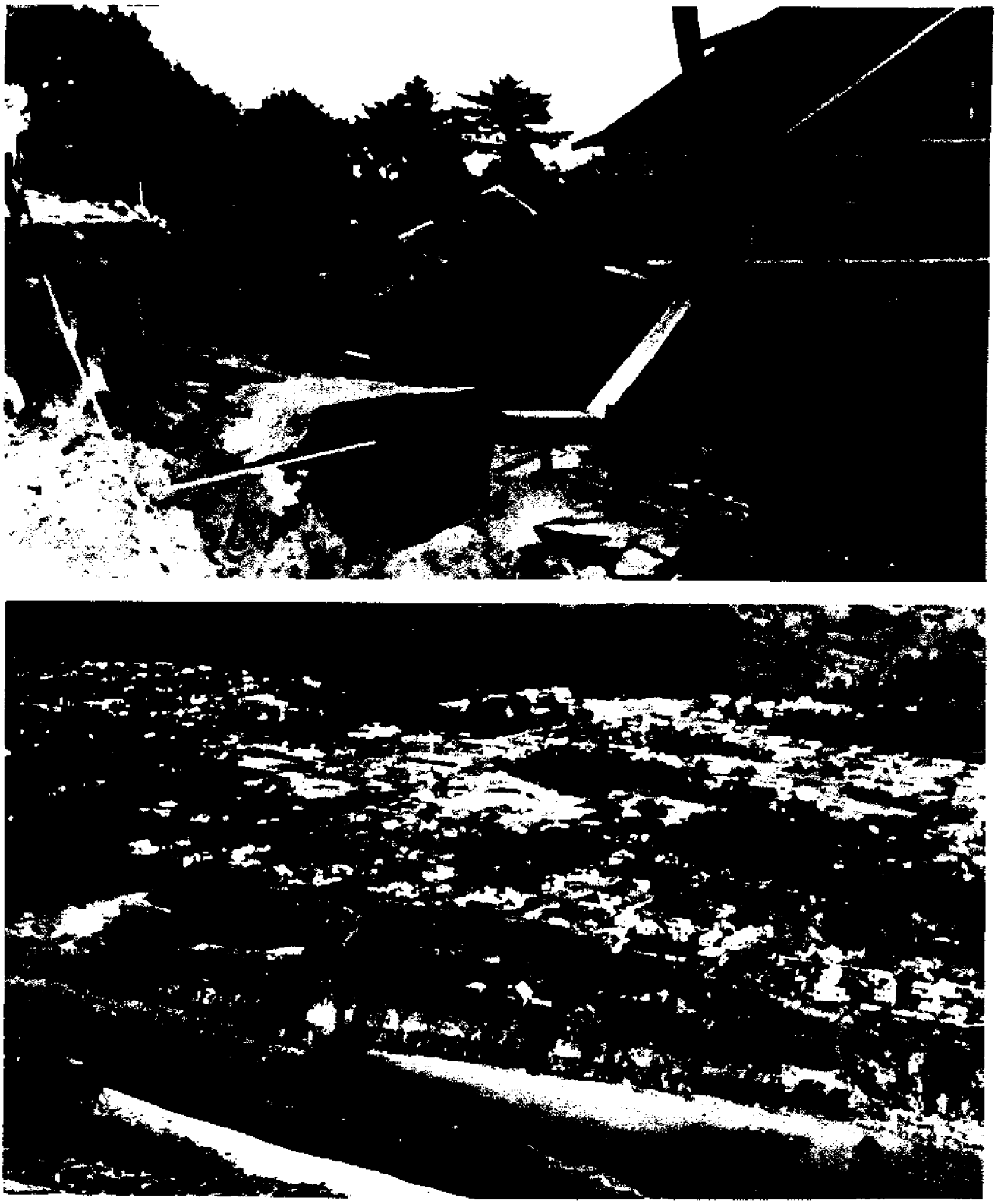

Figure 7: The 1942–43 landslide at Jump-Off Joe. The upper photograph shows the effects on houses at the time of the slide (Feb. 3, 1943), while the aerial view taken in 1961 shows houses on the slump block that were still being lived in (courtesy Rose Troxel).

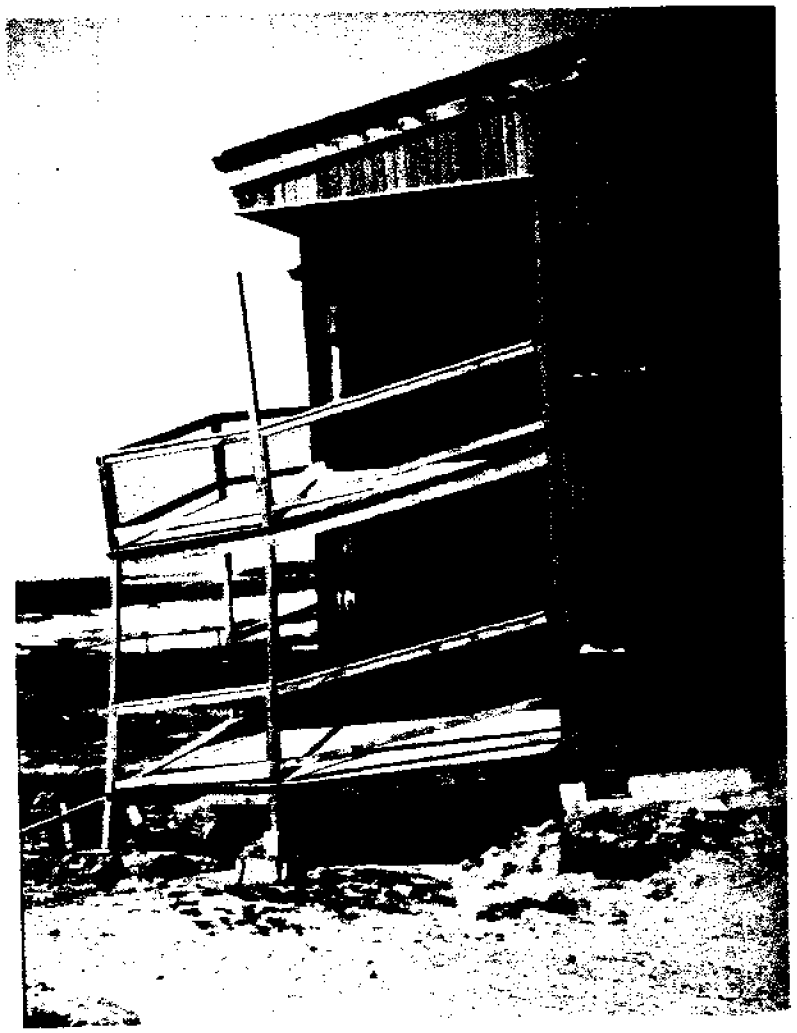

Figure 8: Condominium construction and destruction at Jump-Off Joe in the 1980s (upper photo courtesy *Newport News-Times*).

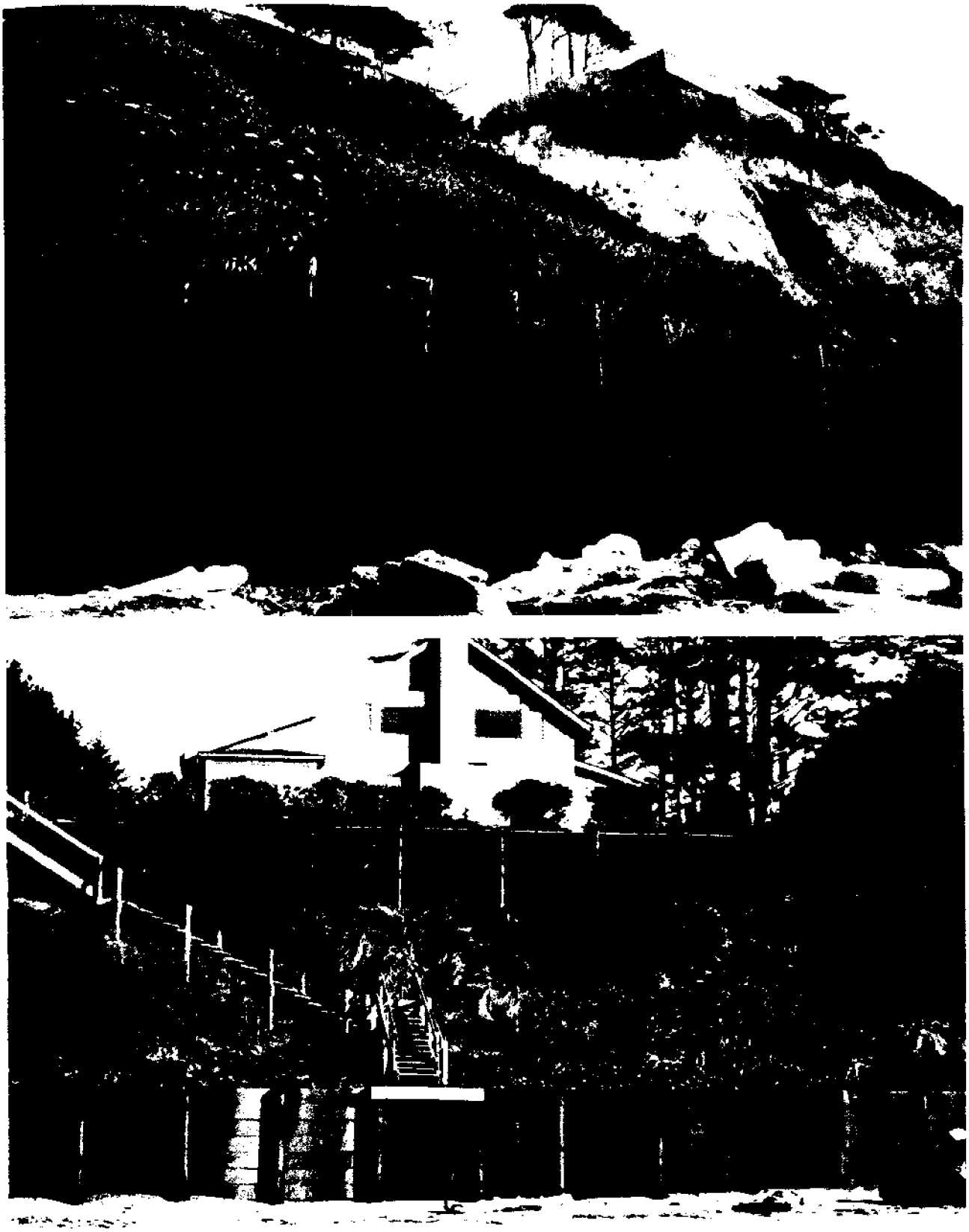

Figure 9: Examples of seawalls on the north Oregon coast that were not needed.

Pacific Ocean Governance in the Twenty-First Century[a]

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Advances in technology, transportation, and trade make the Pacific Coast of North America partners with Asia. These partners are linked geographically by the Pacific Ocean. But a successful partnership also needs a solid legal and institutional foundation at both ends. Building a foundation for the twenty-first century involves questions we label ocean governance. Unfortunately, current U.S. approaches to ocean governance are not adequate for the twenty-first century.

With its extensive Pacific coastlines, the U.S. is a significant coastal nation. As such it shows the same interests and concerns regarding the seas off its shores as other coastal nations have shown. Its additional role as a naval power complicates its attitudes and actions in ocean affairs, but as it has participated with other coastal nations in the trend toward expanding national jurisdiction over the oceans, this should not be unexpected. In March 1983 President Reagan proclaimed a 200-mile U.S. Exclusive Economic Zone (EEZ) generally reflecting the EEZ described in the 1982 Convention on the Law of the Sea, which the U.S. so far has refused to sign or ratify. The proclamation asserts U.S. jurisdiction and "sovereign rights" over a long list of present and potential activities throughout a sea-covered area that, at 4.9 billion acres, is half again as extensive as the nation's land territory. The EEZ proclamation, however, has not yet been implemented by Congress. In addressing the implementation problem, we believe that the basic question is, How should the U.S. EEZ be governed?

Today in the U.S. we need a broader vision as we consider the governance challenge posed by the acquisition of the EEZ. Many current clamorings and immediate concerns must be addressed and resolved in ways acceptable to the present participants in the debates about sharing offshore revenues or protecting the coastal zone environment. But this broader vision should encourage us of this generation to also begin considering approaches to EEZ governance that will be responsive to issues that will confront all future users of the Pacific Ocean off our shores.

[a] We gratefully acknowledged the research assistance of Andrea Coffman and the manuscript assistance of Nancy Farmer.

We must see the advent of the U.S. EEZ as the beginning of a new ocean age for our nation, one that will run for generations to come. It is not likely that the EEZ is an aberration that will soon go away (even if there are those who would prefer to see it disappear). It is far more likely that it is the foundation of increasing national governmental authority in the offshore ocean.

In the past several years, as the central government has continued to expand and solidify its control over a growing number of events and activities off our nation's shores, the coastal states of the United States have become increasingly vocal in expressing their concerns about the regulation of offshore activities and events. In addition, they have demanded some role in this regulation. Almost always, however, their demands have characterized the issue as one of "managing resources," not as one of "governance." There is a difference, and we believe the EEZ, proclaimed for the U.S. less than five years ago and not yet implemented domestically, brings us face to face with that difference and with a historic challenge to the American federation: how to be true to the constitutional conception of the federation in governing more than half the area assigned by international law to the U.S. for its governance.

It is by now fairly common to see references to the EEZ as new U.S. territory, or something like territory, or as similar to the acquisition of the Louisiana Purchase. Is this a fair comparison? Is the EEZ now, or is it likely to become, "wet territory" of the U.S.? If so, then the U.S. arguably should face the task of governing this new territory, and in a way consistent with the constitutional design of federalism and with the practice of governing acquisitions of large territories that began, even before the Constitution, with the Northwest Ordinance of 1787.

The framers of the Constitution can be easily forgiven for failing to anticipate the semi-occupation of broad ocean spaces off the American shores. They did not even effectively anticipate the acquisition of large land territories, such as the Louisiana Purchase. Those who constructed the U.S. approach to the Louisiana

Purchase and most of the territory subsequently acquired deserve praise for remaining basically consistent with the constitutional ideal of federalism. After all, the typical approach to territorial acquisition by other nations at the time was colonization.

But also in our governance of the EEZ, is it not wise to consider the enduring values of federalism—the division of governmental labor that is both convenient and protective of local concerns and the values inherent in the deliberate decentralization of governmental power? If the federation is to remain the essence of our nation's constitutional structure, should it not be the essence of the governance of the EEZ?

Unfortunately, the current approach is simply more of the same—that is, the piecemeal approach that has accompanied the pre-EEZ accumulations of various offshore rights and jurisdictions. As we argue here, and others have urged elsewhere, this approach is no longer appropriate. Years of managing resources in the pre-EEZ context have induced a resource-management mind-set that ought to be seen as obsolete in the EEZ age. The EEZ challenges the U.S. to assume the primary role in regulating a complexity of interrelated human activities that represent, at base, the frontier edges of the seaward extension of American society. It is a governance challenge, one that demands—in a phrase currently in vogue—a holistic approach. Even apart from the federalism issue, it would seem a propitious moment in the history of U.S. involvement in the offshore ocean for us to consider integrating and coordinating our rather haphazard management and regulatory efforts in recognition of this major development. In doing so, we should also decide on a governmental structure or process that ensures and spells out the roles of the states, so that both levels of government will be more certain of the respective allocations of governmental powers. In this way, perhaps we could obviate the seemingly endless litigation process that has so far been a prominent feature of the piecemeal approach.

Would it instead be possible—and, if so, preferable—to treat the EEZ acquisition, and all that it portends, precisely the same as a large acquisition of land territory? If so, then the EEZ would be administered by Congress "in trust for the several States to be ultimately created out of the Territory," in the words of the U.S. Supreme Court. New EEZ states? At this stage in the U.S. acquisition of offshore "wet territory," no matter how many points of analogy to the Louisiana Purchase, this approach seems more than a little fanciful. There is as yet no real basis for the typical trappings of a territorial government—complete with territorial governor, legislature, courts, and so on—for the simple reason that no one yet resides in the EEZ. Nor is any significant population likely to move permanently offshore in the near future. The growing number of people who do work and play in EEZ areas typically reside in the nearest coastal states, which already have the institutions of government as well as the close economic and social interrelationships with EEZ activities.

Perhaps, then, coastal state boundaries ought to be extended seaward to bring parts of the EEZ within the territorial jurisdiction of those states' governing institutions. In this way, the virtues of federalism could be extended to EEZ governance, with the states allocated authority over essentially local or internal events and the central government allocated its constitutionally enumerated (and, over time, greatly expanded) powers.

If this approach is acceptable, how far should state boundaries be moved seaward of the three nautical miles currently recognized for all but two coastal states (Florida and Texas are exceptions). The full 197 miles to the 200-mile limit? In a sense, this approach would simply be extending the division-of-governmental-labors scheme of the Outer Continental Shelf Lands Act (OCSLA) two steps further. The OCSLA "borrows" the general civil and criminal laws of the nearest coastal states and applies them, as federal law, to events and activities related to resources development under the OCSLA, to the extent that these state laws are not inconsistent with federal law. This application of state law is satisfactory for at least two reasons. First, it is convenient in that it avoids the necessity for Congress to devise an entire body of law for all human activities that occur on offshore platforms. Second, it allows each coastal state to govern, if only indirectly, the activities of people who, more than likely, actually reside in that state. In fact, the federal "borrowing" of state law can be viewed as a congressional recognition, conscious or not, of the enduring virtues of federalism. Extending coastal state boundaries to the outer edge of the EEZ would (1) give direct governmental powers to the states over general civil and criminal matters and (2) expand this power to all EEZ activities.

However, this approach seems not only highly unrealistic and improbable but also

undesirable. The farther offshore EEZ activities occur, the less local, or "internal," and the more international, or "external," they become. Legitimate state interests and concerns do extend beyond the three-mile boundary but hardly 197 miles beyond. And the closer EEZ activities are to the remaining international commons beyond 200 miles, the more significant is the federal government's exclusive role in conducting our nation's foreign policy and protecting our national security.

Why not, then, extend coastal state boundaries to some fixed distance offshore, but less than the full 200 miles? In this way, local interests and capabilities could be recognized in the areas of most concern to the states, leaving the areas more distant from shore and closer to the international commons for governance by the federal government. Should this be acceptable, how far to sea should state boundaries be moved? The distance most frequently urged by coastal states is 12 nautical miles. The 12-mile limit offers a convenient dividing line for primarily state and primarily federal governing authority, especially, now that the U. S. has extended its territorial sea from 3 nautical miles to the 12-mile maximum allowable under international law. Nearly any other fixed line would be largely arbitrary. Yet it is often urged, and undeniable for that matter, that state concerns over offshore events often, probably usually, extend some distance beyond the 12-mile line. The segments of society that conduct activities in the EEZ area farther than 12 miles from territorial sea baselines also typically reside in coastal states, the support facilities for these activities exist there, and economic and environmental impacts occur there.

All of this suggests extending coastal state boundaries—if that is the chosen approach to the constitutional challenge—to some distance beyond 12 miles but short of the entire 200, a state zone calculated to project the structure of the federation seaward in proportion to the desirability and need to perpetuate the federation's values in the U.S.'s new "wet territory." This distance might be 25 miles or 100 miles or some other 12-to-200-mile range established to mark the "true" outer edge of American land-based ocean society. Such a line would be arbitrary to some degree, and quite possibly obsolete within the next century. But it could nevertheless be more rational than either a 12-mile or 200-mile boundary.

A better approach might be to extend state boundaries to 12 miles and to establish a state-federal partnership government for the EEZ areas beyond. This approach would have the advantage of allocating to coastal states general governmental jurisdiction over the nearshore activities with which they and their residents have the greatest concern. The federal government would, of course, still exercise its constitutionally enumerated powers in the expanded state zone, just as it does now in the territorial sea and, for that matter, the land territory within state boundaries. But, in accordance with the enduring values of the federation, general governmental jurisdiction would rest in the state governments within their boundaries.

Beyond the coastal states' extended boundaries, regional EEZ governmental units could balance the concerns and interests of the appropriate states (some of which might not be coastal states) with the proper roles of the federal government. The Magnuson Fishery Conservation and Management Act's system of regional councils—as often maligned and praised as any other governing arrangement—might be used as an example or model. It should be emphasized, though, that the suggested regional EEZ partnership governments should be charged not with managing resources, but with *governing* all activities and events over which the U.S. has rights or jurisdiction in an integrated and coordinated manner. Others have also suggested regional EEZ governance (or management), and it ought to be given serious consideration.

The details of such an approach, or of any of the others, would need to be developed within a framework or mechanism. The most obvious appears to be the Congress, where the states do wield their designed influence. Less obvious, but perhaps more appropriate, if we resolved to do the job correctly, would be by constitutional amendment.

It is clear to us that all coastal states have great and legitimate concerns about the events and activities that occur in and under the ocean waters off their coasts. Many have, in addition, considerable expertise and knowledge regarding offshore areas and resources. Others are busy acquiring such expertise and knowledge. It is appropriate for coastal states to have direct roles in EEZ governance, not only because of their interests and concerns and their growing capabilities, but also because the U.S. EEZ should be governed in accordance with the federation scheme devised 200 years ago by the framers of our Constitution.

Shuttle Views the Marine Environment

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Looking at Gemini photographs of the Gulf of Mexico more than 20 years ago, oceanographers realized that color photographs could be used to identify the spawning grounds and migration of gulf shrimp. This information was rapidly passed on to the fishing fleet, and as a result of this discovery in August 1966, oceanographers have been involved in briefing the crews for every subsequent U.S. manned spaceflight.

With sophisticated Earth-monitoring satellites returning a continuous stream of data from orbit, what can photographs of ocean surfaces taken by an astronaut using a handheld Hasselblad camera contribute to serious oceanographic studies? The majority of satellites provide direct overhead views in crisp daylight conditions in the form of false color images. By contrast, the shuttle can be positioned to provide oblique views which reveal a wealth of new data, for example in the sunglitter reflecting off the ocean surface. Additionally, there is the undeniable attraction of a natural color photograph taken by a human observer orbiting our planet who saw something fascinating or awe inspiring in that particular view. In order to give some idea of the scope of shuttle Earth observation studies of the marine environment over the past eight years, I will briefly consider some of the exciting new oceanographic discoveries from space and illustrations of environmental issues resulting from human-induced change.

Important oceanographic discoveries were made right from the start of the shuttle program. On STS-1, in April 1981, the first test flight of the *Columbia*, John Young and Robert Crippen photographed large-scale spiral eddies in the Gulf of Oman. At the time this was thought to be an isolated phenomenon, but the next mission revealed another similar eddy in the Caribbean, and subsequent observations have shown that spiral eddies are a widespread feature and that fields of spiral eddies are interconnected. Like the circular systems of cyclones and hurricanes, spiral eddies in the Southern Hemisphere rotate in the opposite direction from those in the Northern Hemisphere.

The outlines of spiral eddies and related shear current boundaries are highlighted by the accumulation of natural surfactants—natural oils exuded by phytoplankton which enhance the reflectivity of the sea surface—along the shear. Paul Scully-Power, the only oceanographer to fly aboard the shuttle to date, observed widespread examples of sea surfactants during his eight-day mission in 1984, suggesting that the concentration of surfactant material worldwide is higher than previously assumed.

The photograph of the Aegean (figure 1) taken by *Challenger* astronauts in November 1985 reveals an entire eddy field in the sunglitter off the northern coast of Crete. Also visible in this photograph are "island wakes" extending northward from Santorini, Anafi, and Amorgos. Island wakes are produced by upwelling and vertical mixing induced by current action which brings deep, cold, nutrient-rich waters near the surface when the presence of islands disrupts the progress of waters propelled by a strong current. They may extend for more than 150 kilometers down current of an island. Historians believe that an early seafaring race, the Phoenicians, were aware of island wakes and used them to navigate their way to islands out of view, over the horizon.

An interesting feature of the close correspondence between ocean water movement around the globe and atmospheric circulation patterns is evidenced in the "cloud tails" which develop downwind of oceanic islands where the atmospheric current is disrupted by the intrusion of an island in a manner very similar to the development of "island wakes."

Unfortunately much of the reflectivity and differentiation viewed in the ocean surface is directly attributable to the presence of humankind on Earth rather than to natural phenomena. The cyclonic eddy featured in figure 2 is emphasized not by natural surfactants but by oil where a tanker has bilged its tanks. Astronauts have observed ship wakes extending for more than 150 kilometers, and the most conspicuous wakes are those of oil tankers pump-

ing their bilges, depositing reflective oil in the water.

The ecologically disruptive practice of oil bilging by tankers can occasionally have interesting visual results when observed from space. Figure 3 shows a boundary between two currents in the Mozambique Channel. Such sharp current boundaries are similar to meteorological current boundaries; they are simply occurring in a denser fluid. In this record brought back by the *Discovery* crew, the tanker is traveling from the bottom of the frame toward the top. The older part of the slick (which has been produced over about a 45-minute period) shows greater dispersal than the more recent section. Dispersal is being aided by a light wind blowing from the left of the photograph. The current at the top of the frame is traveling to the right, relative to the current at the bottom. With the passage of time, the oil slick exhibits an offset shear to the right.

As we move towards the twenty-first century we face two major environmental concerns. What will be the impact of sustaining an exploding world population (expected to double to 10 billion over the next century)? And what changes will result from global warming? It is well understood that the melting of polar ice caps will result in a rise in sea level, threatening low coastal communities worldwide. These are major concerns which must be addressed by politicians on an international basis without delay. Yet some of the problems which will confront us in the twenty-first century are already apparent. In the name of progress and often with the need to feed an expanding population as motive, people have attempted to transform the natural environment to their needs, sometimes with catastrophic and irreversible effects. The scale of many of these human-induced changes will be accelerated when global warming takes hold. Few of us realize how rapidly these changes are taking place, but orbiting astronauts have observed deterioration from one shuttle flight to the next.

To cite just one example here in the United States, geologists and geographers have long predicted that, following the pattern of geological history that has taken the delta up and down the Louisiana coast, the Mississippi Delta will stop expanding and start eroding. Consequently, New Orleans' days are numbered. Dams built for hydro-electric power and water supplies upstream have reduced the amount of rich Mississippi silt reaching the delta. This reduction in silt, combined with a steady rise in sea level, is rapidly changing the face of the region: one acre of the Louisiana coast is being lost to the Gulf of Mexico every 16 minutes. From the vantage point of space we see that already. Despite the construction of flood barriers and the excavation of navigation channels, the Mississippi has found an easier course and much more sediment is disgorging from the Atchafalaya River into the Gulf of Mexico through Atchafalaya Bay than from the Mississippi Delta. Atchafalaya Bay is the location of the next Mississippi Delta.

To the west of the Mississippi delta the barrier islands of the Texas coast tell another tale of human interference and the demands of an exploding world population. Over the course of geological history since the last ice age 18,000 years ago, these barrier islands have migrated towards the present coast, their seaward profiles sculpted into a smooth curve by the repeated assaults of hurricanes.

Historically, the landward side of the islands has extended, built up by sand deposited from overwash during storms as the Gulf coast retreated. Today, that process has ceased in the case of many of the Texan barrier islands and similar barrier islands around the world. The beaches of the islands are being eroded by wave attacks promoted by sea walls, jetties, and vegetated dunes that obstruct the incoming sand. The introduction of vacation condos and high rise hotels is hastening the erosion of these natural storm barriers by preventing the landward extension of the islands by storm sand movement. As a result, the islands become narrower and more vulnerable to rapid inundation as sea level rises.

The floods which devastated Bangladesh in September 1988 were triggered years earlier by the cutting of the great mountain forests in Nepal and northern India, which removed anchorage for topsoil and allowed millions of tons of silt to rush downstream during the monsoons to clog the world's largest river delta. Now, with much of the Himalayan forest gone, there are fewer trees to soak up the moisture of the monsoon rains, so increased runoff reaches the clogged delta, submerging at least 20 percent of Bangladesh in monsoon flooding annually. Add to this the possibility of an increased rate in the rise of sea level, and one of the most densely populated areas on Earth could be rendered uninhabitable within a century.

In Madagascar we see the same process at an earlier stage of development (figure 4). The red,

soil-laden waters of the Betsiboka estuary are a striking symptom of the ecological disaster that has befallen Madagascar. Felling and clearing of this island nation's tropical forest to provide additional agricultural land to feed an expanding population has been so extensive that soil erosion has been vastly accelerated. The sediment clearly visible in photographs from space represents the draining of an irreplaceable natural asset. Such rapid loss of topsoil means that the new agricultural lands provided by clearing the forest over the past 20 years will be worked out and unable to yield crops within another 20 years.

Yet another center of population where the coastal profile is set to change is the Nile Delta. The Mediterranean has experienced relatively minor changes of sea level for several thousand years. The rich silt flowing down the Nile to the fan-shaped delta produced a soil rich for agriculture and hence an obvious hub of civilization, from the time of Egypt's "Golden Empire" nearly 6000 years ago to the present day.

Once again, the necessity of providing food and power for an exploding population resulted in an engineered reversal of natural process. This shuttle view (figure 5) of the Nile Delta shows numerous small communities clustered closely together in the still fertile delta. The inadequacy of the food yield of the area is revealed by the presence of exorbitantly expensive circular irrigated fields cut into the desert east of the fertile delta. A large percentage of Egypt's population still lives on the delta or along the banks of the Nile. The nation's second largest city, Alexandria, with a population of 3.5 million, is little more than a meter above sea level. The Nile delta has been in retreat since the closure of the Aswan Dam in 1970 stopped the transfer of silt to the delta, and this is expected to be a lasting phenomenon. However, the situation will be worsened by a significant rise in sea level. Current predictions suggest that the Mediterranean will rise by as much as 2 meters within a century.

While we contemplate the longer term behavior of the Mediterranean, observations from shuttle have helped us understand the passage of water through the Strait of Gibraltar into the enclosed Mediterranean Sea. Solitons, or large pulses of water which appear to travel without distortion in the open ocean for many miles, were first observed in England in 1834. They were first observed from space during the US/USSR *Apollo-Soyuz* mission in 1975, and in 1984 the *Challenger* crew, from their unique perspective in orbit, observed a dramatic example of ocean solitons propagating through the Strait of Gibraltar. This soliton package is triggered by inflowing Atlantic water accelerated by its passage through the narrow strait and across the sill at the entrance to the strait. At the interface between the fresher, lighter Atlantic water and the more saline, denser Mediterranean water, internal wave sets are generated at a depth of 60-80 meters. Each soliton develops independently as the tidally driven, eastward-flowing water is compressed and upwelling results. When the tide turns, upwelling does not occur while water flows back through the strait, and no solitons are produced. Hence astronauts see the imprint of 24-hour tidal cycles with about 60 kilometers separating one series of solitons from the next. Collaboration by naval oceanographers at the time these observations were obtained confirmed that the surface variation identified with these solitons is of the order of only 3-4 centimeters.

Although it is essential to understand the role humankind is playing in changing the environment of planet Earth at a time of apparent climatic change, it is also vital to keep in mind the naturally fragile nature of our environment. From the vantage point of space, astronauts observe the close interaction of oceans and the atmosphere as circlets of cloud pop up over the heads of oceanic cold-core columns and cloud patters are seen to change at ocean current boundaries. In the course of one 90-minute orbit of the globe, a shuttle-borne observer may see active volcanoes contributing to the growth of islands, corals building new atolls on the submerged remnants of eroded volcanoes, and the ocean reclaiming submerging atolls.

Twenty years ago *Apollo* astronauts on their way to the Moon first showed us the beautiful and fragile planet we call home. Nothing has done more to emphasize the delicate balance of the environment of planet Earth than those photographs from space, yet in the 20 years since we observed Earth rise from the surface of the Moon humankind has polluted and damaged this fragile environment with greater vigor than at any previous time in civilization. As we move into the last decade of the century, NASA will lead an international effort to monitor our planet from space. Through the Earth Observing System we will better understand how our planet functions, and we will see how it is evolving and changing on a daily basis. To

benefit from this program we need a strident international political agenda for the twenty-first century to reduce pollution, to legislate for conservation and for landuse and ocean arena management, and to provide educational programs that will instil respect for the delicate balance which creates our natural environment with a view to preserving it before we head too far down the path of irreparable change.

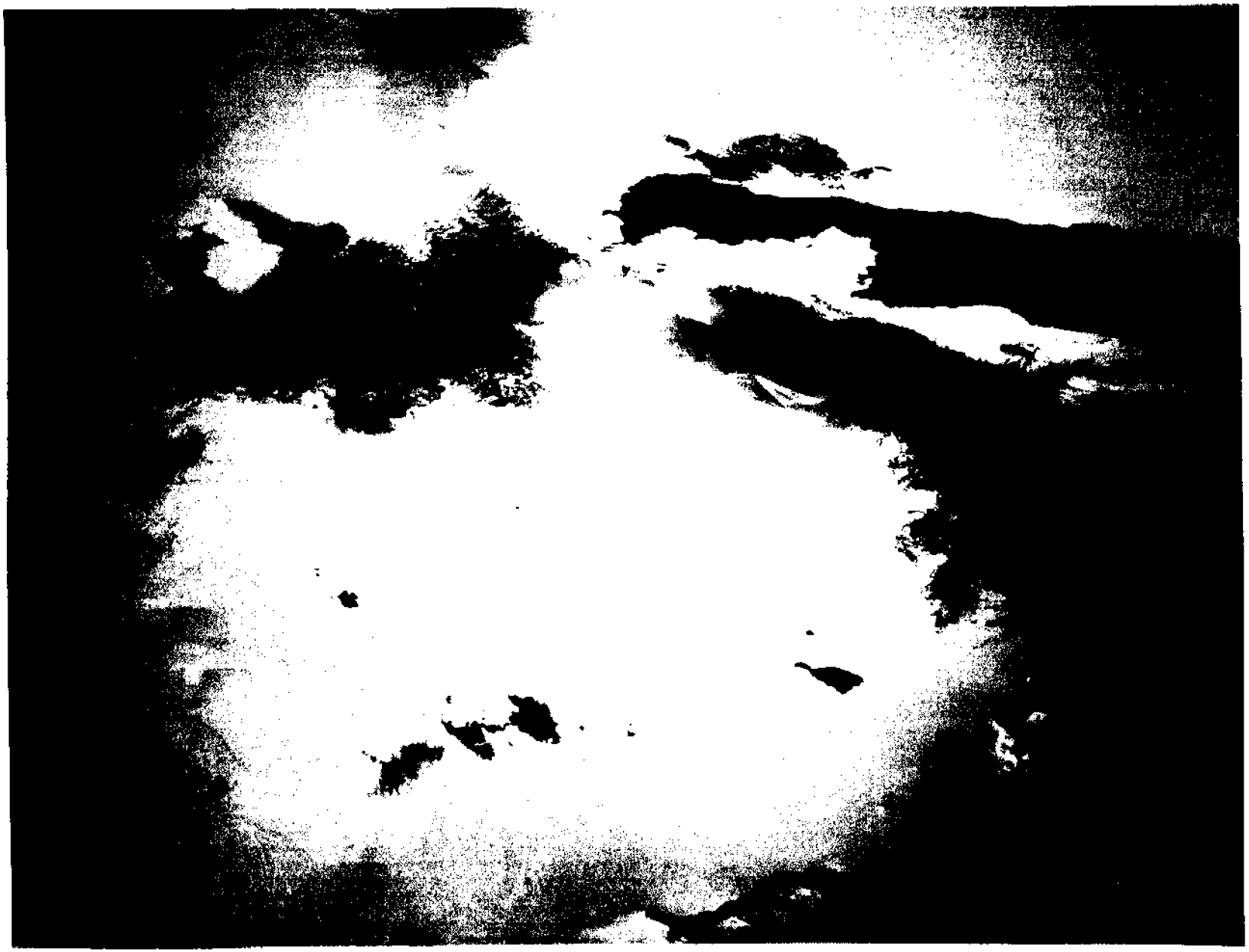


Figure 1. Aegean Sea, featuring eddy field and island wakes.

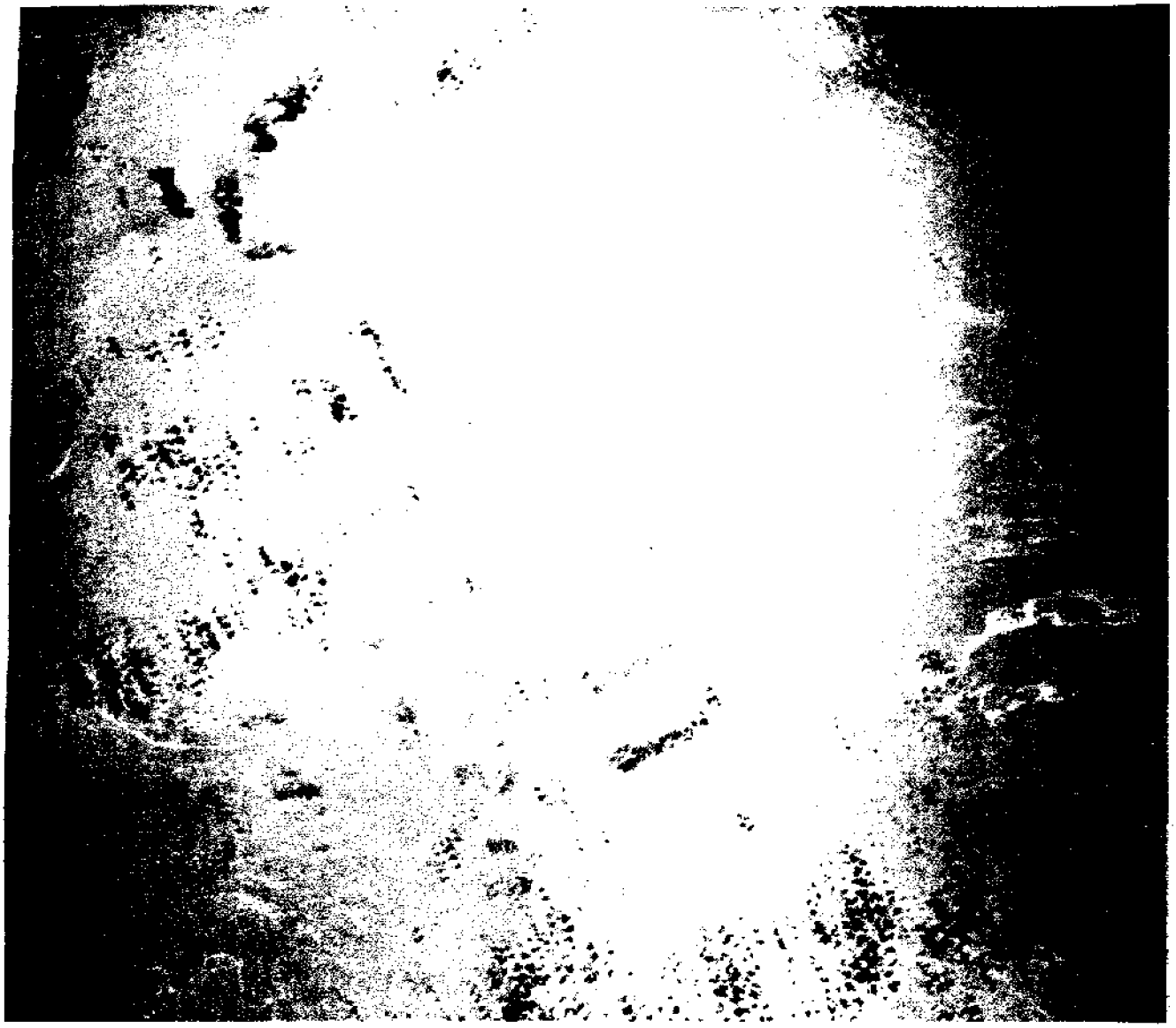


Figure 2. Caribbean spiral eddies.

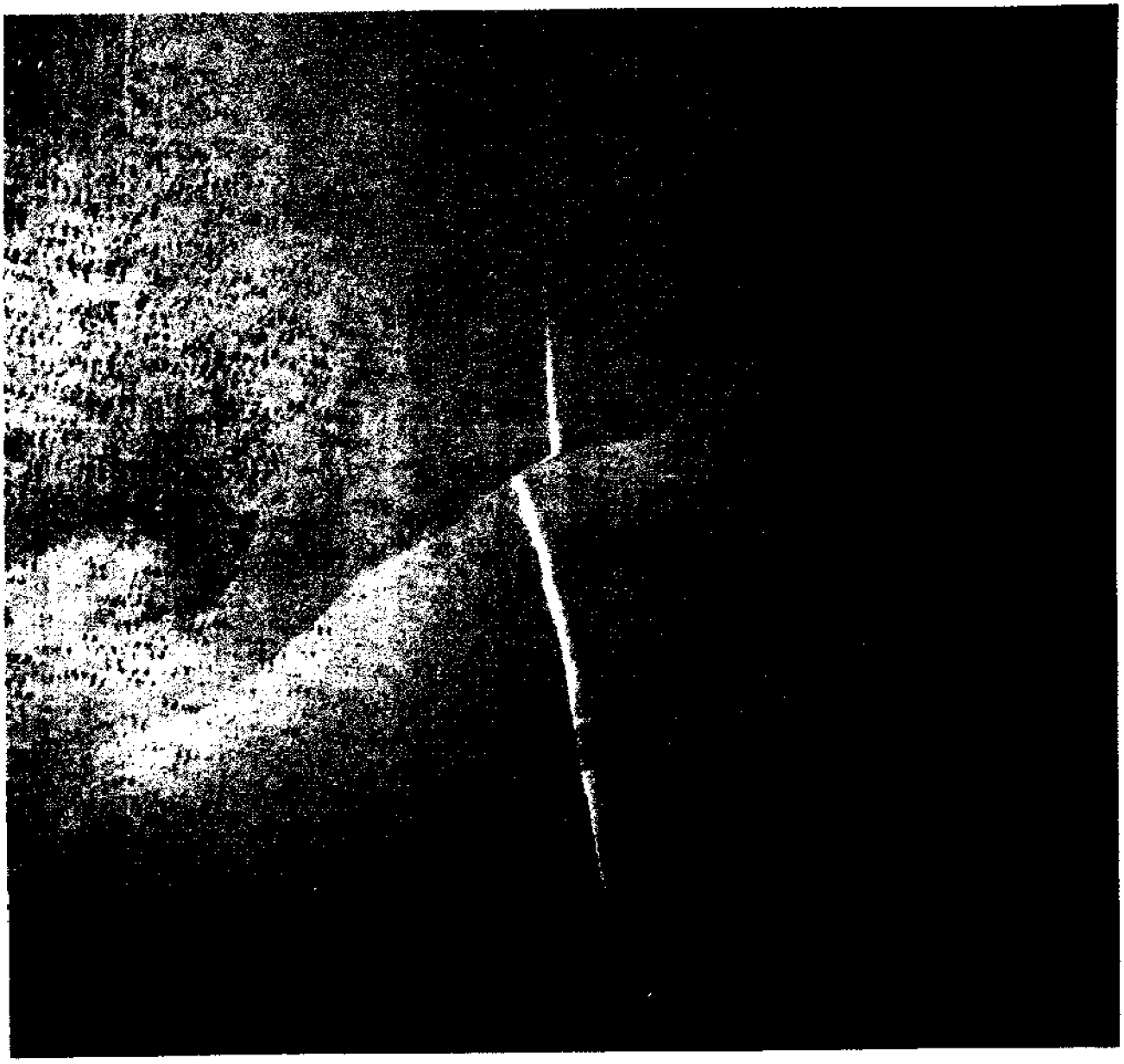


Figure 3. Mozambique Channel oil slick and current boundary.

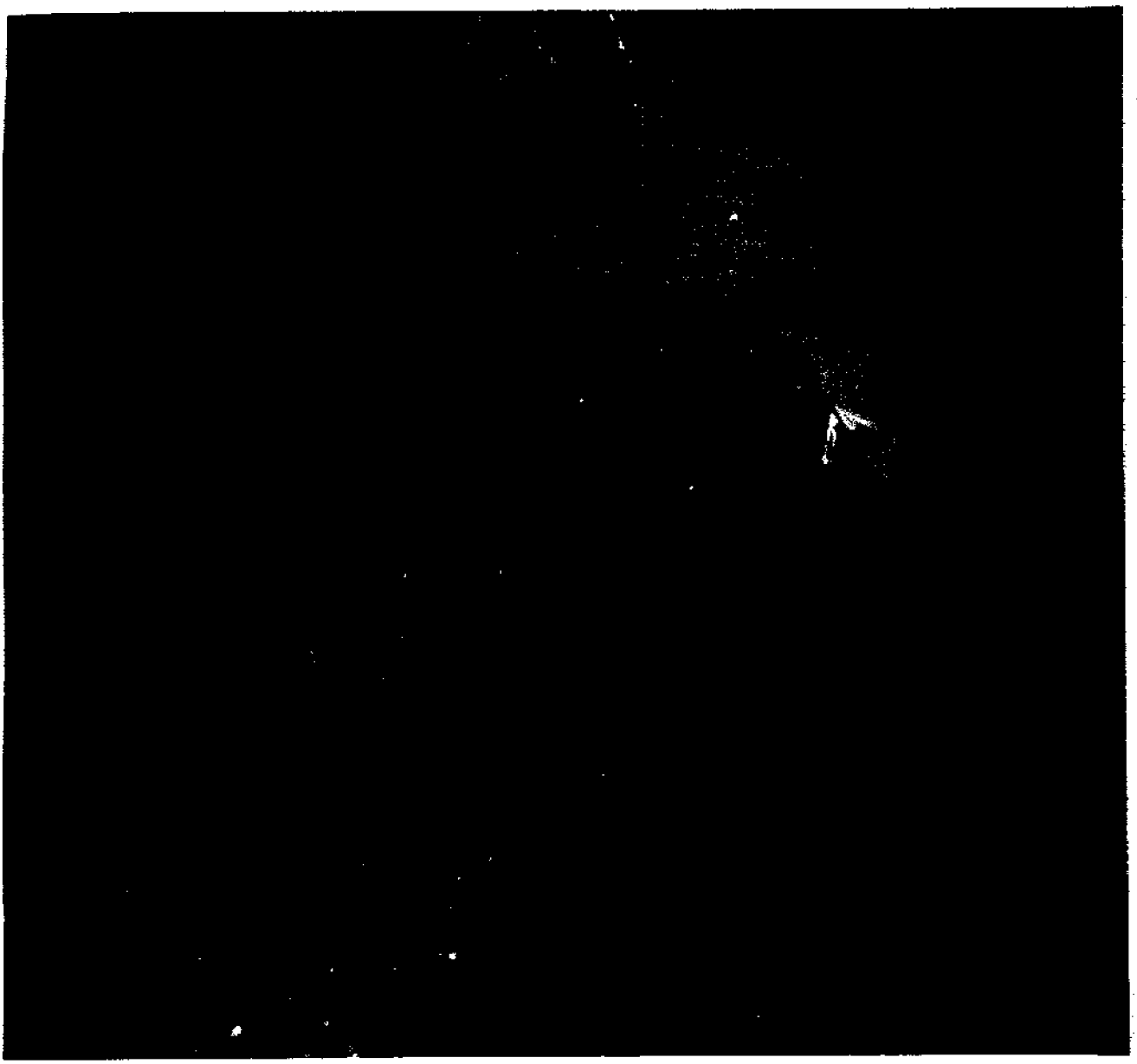


Figure 4. Madagascar. Betsibaka estuary.

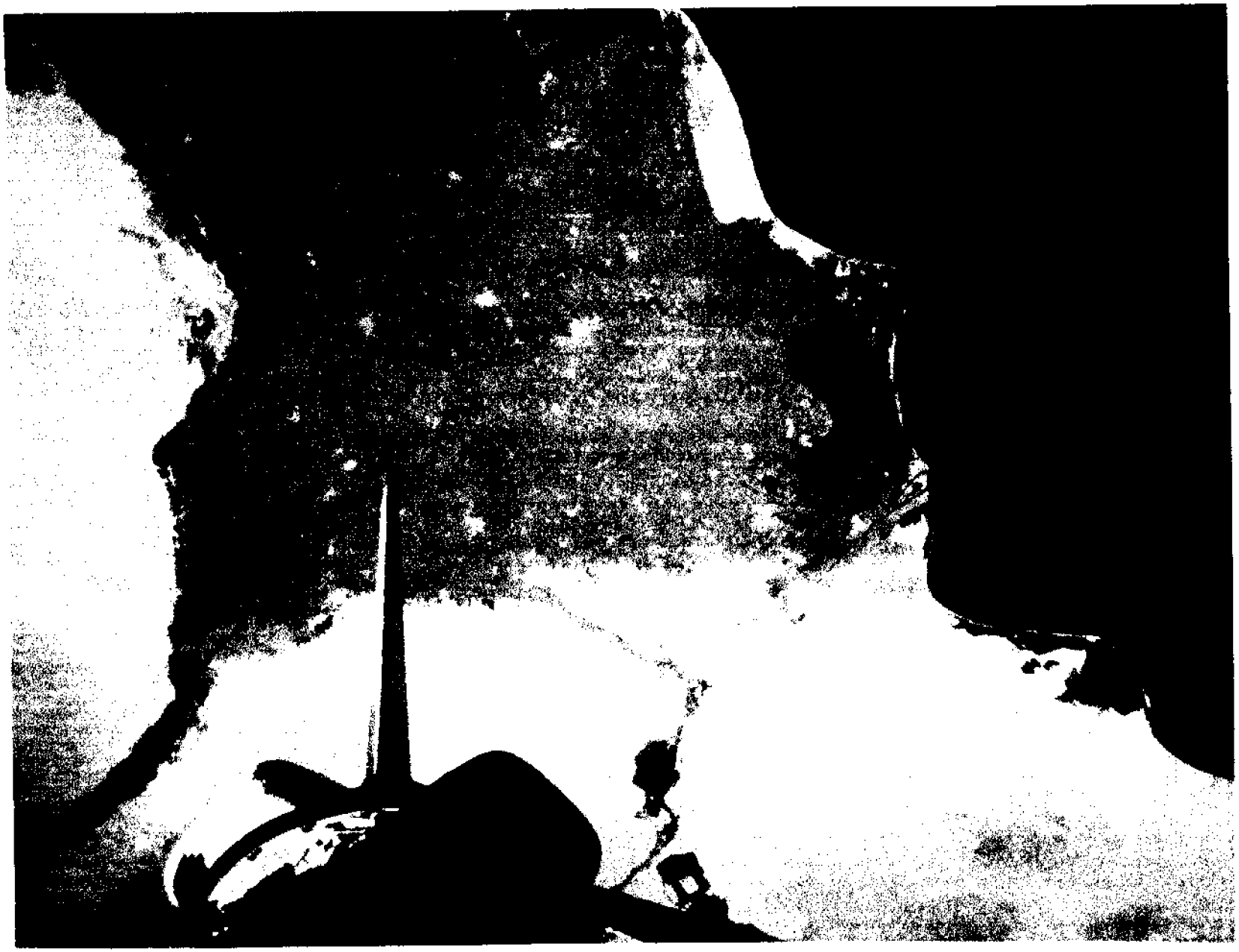
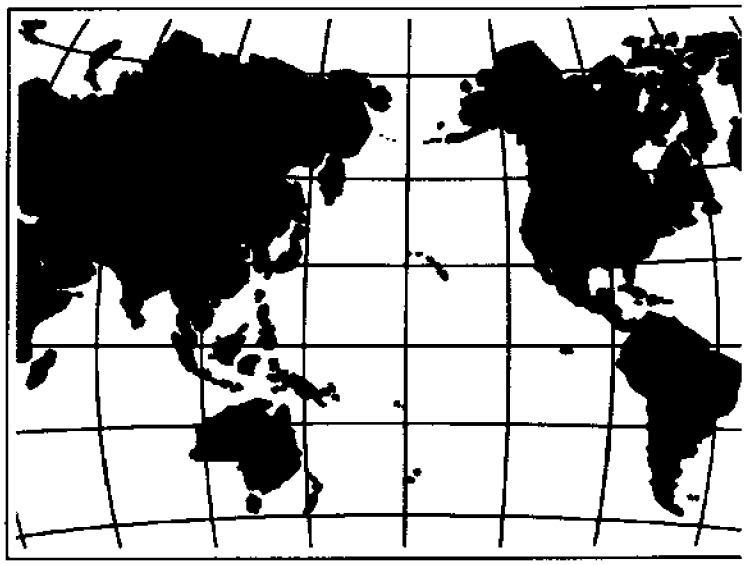


Figure 5. Mediterranean/Nile Delta.

Business and Trade



Marketing Coastal Recreation Enterprises Toward the Twenty-First Century

Bruce DeYoung
Oregon State University Extension Sea Grant Program

As marketing researchers are increasingly aware, the past is not the future. Thus, the clients of water-based recreational enterprises of the future will bear little resemblance to those of the last 30 years (1). These changes will also affect the employment pool that marine enterprises will draw upon.

Although in this paper I consider socioeconomic changes as the twenty-first century approaches, no crystal ball will be required in forecasting the future. Future patterns are already being shaped by trends underway today (2). Hence, I present trend data for the marine recreation industry as well as interpretations of them. Obviously, the process of interpreting data trends is a tricky undertaking. For this reason, you are invited to make your own interpretations of the data and apply it to individual situations. The trends I considered are the graying of marine clientele, the growing service economy, the changing family structure, the increasing ethnic diversity, and the changing work force.

The Graying of Marine Clients

In 1984, 40 percent of the U.S. population lived within 50 miles of the shore. But by the twenty-first century, the coastal population is expected to double.

Who are these people and what are their interests?

They will be members of the post World War II baby-boom generation born between 1946 and 1964. This population group represents the nation's demographic heartland. By the year 2000, more than half the population will be over 40 years of age and a significant percentage will be above 65. People over 65 now control 40 percent of our nation's personal financial assets. As we move toward the twenty-first century, this percentage is expected to increase with the growing number of older Americans (3).

When the United States was founded, a newborn child could expect, on the average, to reach 35 years of age. Today, a large percentage of Americans could live into their 90s, and the fastest growing age group comprises people 85 and over. By 1995, the population of the average U.S. town will look like Florida's population today (4). Because of this, many middle-aged families will feel "sandwiched." They will feel an intense financial strain in trying to raise young children and sustain their parents on an increasingly squeezed household budget. This may mean that the discretionary spending patterns of many middle-aged Americans will be constrained, with smaller recreational boats moored at marinas in the future.

Marine recreation clientele have traditionally been middle-aged. However, because our population is aging, managers will need to shift marketing targets in response to the demographics. This will likely lead to changes in operating procedures to accommodate older clients (5).

In the 1960s and 1970s people chose early retirement mainly because of health. A new trend begun in the 1980s and projected for the twenty-first century is voluntary retirement for most by age 65. While men are shortening their time in the work force by retiring early, women are lengthening their work time. The most common retirement age for men is 62 (6). By the twenty-first century the retired population will be "more female," especially among the very old.

Longer life expectancy and earlier retirement suggest more leisure time in future years. Presumably older boaters will stay active longer in water-related recreation. Safe, functional, small boats for use in marinas near to older clients' homes are expected to become the norm (4). This situation will stimulate widespread growth of marina dry stack boat storage facilities. Likewise, charterboat clients and bed and breakfast guests will likely be older and increase in number toward the twenty-first century.

To accommodate the needs of older and handicapped clientele, successful twenty-first century businesses will provide "user friendly" facilities. Virtually all stairs and other barriers will be replaced with gently sloping ramps and gangways. Grab rails will become common throughout marinas, and doorways to wash-

room and shower facilities will be expanded to aid persons using canes and wheelchairs. It is also expected that gravel parking areas will be paved. These paved parking areas will be provided with curb cuts to sidewalks. Extra wide spaces between parked cars will make it easy for older clients to get out of their automobiles (7).

Service-Driven Economy

The emergence of a service-driven economy has had a significant influence on coastal recreation business. While our nation's manufacturing industries are automating to decrease reliance upon human labor, the number of jobs within the service sector is exploding. Over 90 percent of new jobs during the last 20 years have been in the service sector. This sector now accounts for over two-thirds of the GNP within our country and over 75 percent of the current jobs (8). Whether this socioeconomic change is labeled "the information age" or something else, the result remains the same. More of us are employed in positions which deal with intangible services as opposed to manufacturing products.

The fact that humans must be present to custom fit and tailor the services being offered to clientele often results in longer work weeks. Whereas a generation ago unions fought for work weeks of 40 hours or less, the trend is now in the opposite direction. In 1973 the average adult put 40.6 hours per week into school, work, and commuting; however, now the average is 46.8 hours. Even this number is considerably below the 52.2 hours for the typical professional or the 57.3 hours averaged by owners of small businesses (9). By 1995, it is expected that most full-time employees will work at least 50 hours each week. In order to maximize service to clients, this time will be increasingly spent during evenings and weekends.

This tempo also extends to leisure time. In the past 15 years, the typical adult's leisure time has shrunk from 26.6 to 16.6 hours a week, a 40 percent reduction (9). Europeans now enjoy 25-30 vacation days a year. However, on the average, United States workers are down to 12 days with shorter vacation periods expected in the twenty-first century (10). Presuming that these trends continue, marina clients may desire shorter boating trips with boats moored closer to home.

The implications of dual career spouses working in a service-based economy are many. Presumably, a portion of these clients will be able to afford to purchase upscale boats and equipment. Others experiencing long work days will value "time share" boating opportunities. Conceivably, marinas could offer boater services akin to those provided by firms managing "time share" lodging units. These time-constrained clients will likely also seek marinas closer to their home and valet services (for example, cleaning, waxing, and maintenance) to conserve precious recreational time (11).

Other implications of the service economy for marine recreation enterprises are enormous. For instance, changes are expected in the pattern of peak participation of boaters. While weekends and holidays have traditionally been viewed as periods of high demand, this pattern may reverse. Increasingly, service workers are being compelled to take time off during the traditional work week rather than on weekends. This could reduce the crush of weekend recreational crowds, spreading activity more evenly throughout the week.

To cope with these changes, marine enterprises will need to stay flexible and understand emerging client patterns. Ironically, clients of the future recreating on weekends and holidays may largely be those who are retired from the work force.

Future Family Structure

American family life changed more between 1955 and 1985 than during any 30-year period since Colonial times (12). When many of us were growing up, the television series *Leave It To Beaver* portrayed the typical American family. This traditional nuclear family-husband, wife, and children—made up more than half of all the households. This family pattern now accounts for only 28 percent of all households. The decline in the nuclear family is a result of two factors. First is the phenomenal rise in the number of children born outside of marriage (today more than one child in five is born to an unmarried mother). The second factor is the increasing prevalence of divorce. In the foreseeable future, one million children will see their parents' marriage dissolve every year (13).

Marine enterprises can begin attracting the single female parent by appealing specifically to women. Day care services, onshore playgrounds, and female sales personnel will reinforce the inviting image. Boat sales and rentals will increasingly be made by marine business women for single female clients. Retirees will be available to teach boating skills to novices to

improve marina boat sales and general public boating safety.

The Census Bureau estimates that, if current trends continue, the majority of children born in the 1980s—almost 6 out of 10— will spend some time in a single parent family before turning 18. Nationally, the number of single parent households has nearly doubled since 1970, primarily due to increasing divorces. In 1985, 20 percent of the 63 million family households were headed by a single parent, usually a female. Of the nearly 15 million children under the age of 19 living with only one parent, 90 percent resided with their mothers (14).

The changing family structure has important implications for marine recreational enterprises of the twenty-first century. In two-parent families, males (especially fathers) have typically served as role models in providing the information and experience necessary to stimulate children's interest in boating and water-related recreation. Children raised in a home with no male role model—and with the financial restraints that often accompany divorce—are less likely than other children to be exposed to recreational experiences. Research suggests that children not exposed to outdoor recreation activities such as hunting in their formative years will not actively seek this experience later as adults (15).

Although it is not possible to precisely predict future marine client patterns, we can assume that, when they become adults, children raised only by women will participate less in marine recreation than will people raised in a two-parent family. However, such projections assume a relationship of marine enterprises to future conditions without intervention. Research that anticipates how various sociodemographic trends could influence the future of the marine recreation industry can also help us to mediate the consequences of such trends.

For example, innovative approaches to sportfishing education such as Sea Grant's "Master Angler Program" could provide surrogate parental role models for water-related recreation experiences. The key is for the marine recreation industry to recognize the importance of not ignoring youth in favor of "graying marina" clients. The industry needs to develop creative avenues such as the Master Angler Program to link the two generations together around a common interest of boating and angling experiences. In this way, marine business of the future will help to insure a vital client base.

Ethnic Diversity Becomes Predominant

By around the year 2000, the United States will be a nation in which one of every three of us will be nonwhite (16). The majority of the U.S. market will be composed of three present day minority groups: Hispanics, blacks, and Asians (17). These ethnic groups will cover a broader socioeconomic range than ever before with increased access to good jobs, political leadership, and business ownership.

There is only limited, outdated quantitative data addressing the level of minority participation in marine recreational experiences. Nevertheless, qualitative observations by those of us working with marine recreation enterprises seem to indicate low levels of participation by minorities. It would, therefore, seem important that entrepreneurs come to understand the growing economic importance of American minorities and the untapped market which this audience represents.

Marine enterprises of the twenty-first century will be financially rewarded for tapping into the American minority market. No doubt, nontraditional marketing approaches will be needed to attract and retain minority clientele. Certainly the starting point for this may be more vigorous recruitment of minority managers and staff for marine businesses of the future. It also means that marine recreational education for minority youth will grow in importance (16).

The Changing Work Force

In the year 2000, only 17 percent of the country will be between the ages of 25 and 34. Meanwhile, a record number of service jobs are being created which young people traditionally fill (18). This conflict between need and diminishing human resources is creating new financial pressures on small businesses. While some large franchised fast-food chains are offering a $50 sign-on fee, marine businesses will find it difficult to compete with these year-round, part-time jobs. Creativity may be part of the answer. Some marine businesses are now exploring avenues for creating targeted scholarship programs for college-aged workers. The basic idea of this initiative is that of providing a "bonus" system for staff who perform satisfactorily throughout the season and then go back to college. If successful, this approach may help the marine recreation industry to outbid employment competitors and build employee loyalty.

Another significant change in the twenty-first century work force will result from the growing number of women seeking employment. At present, about 55 percent of all women work, and 80 percent of women aged 20-30 are employed (18). Participation by women in the work force is expected to increase through the early part of the twenty-first century, primarily in service enterprises. It is expected that 85 percent of new U.S. workers in the 1990s will be Hispanics, blacks, and women (19).

While marine enterprises have not traditionally looked toward women either as employees or clientele, the need for profits may dictate a change in assumptions. Preliminary research indicates that more women would be attracted to marine recreation if there were more female staff involved in the enterprise. Likewise, with increasing entry of females into corporate leadership positions, more corporate-financed recreation will likely take place if the needs of this demographic group are identified and addressed.

With an aging population, it is expected that marine enterprises will increasingly have an older work force toward the twenty-first century. Again, although this will be a marked change from current staffing patterns, the result may be a constructive marketing tool. For, in order to attract older participants to marine recreation, there must be an empathy for their needs. One way to create this empathy is through the hiring of cohorts of the same age class.

Conclusion

Marine enterprises of the twenty-first century will need to adapt to changing sociodemographic conditions confronting them. By doing so, they will be in the enviable financial position of supplying recreational experiences being sought by a growing coastal population (20). To be successful, these enterprises will need to shift their marketing targets to nontraditional age, gender, and ethnic groups. They will also need to alter their services and timing of business hours to accommodate the lifestyle of target clientele.

Moving toward the twenty-first century, successful marinas will increasingly offer a diversity of complementary services to clientele. These services will expand the marina's role in recreation far beyond a place to dock boats (21). Likewise, charterboats will increasingly find clients' interests in nonconsumptive recreational experiences (for example, whale watching) (1).

University researchers and extension staff can help the coastal recreation industry realign its marketing efforts. Certainly a starting point for academics is that of helping the industry to perceive and adapt to a changing society. Armed with this knowledge, marine businesses can strategically plan for the business challenges ahead. By doing so, this business sector will grow in vitality and continue to grace our nation's coasts with their presence.

I gratefully acknowledge the helpful suggestions for strengthening this article offered by professional colleagues at Oregon State University. This manuscript was measurably improved by editorial critique and content advice from Sandy Enschede, M.S., Sandy Ridlington, Ph.D., and Court Smith, Ph.D.

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Maritime Transportation in the Twenty-First Century

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Introduction

Looking into the next century requires a knowledge of this century, imagination, and bravado. This exercise contains all three elements. The reader is invited to sort them out.

Trade exists because resources and people are unevenly distributed and because trade produces clear economic benefits. Seventy percent of the globe's surface is water. Trade takes place across this water. Hence, trade depends upon maritime transportation.

Trade is directly correlated with economic growth, which we have enjoyed since the end of the Second World War. Only a confirmed pessimist would forecast a major break in this pattern. Therefore, maritime transportation will continue to play an important role in the world's economy.

The technology of the twentieth century has multiplied the productivity of human muscle. The technology of the twenty-first century will multiply the productivity of the human brain. Therefore, major changes in maritime transportation will be more closely related to mental finesse than to muscular capabilities.

The Basis for Trade

Adam Smith and David Ricardo first talked about the economic advantages of trade in 1776 and 1817, respectively. They recognized that not all people are equal in all abilities, nor are all geographic areas of the world equal in all natural resources. Therefore, each has some comparative advantage over the other. Producing that for which you have a comparative advantage and trading for that for which others hold an advantage raises your quality of life.

Smith pointed out that little would be gained if the trading area were small. Therefore, the wider the trading area the greater the trade benefits. Could Smith have foreseen the fruition of this concept, the trade across the Pacific, the absolute economic interdependence between East and West?

Trade takes place because the earth's five billion inhabitants are forced to live on 30 percent of its surface. These inhabitants are scattered about in dense pockets. Trade takes place because people don't always live where natural resources occur. Large petroleum resources in the Middle East and the North Slope are great distances from petroleum-consuming populations. Australia, Argentina, and the corn belt of the U.S. produce surpluses of food but are sparsely inhabited.

Finally, technical productive capability does not always occur close to areas of human need. The consuming masses of Southeast Asia live across the water from the efficient factories of Japan, the United States, and Western Europe.

All this leads us to accept the necessity, and indeed, the importance, of trade. Trade is an irrevocable part of our lives, and in spite of various antitrade movements, will continue to have a profound impact on all of us.

A Short History Of Maritime Transportation

Several nearly catastrophic events have shaped maritime transportation during the past 50 years. While it is not likely that similar events will take place during the next 100 years, these past occurrences have an impact on the future of maritime transportation.

World War II demonstrated for the first time that large volumes of goods and people could be moved quickly across the world's oceans. This volume of maritime traffic was maintained after the war and soon increased with immediate postwar movement of materials provided for in the Marshall Plan. The reconstruction of Europe brought a shift in maritime traffic from food for Europe to manufactured goods and raw materials for the rest of the world.

The rapid liberation of nations from Asia and the Southern Hemisphere also changed trade patterns. Trade routes lengthened and major routes around Africa and South America were added to rapidly expanding trans-Atlantic and trans-Pacific routes. Ship sizes grew rapidly, ships became more specialized, and ports began modernizing.

Japan rose from a defeated nation to become the second most important trading partner for the United States in the early 1980s. This nation, poor in natural resources, turned to

maritime transport to feed raw materials to its factories and to send its products around the world. Dependence on maritime transport put Japan in the forefront of ship innovation and ship building.

Since 1928, the gross domestic product of the United States has increased by a factor of six; in Japan, 17.8; in West Germany, 7.1; and in Britain, 3.4. Since 1945, world growth has averaged 6 percent annually.

Frantic substitution of petroleum for coal fueled much of this growth, but the greatest industrial growth took place in areas far removed from petroleum sources. Cost-efficient transport of bulky petroleum required ever larger tankers.

During the peak of world petroleum movement, the Suez Canal was closed. Petroleum bound for Europe and North America from the Middle East had to be transported more than twice as far as before. The most economical tanker size also more than doubled, and continued to increase until the 1970s petroleum crisis.

The modernization of world finance and banking systems has been a largely unrecognized contributor to world trade growth. This is especially important across the Pacific where cultural and language barriers make a common trade technology more critical.

Increasing trans-Pacific trade has made specialization in cargo, ship, port, and trade services possible. The result has been technological innovations such as Ro-Ro (roll-on, roll-off) ships, pure auto carriers, pure container ships, bulk petroleum terminals, bulk ore terminals, container terminals, and in the 1980s, intermodalism.

Less visible but of equal importance has been the paperwork revolution. Universal computer availability, the telex, and now the fax have made it possible to move a container of VCRs from Nagasaki to Tacoma via liner, to Baltimore by unit train, and on to Rotterdam without opening the box or holding the cargo for more than a few minutes en route.

Economic Events Play an Important Role

We are currently enjoying an unprecedented period of world peace, notwithstanding conflicts in the Middle East, Central America, and several other hot spots. Certainly, it is unlikely we will ever again see conflicts similar to those of the twentieth century, including Vietnam. While there may be more Afghanistans, more Iran-Iraqs and more Nicaraguas, experience has shown us that disturbances on this scale do not interfere with the larger trends in maritime transportation. Yes, this even includes the mining of the Gulf of Hormuz and the subsequent damage to petroleum tankers in these waters!

There will be economic crises, resource crises, and even political crises in the twenty-first century, but unless they turn into international disasters, they will generally be short-lived. They will be short-lived because governments are becoming more rational, more technocratic, and more international; because communication now reduces the chance of misunderstanding or misinterpretation; because the people of the world are more world conscious; and because in the twenty-first century we will all be tied much more closely together through our economic activities.

There is no reason to expect a dramatic slowdown in economic growth, at least over the long run. As we continue to use up more of the earth's nonrenewable natural resources, we are learning how to obtain more from the earth's most valuable renewable resource—people. We are on the verge of a breakthrough in education, a breakthrough that will produce an economic boom greater than any we have seen. Already, we are discovering ways to bring five-year old children to the educational and intellectual level of young adults. The widespread use of new educational methods will increase the average intellectual capability of the earth's population fourfold.

Before the end of the twentieth century we will see the emergence of more newly industrialized countries (NICs) in Asia— Thailand, Indonesia, India, and eventually the Philippines. If it can happen in Singapore and Taiwan, it can happen anywhere. We are on the verge of a NICs phenomenon in South America—Brazil, Argentina, Chile, and Peru. The stabilization of democracy in Mexico will be seen by the end of the twentieth century and after a period of adjustment, that rich nation will join the NIC ranks.

More dramatic will be the capitalization of China, with access to that country opening to the rest of the world. The Soviet Union is more difficult to predict. Will the boldness of Gorbachev lead the Soviets to abandon Marx and Lenin or retreat to Stalin? The economic bankruptcy of Communism is becoming more difficult to disguise. This will encourage more of the

Soviet Union's proxy states to turn to some form of capitalism whether the Soviets can make the painful change or not.

Technology Also Plays a Role

There is abundant literature describing the dramatic changes in marine transportation technology since 1940. The song of the container revolution, the supertanker evolution, and now the intermodalism boom is played in every industry periodical. However, a more important technological change has not received its due.

The technological revolution in the business world is greatly reducing delays in the transportation system, increasing transportation security, raising the quality of administration, management, and the bureaucracy, and improving the flow of paper, information, and money worldwide. Improved utilization of computers and telecommunications has removed much of the hands-on work in marine transportation business.

The paperwork revolution also makes it possible for very small enterprises to obtain all the economic and financial advantages of large enterprises. Computers, telecommunications, and the specialization of business services have removed the economic advantages of large groups of workers under one roof. This is significant for marine transportation enterprises and for enterprises producing goods and services for trade.

The average enterprise size is decreasing and will continue to decrease. These smaller enterprises produce goods and services customized for the individual market and even the individual consumer, and at a lower cost.

The Bold Look Forward—Shipping Technology

The growth of smaller national economies as well as the larger economies will require the continued use of small ships as well as large ships in the foreseeable future. Each ship type and size will find its most economical niche. However, the continued push for efficiency will result in more specialization and ever larger ships. Even smaller ships will become more efficient.

Dramatic changes in ship operating technology is not likely since there is still much to be gained by incremental improvements in current operating technology. For example, nuclear power, underwater ships, and large nondisplacement hulls will continue to be cost effective only in very special situations. Internal combustion engines will be refined, propellers will be made more efficient, and incremental improvements in current sail technology will occur.

And Port Technology

These evolutionary ship changes will be accompanied by evolutionary port improvements. Typical will be larger container cranes, more cargo specialization, and the increasing use of load centers. Deeper drafts will be obtained by moving ports closer and into the sea as dredging becomes less cost effective.

And Marine Transportation Business

The business of marine transportation will see the most dramatic changes in the next century. Wheel houses will look like the cockpit of a Boeing 747. Propulsion, navigation, and cargo handling cabs will be standardized, computerized, automated, and safety designed. Ship's crews will be specialists at operating and managing electronic and highly technical equipment. This new, more efficient ship operating and management technology will rapidly move to smaller and smaller ships.

More modern navigation systems will allow ships to always find the most economical and safe route and speed between two points. The ships will spend less time at each end of their routes as just-in-time scheduling is introduced at the ports.

This just-in-time scheduling for ships will match the just-in-time scheduling for materials needed for manufacturing, wholesaling, and retailing. Inventories will be within the transportation system and not in warehouses. However, continual pressure to lower transportation costs will result in more consolidation of cargoes and more use of standardized shipping units.

The containers will be the same, but the contents may be a live cow or a vase, all bound for common destinations. The carrier doesn't care what is inside, or may not even know. The paperwork will be automatic.

The maritime service sector will outpace shipbuilding, ship operations, and port operations in the number of employees and importance. The majority of employees in the maritime transportation industry may never see a ship, a port, or a cargo, yet they will be critical to the entire system.

Finally, the Politics of Marine Transportation

The politics of marine transportation will be different in the next century. In spite of the work of international organizations, some nations and groups continue to seek special-interest treatment. However, economic reality makes these efforts increasingly ineffective. The next century will see an abandonment of these special-interest rules and regulations in favor of free trade. For example, more Third World economies will take their place in maritime transportation by virtue of their economic performance and efficiency and not through special protection or subsidy.

This will leave the shrinking family of poor nations ineffective in obtaining economic advantage through the political process. Pressures to get their economies in shape and trade openly with the rest of the world will become irresistible.

Back to the Basics

While the distribution of the world's population will change, that distribution relative to the natural resource base, and of increasing importance, relative to the productivity base, will still be uneven through the twenty-first century. Therefore, trade on a wide scale will grow, and more nations will be unable to extricate themselves from complete dependence on trade.

Continued economic growth, albeit with some aberrations, will force us to make ever better use of scarce marine transportation resources. Fortunately, the boom in intellectual technology and ability will make this possible. Sure, there will be increases in ship efficiency and cargo handling efficiency. But the most dramatic improvement gains will be in the management of the system—in the business of marine transportation.

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What Is Needed for Trans-Pacific Partnerships?

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I've heard it said that speeches projecting the future fall conveniently between thought on the one hand and action on the other—and that too often they substitute for both. That is probably true of my remarks, but I won't let that dissuade me. What I really want is to simulate some thought—and, even better, some action—in you.

My focus is a little different from that of the others. While most discuss what's in the ocean, my subject is what's across it.

I'm going to be the heretic: From a trade standpoint, the interesting thing is not that the ocean has untapped potential— but that the ocean has virtually disappeared.

For most of our history, the sea has been like a barrier between us and the countries of east Asia. Now—through modern transportation and communication systems—that barrier has been dropped. The wall is gone. Telecommunications and modern air travel have, in effect, wiped out the ocean.

This is a monumental change. Imagine what the world would look like if we really took out the oceans and compressed the land masses. As wild as that may sound it would be a realistic portrayal of the economic world of today, because when you take out the oceans, the world shrinks. And that, from an economic viewpoint, is precisely what has happened: The world has shrunk.

Look at the trade statistics.

In 1988, almost one-fifth of the United States' industrial production was exported. U.S. exports exceeded $220 billion a year, providing direct jobs for 5 million American workers. Almost three-fourths of American projects in 1989 compete directly with merchandise from abroad. Our major competitors are Japan and the newly industrialized nations of the Pacific Rim—Taiwan, South Korea, Singapore, Hong Kong, and Malaysia. The United States did more trade with these countries than with all of Europe combined.

What about Oregon? Our future, too, is plainly tied to Pacific Rim commerce. Our top three export and import partners are Japan, Korea, and Taiwan. And we have become a rapidly growing center of direct investment for these nations. Since 1984, the Japanese alone have invested more than $400 million in our state and have added almost 2,000 jobs to our economy.

These are more than just interesting statistics. In my mind, they are a call to action. The global economy is not something coming at us tomorrow: The global economy is here—now—today. The need for us to open our view to a wider world is here—now—today. The urgent need to creatively position ourselves in the global marketplace is here—now—today.

There are those who say we don't have to make the effort. Pacific Rim trade is already coming to us. Foreign investors are seeking us out. We're going to grow automatically.

To them I say—it is the difference between having control over your own fate or giving that control to others. It is the difference between being an economic power in your own right—or being a trading colony.

The fact is if we want "the century of the Pacific" to truly be our century, here in Oregon, we must make it so. We must make the effort to get to know our foreign neighbors, to learn their languages, to better understand their cultures and economies.

The whole world seems to be courting the business of these east Asian economic powers. If we want them to choose us, and choose us on our terms, we must be able to relate to them and understand them and their needs.

We already have some points in our favor. In a recent survey for Portland State University's International Trade Institute, Asian businessmen in Oregon listed what they liked and disliked about doing business here.

On the plus side, they liked the way we got rid of the state unitary tax. They cited our superior port and import-export transportation facilities. They like the relatively low cost of living and doing business here and the proximity to Japan. They were impressed with our clean environment and scenic beauty, our abundant water supply, and our overall sup-

port—by the government and the community—of foreign investment.

What didn't they like? They didn't like our overall tax structure—especially our high property taxes. They didn't like our crime rate. The quality of education here, at all levels, was below their expectations. They were disappointed in the lack of commitment to science, research and development, and innovation in our state. In some cases they found language differences to be a barrier to good communication. And, finally, they said it was not clear that Portland held any distinct advantage as a place to do business on the West Coast.

What does that tell us? It tells us that to attract international partners on terms consistent with our interests, we must start with the basics: our tax structure, safety in our communities, the quality of our education, drug problems, the plight of the disadvantaged. Until we've cleared the deck on these fundamental issues, we will make little headway on the next level of effort.

That second level involves, in my mind, a broad, intense effort to indoctrinate our citizens into "global thinking"—to help us better understand our east Asian neighbors.

We have a lot of catching up to do. The Japanese have become virtual experts on us. Now Korea, Taiwan, and other east Asian countries are following suit.

How have these countries made such deep inroads into American consumer markets? It has not been by luck or by chance. They've done it through tireless investigation into American culture, language, habits, needs, and markets.

We need to make the same kind of effort to learn about them. And that will require a fundamental change in the American way of thinking.

We in the United States have grown so accustomed to the world dancing to our tune that many of us won't even acknowledge that now another band is playing, much less that it has a worldwide audience. We're so used to everyone moving to our beat, to our rhythms, that it is a radical change for us to even consider that others might have a better way of doing things—and that, indeed, we should pay attention to them.

Frankly, we've become arrogant, lazy, and complacent. And until we humble ourselves to the task of learning about others, we are headed down a path of economic demise.

How can we turn the tide back in our favor?

The obvious place to start is with our educational system. Some people will say that's the same old remedy we always give for solving our problems: educate our students to make American business more competitive, educate society to reduce crime, and so on and so on.

But the fact is, an international orientation is a must for playing in the international ball game. Until we understand something about how the other team operates, we aren't even in the game.

Many of our educational institutions are taking steps to meet this challenge. Colleges and universities throughout Oregon have increased their offerings in Asian foreign languages and east Asian and international studies. Students can earn a bachelor's degree in international business now at Oregon State, or an MBA in international business at the University of Oregon.

Student exchange programs, particularly involving Japan and China, have been expanded. Foreign student enrollments are up, with noticeable increases in the number of east Asian students. There are some exciting international programs at Oregon State, the University of Oregon, Portland Sate University, the University of Portland, Pacific University, Lewis and Clark, and other institutions.

Progress is also being made at the high school level. For example, did you know that Oregon now offers more hours of Japanese language classroom instruction at the secondary school level than any state except Hawaii?

All of these are marvelous developments, like shining stars in a big sky. But if we really want Oregon to stand out in the new world marketplace, we must light up the whole sky. We must take a more coordinated, strategic approach, so we can reach more people and make the fullest use of our limited resources.

It isn't enough to offer a foreign language course here, or an international studies program there. We need to integrate an international and intercultural perspective into our basic curriculum at all levels—kindergarten through postgraduate school.

The need for elementary school programming is especially acute, and not without problems.

For example, there is a special challenge in exposing students to foreign languages and cultures before they reach high school: Their parents don't know anything about these subjects. It's like teaching a child to read when his parents are illiterate. It puts an even heavier burden on the teachers and the schools.

We need to better train our teachers to provide a global perspective in their classrooms, at all levels. And, where exchange programs are available, we need to encourage students to take advantage of them. It's a sad fact that when college students in Oregon now have the opportunity to study in some 25 different countries, only a few take advantage of it.

Lord Chesterfield, the eighteenth century English diplomat and writer, once wrote, "Knowledge of the world is only to be acquired in the world—and not in a closet."

So often we hear about Japanese students coming here to study. This year, "Asia University" in Tokyo will begin requiring its students, as a prerequisite for graduation, to spend five months of study in the United States. (Parenthetically, one of the four institutions where they'll be studying is OSU.)

By comparison, the number of Oregon students or teachers who study in east Asia, or even visit there, is small.

A number of people have been working to change that, and some of their efforts are bearing fruit. The governor has just announced an exciting new exchange program being jointly sponsored by his office and the Kyotaru Company, one of Japan's largest restaurant companies.

Under that program, six Oregon elementary and secondary teachers will be chosen each year to study and travel independently in Japan for three weeks. After they return, the teachers will prepare coursework that can be used in their own schools and shared with others. They will also conduct school and community programs about their experiences. Six teachers a year is not many, but what a wonderful way to get the ball rolling!

Once our young people are better educated in the ways of the world, we must take the next logical step and put their newfound knowledge to use, here.

We are not doing a very good job of that so far. Today, many of the students who have been educated in multicultural studies, foreign languages, and international trade can't find jobs. They aren't being picked up by the business community. And the loss is ours. We're wasting a precious resource.

Here are students who are already culturally sensitive. They are actively interested in the world around them. They have acquired some knowledge of value in an international context. And what are they doing for employment? They're counting the Hyundais coming off the dock, tabulating import and export trade figures, documenting foreign purchasing.

Can't we do better than that? Sure, we can't use students fresh out of college for our most prestigious work in international public relations or as top-level liaisons. But can't we figure out more creative and productive ways to put their skills to use? What about internships? What about special projects? What about helping us evaluate foreign trade opportunities?

Our educational institutions are positioned to be a powerful aid to businesses that want to expand their international trade. And, more and more, our academic institutions are taking a strong interest in this kind of community- and business-based education.

For example, a National Resource Trade Consortium was recently formed at Oregon State University. It is doing research for Oregon's natural-resources-based industries, particularly forest products and agriculture.

The consortium includes representatives from OSU's colleges of business, agriculture, and forestry. They're working one-on-one with industry representatives on three main issues. First, the consortium is exploring the notion of "value-added." How can Oregon's wood products and agricultural industries add value to their commodities for export? Second, the group is identifying current barriers to international trade. And, third, it is doing long-term "futures" research, projecting the demographics, consumption patterns, and political and economic trends in east Asia.

A consortium sponsored by the International Trade Institute has already analyzed the impact of the new U.S.-Canadian free trade agreement on Willamette Valley farm producers. It has offered suggestions on specialty crops and market niches that might be pursued.

That's the type of valuable, practical research our businesses need and our academic institutions can provide. These programs should be encouraged and expanded.

The hardest part of any cause—after all the dreams and ideals have been laid out—is to narrow the mission down to a concrete call for action.

I don't have one.

There is no single action that will allow Oregon to become a meaningful participant in global trade. But there are two changes we can strive for, starting now: a change in the way we think and in what we think about.

I'm a firm believer that "action follows attitude." If we can adopt an inquisitive attitude

toward our foreign neighbors and recognize the urgent need to better prepare ourselves for life in a shrinking world, constructive action will follow.

Thinking globally can seem overwhelming. But remember that old adage: "Even the journey of a thousand miles must begin with a single step."

For you, that step may be hiring a college student as an intern to help your business or your project analyze international markets. Maybe it will mean working with your school board to promote more international programming. Perhaps you will encourage your own son or daughter to learn an Asian language or study abroad. Or you may choose to get actively involved in supporting the governor's agenda for educational change and restructuring in this state.

James B. Conant, a famous educator and former president of Harvard University, had a poster of a turtle on his office wall. It read: "Behold the turtle. He makes progress only when he sticks his neck out."

If we're going to make progress in this international arena, we must be willing to stick our necks out. It's time to come out of our shells—to take a good look around us at what's happening in the world.

Yes, in an international trade sense, the ocean has been removed. And it's time we got to know our next-door neighbors.

John F. Kennedy once said, "It is the task of every generation to build a road for the next generation." That is our challenge. We can pave the way for an exciting, prosperous future for ourselves, our children, and our grandchildren. So let's move from thought to action. Oregonians, let's go for it!

Sea Grant: The New Paradigm

Ned Ostenso
National Sea Grant College Program

Forecasting the future is risky business. We must be clairvoyants or egoists to predict what will happen in years hence. There are mercifully few of the former and multitudes of the latter. Humble morals can see the future only as projections of the past, and prognostication is uncertain even when events appear to be progressions along a continuum.

Still, we must plan for the future and organize our institutions accordingly—universities into disciplines, governments into functions, and industry into products. These corridors of discipline, function, and products direct our thoughts and actions. Ant it is these structures that now hinder rather than facilitate progress. Daniel Greenberg (1) aptly describes the resulting frustration.

> Today, however, the political system is obsessed with both frugality and an overblown faith in research as an economic elixir. But, in matters ranging from the initially slow response to AIDS to the astonishingly inept management of the space program, politics feels let down by its cherished research establishment. Having supported it lavishly for decades, it now find the research system creaky and unresponsive to changes in political and economic concerns. Science, in turn, finds the political system failing in its long-established role of paying for the programs and equipment that underpin the practice of science.

I hold that the true genius in the Sea Grant concept is its ability to work across traditional boundaries. Central to the Sea Grant concept are comprehensiveness and purposefulness.

Invention is a complex process relying most often not upon the advance of an idea, but the confluence of several ideas. This can occur ad hoc, but Sea Grant actively promotes dialogue among idea generators from different fields. Invention, no matter how innovative, is useful only when it is adopted by entrepreneurs and policymakers. Thus, Sea Grant is assertive in attacking the traditional barriers between discovery and application, between the problem and its solution, between opportunity and its fulfillment. The key to our success in untying the Gordian Knots of purposefulness and comprehensiveness has been the partnership between academic institutions and a federal agency with a mission. This intellectual partnership is made possible by brokers called Sea Grant directors who have the license to range throughout the talent of their states.

The modern history of science in the United States really begins with the close of World War II. Although significant discoveries were made during the war (radar, synthetic rubber, jet engines, nuclear bombs), the research effort was an anomalous marshalling of talent for a specific duration. Not until after the war did the federal government institutionalize massive support for research at large universities. This approach has served us well, for we have progressed far in the search for knowledge during these intervening 40-plus years.

Another aspect of the post-World War II approach was that of a federal agency supporting an individual investigator (or small groups) for a finite period to fulfill the terms of a specific proposal. The selection process and the relationship between sponsor and researcher may have varied from time to time and place to place, but the structure was pretty much the same and it worked to advance the function and products of science. This structure is no longer sufficient.

Now, the issues salient to our society come with a complexity and necessity that call into question not only what we are doing, but how we go about it. Alteration of the global habitat, competitiveness in a world economy, and disposing of humanity's waste products, for example, are very urgent issues. They are intrinsically interdisciplinary and require attack with technical activities ranging from basic research to commercial application.

Meanwhile, the whole field of marine research has been going through a remarkable revolution. My generation and its predecessors were geologists, chemists, biologists, and geo-

physicists who chose to ply their trade in the oceans. This led in turn to the discipline of oceanography. The newer generation of oceanographers busied themselves trying to describe oceans and their deterministic properties. These oceanographers left behind an intellectual residue that is emerging as "marine science." The marine scientist is less interested in describing the oceans than in studying physical, chemical, and biological processes that occur therein (for example, aquaculture, marine biotechnology, energy and chemical fluxes that relate to climatic and air quality change). Oceanographers and marine scientists are, strangely, quite distinct. They do their own thing, produce and read their own literature, and belong to their own societies.

The National Sea Grant College Program became the first federal program to support the full spectrum of marine science. Now, we must reassess our sense of mission. Whereas we have considered resource and economic development as our raison d'etre, we need to take a broader view. Surely the societal impacts of climatic change, acid rain, greenhouse warming, and ozone depletion will be greater than the development of a given fishery. Just as surely, a better understanding of the geography of the oceans is relevant to understanding these processes. But is that sufficient? I think not. Our experience in involving the social, physical, and biological sciences and engineers to address problems in, for example, aquaculture, must be replicated in addressing our civilization's problems on a changing and fragile Earth. If we cannot be the way, we must show the way. I believe we can. And I believe we will.

But Sea Grant cannot meet all the challenges, for we are confined to marine issues. A more interesting question is whether the Sea Grant paradigm can be applied to other national issues. I think it can. Let me suggest two candidate topics: energy and waste disposal.

Improved energy efficiency, alternatives to fossil fuels, and conservation are important parts of our energy policy. Why not have an organized collegial network of universities working to address these opportunities? Long-term research is needed (versus faddish crash programs) to better develop sources of energy other than fossil fuels and to use energy more efficiently. For example, no thought is being given to harvesting the enormous thermal energy available along the vents of seafloor spreading.

Keepin and Katz (2) report that since 1973, improved energy efficiency has reduced U.S. CO_2 emissions by 30 percent, with a concomitant cut in the nation's energy bill by $160 billion per year. Yet enormous opportunities still exist. For instance, replacing a single 75-watt incandescent light bulb with an equally bright 18-watt compact fluorescent bulb eliminates the burning of 400 pounds of coal per year and saves the consumer $15. Full use of efficiency improvements in the United States could cut today's energy consumption in half, reduce CO_2 emissions accordingly, and save an additional $220 billion annually. What an opportunity for an energy extension service!

Education and outreach are needed to transfer new technologies and develop an energy literate society (sound familiar?).

Ultimately the United States must factor nuclear power into our national energy strategy. An imaginative transformation of the Marine Advisory Service to an energy advisory service might include a specially trained "corps" to design and oversee construction of nuclear power plants and to supervise their operation. This energy corps would be employed by a national energy institute rather than by power companies. Such an arrangement could once again instill public confidence in the design, construction, and operation of nuclear power plants, especially if the employees existed outside pressures of politics and profit.

As a nation, we have developed an emotional and political gridlock that prevents real progress to solutions best for our long-term interests. Must our fossil fuel needs continue to rise while our air quality continues to deteriorate? To break this gridlock, we may need an institutional approach that can serve as a platform for reasoned debate, establish a source of objective expertise, and rekindle public confidence. I believe the proven Sea Grant paradigm represents such an approach.

In a similar vein, we are unable to come to grips with an escalating waste disposal problem. In the United States, we produce 157.7 million tons of waste per year, including an increasing array of exotic chemicals and materials at an annual disposal cost of $4 to $5 billion. Our options for their disposal are becoming politically proscribed. The residual options, set mainly by precedent, are not only inadequate but present threats to human health. For instance, most waste is disposed of at or near its source, rather than remote from population concentrations.

Ninety-seven percent of the Earth's water is in the oceans in a form toxic to human consumption. Of the remaining three percent, two are tied up in ice. This leaves a mere one percent available for our use as potable water in lakes, streams, and groundwater. Yet our disposal practices continue to contaminate this most precious one percent. Public feeling against the very thought of increased ocean disposal is sufficient to serve as an effective barrier to balanced discussion and aggressive research. Whether or not alternative options for disposal of various wastes are best for our environment, health, and economy can never be answered if the questions are emotionally debated rather than logically addressed.

Again, this is where a long-term, university-based approach may move us forward rationally. There is a need for multidisciplinary research directed to understanding the best solutions for specific problems in waste disposal. We must reduce our production of waste per unit of consumable product. In the United States, every man, woman, and child discards 1,498 pounds of rubbish per year, whereas the average per capita waste generation is half that amount in West Germany and Japan. Their living standards are not proportionately lower than ours. Do we need to dispense hamburgers in styrofoam containers whether they are to be eaten across town or across the hall? Let's look for a degradable alternative for thermal and packaging insulation. We need a waste literate society. Should we have to be asked at the checkout counter whether we want our groceries in a paper or plastic bag? Aside from technical innovations, are there creative incentives or disincentives that may be applied to our producers and consumers to make them more waste responsible? All of these questions would be fit topics for "Waste Grant."

Oceans of opportunity exist for innovative reuses of what we now throw away. As Athelstan Spilhaus opines, waste should not be treated as a nuisance to be disposed of, but rather a resource to be used. The socioeconomic structure of our culture should be modified to consider the total costs of products from their manufacturer to their disposal. The list of issues goes on and on. The point is that the issues associated with our nation approaching a more benign accommodation with its consumption are intellectual topics and appropriate grist for the academic mill.

On many fronts, we need an approach to research more sophisticated than that of the past. The National Sea Grant College Program within its sphere of responsibility has achieved that necessary level of sophistication—namely, to conduct multidisciplinary research without watering the stock of the individual disciplines; to travel the distance from discovery to application without getting lost on the way; and to be purposefully directed without being stifling.

My conclusion that the Sea Grant paradigm can be applied to other issues should come as no surprise. Despite my opening misgivings about predicting the future, there is no certainty from our recent past. Sea Grant, in its two decades of existence, has shown there is no such thing as an isolated ocean program. The oceans drive the climate. The climate drives the weather. The weather drives recruitment of fish stocks. The lithosphere drives the chemistry of the ocean, which affects the chemical cycles of the atmosphere and the biosphere that is our water planet. As Shelley so aptly put it:

> Day and night, aloof, from the high towers
> And terraces, the Earth and Ocean seem
> To sleep in one another's arms and dream
> Of waves, flowers, clouds, woods, rocks, and all that we
> Read in their smiles, and call reality.
>
> *Epipsychidion* (ll. 508-512)

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1. D. Greenberg. 1988. Science and Government 18(13):1.
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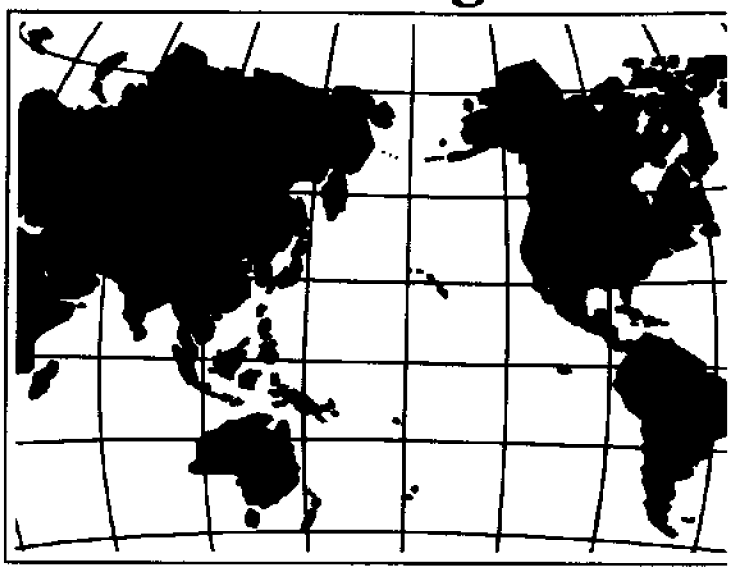
Philosophy of Resource Management



Getting Ready for Pacific Tourism

Marc L. Miller
Institute for Marine Studies, University of Washington

> You can't hop a jet plane
> like you can a freight train. . . .
> — *Gordon Lightfoot*

Tourism is a vexing topic. On the one hand, it is fun. On the other hand, it is a serious business capable of radically changing societies and the natural environment. As the archetype of cross-cultural contact, tourism entails the movement of people, ideas, and money. It creates images that influence how people think about one another.

Tourism is also controversial. When it goes well, benefits are found in improvements in international relations, well-being (for example, as measured by levels of education and health), services, and economies. When tourism goes poorly, costs are reflected in patterns of social disorganization, crime, failing economies, and, occasionally, environmental degradation. Being a responsible tourist in the twenty-first century requires some effort on our part.

Growing up in America virtually guarantees first-hand experience with travel and tourism. Indeed, the business facts of tourism are impressive. The United States is the foremost generator of tourism expenditures and tourism receipts. In 1987, for example, tourism in the United States accounted for

- $292 billion from domestic and foreign visitors, an amount greater than 6.4 percent of the gross national product;
- the direct employment of 5.5 million Americans;
- more than $58 billion in wages and salaries;
- and more than $34 billion in federal, state, and local tax revenues (1).

The travel and tourism industry is also important in other nations. The global presence of tourism is illustrated by several statistics:

- In 1986, domestic and international travel combined to generate $1.75 trillion, with tourism contributing roughly 12 percent of the world's gross national product (2).
- In 1986, the total volume of world travel was estimated at 4.1 billion tourist arrivals (3.73 billion domestic arrivals combined with 340 million international arrivals), an increase of 4.9 percent over the previous year (3).

Figures of this magnitude support the contention of many experts that tourism is destined to be the world's largest industry by the year 2000.

Pacific Problems

The fastest growing tourism region in the world encompasses East Asia and the Pacific (map 1).[a] Domestic travel in this region increased by 8 percent between 1985 and 1986; international travel to the area (measured at 12 percent of the world total) expanded by 6.8 percent over the same period (3). It has been predicted that one-third of all international travel will emanate in the Pacific by 1990 (4). Not surprisingly, the United States is the leading origin of travel to East Asia and the Pacific.

It appears certain, then, that the Pacific will loom large in our future. We will have ample excuses to travel the Pacific, and some of us will no doubt represent the tourism industry. We will all have the opportunity to reflect on the good and the bad of Pacific tourism. Are we prepared?

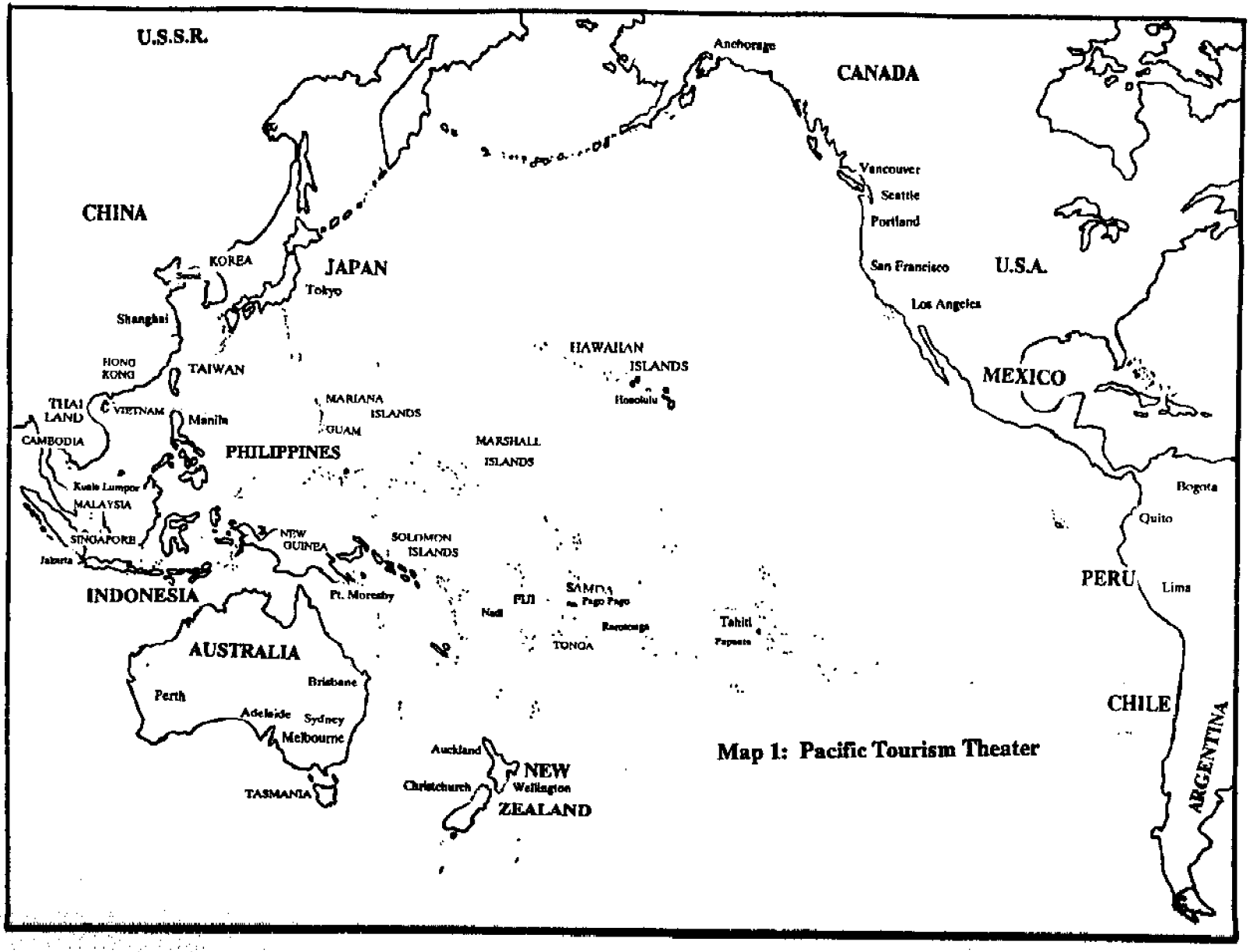
Why We Can't Draw the Pacific Ocean

The Pacific is the largest and deepest of the world's oceans.[b] Together with its marginal seas—the Bering, Okhotsk, Japan, Yellow, East China, Philippine, South China, Coral, and Tasman seas—the Pacific measures 179.7 x 106 square kilometers (5).

If you should try, right now, to draw a map of the Pacific, chances are very good that you would be less than pleased with the results. One reason we have such a poor conception of the Pacific is that we are less sensitive to the contours of "negative" space than we are to the outlines of land. Another reason is that the Pacific is usually not presented on maps as an

[a] North and South America are here taken as a separate region.

[b] Excluding marginal seas, the Pacific (165.4 x 10^6 square kilometers) is more than twice the size of the Atlantic (82.2 x 10^6 square kilometers). It is true that, as some point out, the latter has an area closer in size to a glass of water than to the former. (The times atlas of the world. 1975. Comprehensive and 5th edition. N.Y.: New York Times Book Co., p. xvi.)



Map 1: Pacific Tourism Theater

unbroken body of water. More often we see pieces of the ocean. Even less frequently is the Pacific centered on maps. But the biggest reason probably stems from the sheer size of this ocean. The Pacific cannot be seen in its entirety even with a globe. And, of course, the shape of the Pacific is necessarily distorted when it is projected onto two-dimensional surfaces.

Why We Can't Label Pacific Nations

Try to match the names of Pacific nations with their land bodies (or even try to list them). Again, chances are good you will be disappointed. What Americans can label in the Pacific is partly explained by one positive image and three negative ones. The positive image is the tropical paradise we associate with Hawaii and Tahiti. The negative images are those of three wars—World War II, the Korean War, and the Vietnam War.

One key to the geography of the Pacific comes with an understanding of human history. In modern times, the United States and Japan have had the greatest physical presence and sociological impact in the multicultural Pacific. The pan-Pacific influence which the U.S. exerts today is well known. Many people, however, are less familiar with the size of the area of the Pacific controlled by Japan during World War II (map 2). A second key to Pacific geography comes with exposure to cultural differences (6). The more we are made aware of the rich Pacific array of ethnic traditions—and the more we learn about the nature of religious, linguistic, artistic, and worldview differences—the more we are motivated to discover exactly where those cultures exist and what routes we might use to get there.

Three Tourism Concepts

Given the dramatic rise of international travel over the last decades and the rapid development of East Asian and Pacific destinations, it is clear that American vagueness about tourism and the Pacific Ocean merits corrective action. In the spirit of fostering a more articulated vision of an ocean many of us will have reason to explore, this section presents three concepts relevant to Pacific tourism. The first concept provides insight to the social organization of tourism. The second explores the social change linked to tourism. The third introduces a way of thinking about Pacific destinations.

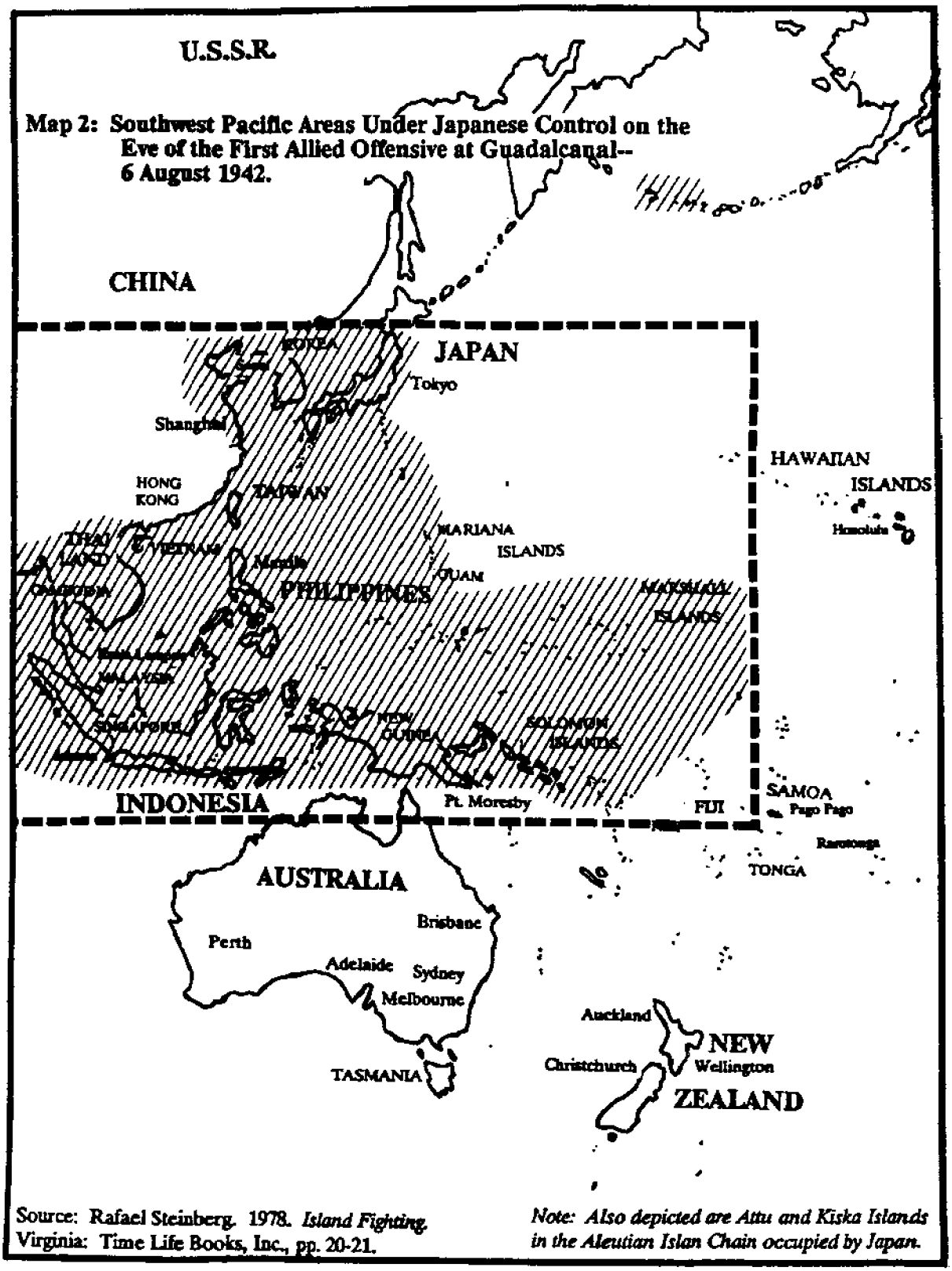
Tourism Systems

From a sociological point of view, a tourism system is composed of *tourists, locals,* and *brokers* (figure 1) (7). Tourists are the temporary visitors at tourism destinations who are motivated by some combination of desires for *recreational, instrumental* (for example, business), and *educational* travel (8). Locals are the residents at tourism destinations. Sometimes locals are found in traditional ethnic communities; other times locals are new arrivals. Brokers are directly interested either in recruiting tourists to destinations or in protecting the rights of locals, and are of two kinds. Private sector brokers (for example, cabbies, hotel owners, the souvenir sales force) provide services and products for tourists. Public sector brokers act on behalf of locals (and also private sector brokers), typically through land use planning and the design and implementation of economic, transportation, and other policies.

This three-part tourism system is useful in understanding tourism for several reasons. First, the system is comprehensive in that it identifies people who both effect and are affected by tourism. Second, the system distinguishes those who are indifferent to tourism (locals) from those who sponsor development (private sector brokers) or regulation and management (public sector brokers). Finally, the system provides a language for talking about how people's attitudes about tourism can change with time and opportunity as, for example, happens when tourists decide to stay on the scene and to become locals or when locals decide to become brokers to make money or in some way manage tourism.

Tourism Change

For centuries, common experience has led travellers to realize that the ambience of places can change, far too often for the worse. One theory about this change holds that destinations, like biological organisms and consumer products, pass through life stages as a logistic (S-curve) function of the number of tourists on the scene (9). To illustrate, figure 2 breaks tourism development into four phases. During the *discovery* phase, locals contend with the first wave of tourists. In the early part of the *growth* phase, tourists arrive in ever increasing numbers, often in response to the entrepreneurial activities of brokers. Later in the growth phase, the rate at which tourists visit



Map 2: Southwest Pacific Areas Under Japanese Control on the Eve of the First Allied Offensive at Guadalcanal-- 6 August 1942.

Source: Rafael Steinberg. 1978. *Island Fighting.* Virginia: Time Life Books, Inc., pp. 20-21.

Note: Also depicted are Attu and Kiska Islands in the Aleutian Islan Chain occupied by Japan.

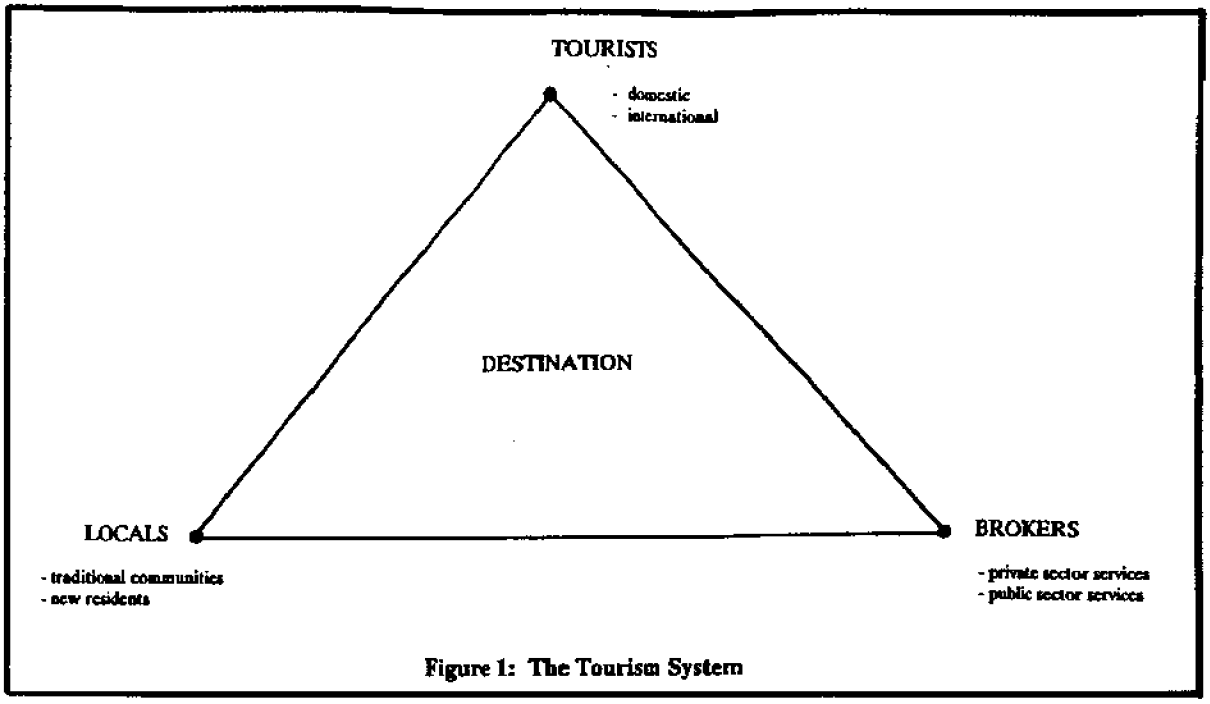


Figure 1: The Tourism System

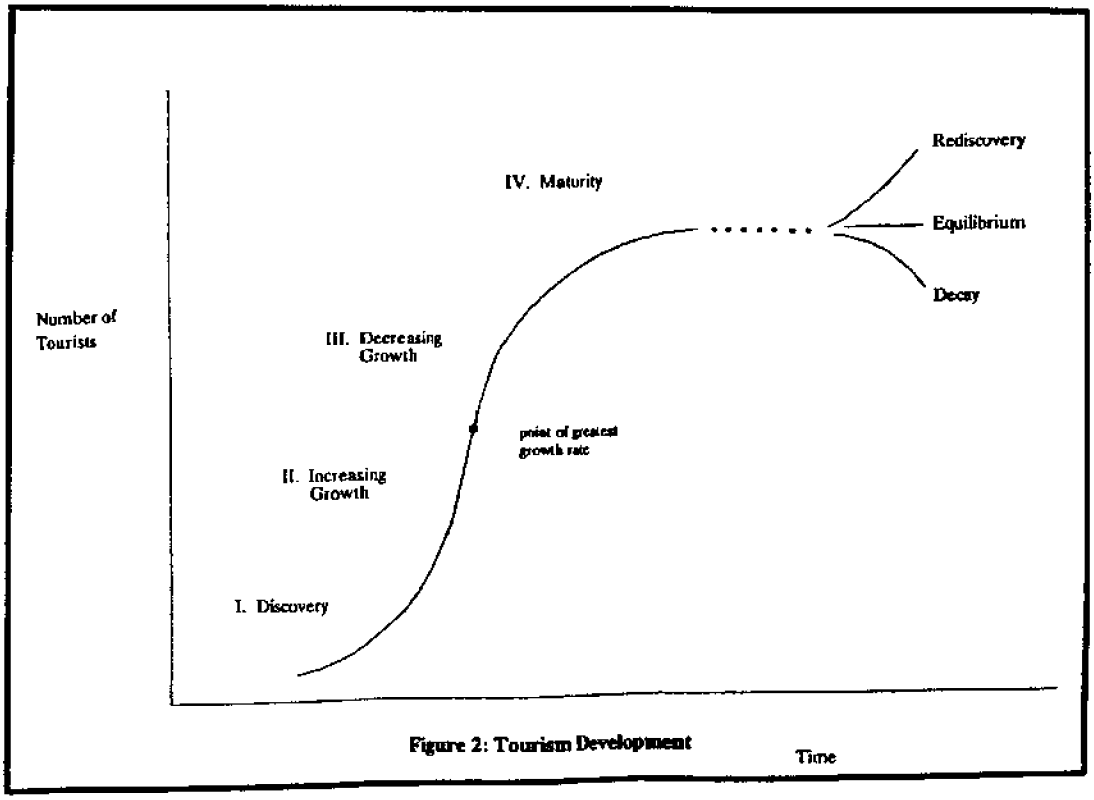


Figure 2: Tourism Development

the destination begins to decline. In the *maturity* phase, there is no variation in the rate at which tourists visit the area. When this phase ends, the destination either experiences new growth, as when new attractions or facilities are advertised, or declines, as when tourists elect instead to visit competing destinations.

Two comments on the S-curve are helpful in understanding the Pacific destinations we plan to visit. First, different kinds of tourists are found at destinations at different times. Tourists in the discovery phase typically are those who have a vigorous preference for the high contrast of exotic and undeveloped destinations and a distaste for fellow tourists. Tourists in the maturity phase, at the other extreme, are sensitive to amenities such as safety, familiarity, and comfort and seek destinations which have developed a tourism infrastructure in the company of their peers (10).

Second, the most sociologically critical time in the life cycle of tourism occurs at the middle of the growth phase where the rate of tourist arrivals begins to decline. Seemingly all of a sudden, opportunities for brokers are no longer without limit, and political as well as economic competition for market share becomes important. Locals (especially those who have just moved or retired to the area) not directly involved in the tourism industry may decide to oppose its very existence. This, then, is likely to be a period of social conflict and confusion.

Pacific Lattices

To elaborate somewhat on my remarks about Americans' patchy knowledge of the Pacific Ocean, consider how it is that when we recall our trips to East Asia and the Pacific we so poorly field questions about the names of places we did not visit, but which were near our destinations. Similarly, we are bad at knowing the locations of well-known places we did not visit. For example, when asked about a trip to New South Wales, Australia, I might fail to note that the Solomon Islands or Samoa is in the general area. Moreover, I might have no idea whether Tahiti or the Philippines was further north or which was closer to New South Wales.

Of course, I would know that I got to Australia from Seattle by flying to Los Angeles and then to Sydney, stopping briefly in Fiji because of stormy weather. (Without this stop, Fiji would not now be part of my travel vocabulary.)

This story is a simple example of how transportation routes help us to spatially organize the places we visit. In the same way that I know that Interstate-5 connects cities in California, Oregon, and Washington between San Diego and Seattle, I know that air routes tie Los Angeles to Sydney and also to Honolulu and Auckland, New Zealand.

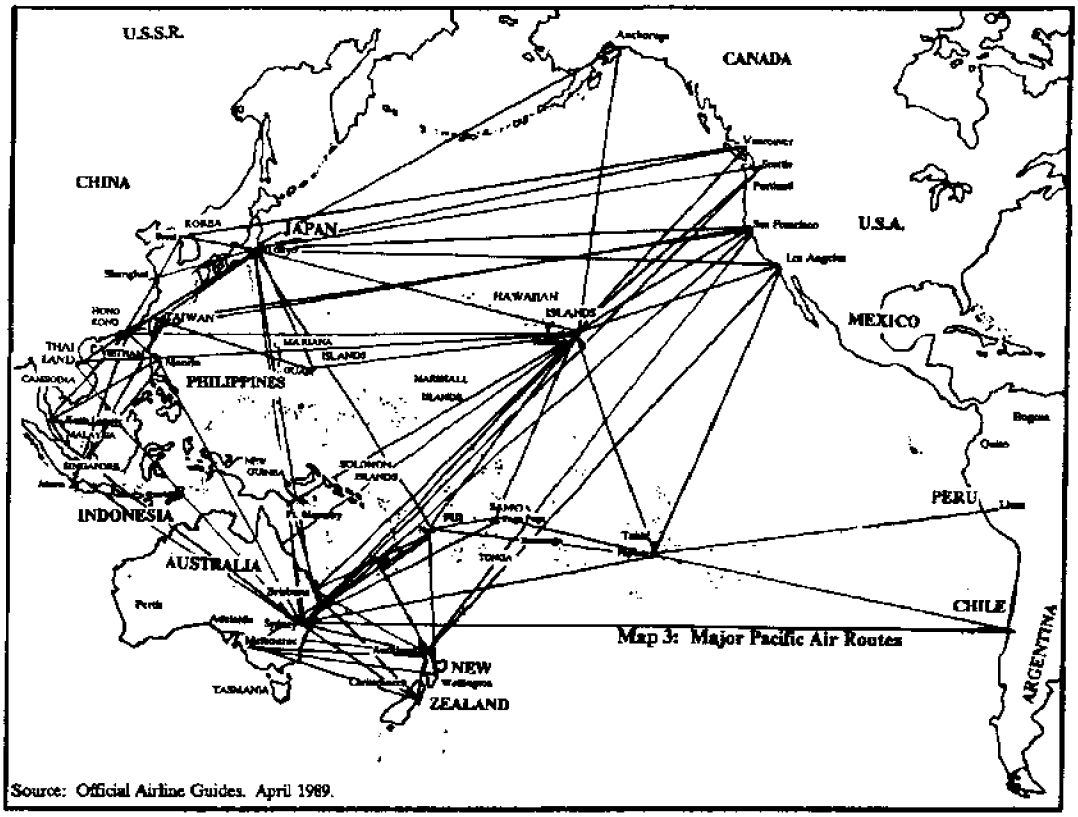
A big difference between U.S. highways and Pacific Ocean air routes is that there are so many more roads. Yet, it is a good empirical question whether we underestimate or overestimate the actual number of air routes in the Pacific. You might try, at this point, to sketch the trans-Pacific air routes you know.

My guess is that our familiarity with Pacific air routes will improve considerably in the remainder of this century. In much the same way that the coastal areas of Washington, Oregon, and California have become a single region in the minds of many of us, the Pacific Ocean will be conceptualized as a whole with orderly relations among its parts. Map 3 is presented to promote this cognitive change.

A first step to a new view of the Pacific is to learn the major transoceanic air routes. Unlike domestic service, which is characterized by hub and spoke networks, trans-Pacific routes are primarily linear (11). East-West routes can be abstracted to resemble something of a ladder-like lattice. Recent trends show that Los Angeles has displaced San Francisco as the leading American gateway to the opposite side of the Pacific, and Seattle is the fastest growing point of departure. Japan (Narita and Osaka airports combined) ranks first among eastern destinations, receiving 35 percent of all trans-Pacific flights. Australia (Melbourne and Sydney airports combined) ranks second with a 31 percent share, followed by Korea, Singapore, and Taipei. The remaining destinations receive less than 6 percent of the total trans-Pacific capacity (11).

Finally, two trends are useful in understanding Pacific travel. First, long-haul, nonstop service between the edges of the Pacific is likely to become increasingly the rule in the future, in no small part due to technological innovations in the pattern of the Boeing 747-400 aircraft which has a range of over 8,000 nautical miles. As travel industry analysts have noted:

> Growth in North American origins farther than Hawaii and the West Coast as well as growth in far destinations such as Australia, Hong Kong, and Singapore provide[s] evidence to support longer haul service. In addition, major markets for passengers are on the perimeters of the Pacific with only



Map 3: Major Pacific Air Routes

> limited traffic originating from the Pacific Islands . . . . It is unlikely that any of the islands, including Hawaii, will become major crossroads of the Pacific.(11)

Second, ethnic tourism is fast becoming important as an alternative to the "surf, sex, and sun" tourism so commonly illustrated in Pacific travel industry brochures. Thailand and the People's Republic of China are but two examples of countries whose ethnic appeal is starting to be heavily marketed.

Discussion

This paper began with statistics underscoring the economic importance of travel and tourism to the United States and the world and then suggested that Americans are cognitively unprepared for a shrinking Pacific Ocean. Three concepts—a triadic model of a tourism system, a logistic model of the rise and fall of tourism destinations, and a lattice model of trans-Pacific tourism air routes—were offered up as a remedy.

But our response to the growth of tourism opportunities in the Pacific should involve changes in our behavior as well as changes in our thinking. Whatever the reason, we Americans have great difficulty admitting that almost all of us (with the exception of the very old, the very young, the infirm, and the very, very poor) act as tourists for interludes each year. For those of us who reside on the West Coast, the odds are good we will travel out into the Pacific in the next decade. What, then, can we do to resolve our ambivalence and avoid the "ugly American" syndrome?

Certainly, part of the solution is to realize that modern "philosophical travellers" of the enlightened kind have not inherited any gift for successful tourism. More likely, they have studied the problems of travel, learned from their errors, and developed rules of tourism praxis. People who commit themselves to being tourists have better times, and so do the locals and brokers with whom they interact. Tourism preparation does, however, often go unnoticed. Giving good tourism—like giving a good party— appears effortless, but takes work.

It is encouraging to note that the positive potential of tourism is beginning to command our attention. One recent example of worldwide determination to comprehend tourism as a stimulant for economic prosperity and goodwill across nations is found in the First Global Conference—Tourism: A Vital Force for Peace—which was held in Vancouver, British Columbia, in October 1988. The conference was organized

to achieve an initial body of knowledge and a comprehensive set of realistic principles, recommendations and proposals through which tourism can contribute to: greater understanding, mutual trust and appreciation among the peoples of the world; an improved quality of environment, both built and natural; and the World Conservation Strategy of sustainable development. (12)

Another event advocating cultural diversity and informal diplomacy, the First International Conference on Cultural Tourism: Defining a Sense of Place, took place in Miami in the spring of 1989.

Tourism in the Pacific theater in the next century does not have to be unfortunate. Travel has the potential to enhance our education, international relations, and the quality of life. Striving to achieve responsible tourism is worth our time.

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Cooperative Ocean Science for Advancing World Peace: A Middle East Example

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Background

People have long viewed the ocean as an infinitely broad highway for commerce, as a source of food, and as a protective shield or convenient battle zone. For the past three decades, the seas have also been regarded as a potential source of minerals and a dump for garbage. Very recently, a new concept has been introduced in certain parts of the world, where nations are turning to management of the ocean as a basis for peaceful cooperation.

It was President Harry S. Truman who observed that nations working together were less likely to attack one another. At the time, 1948, he was referring to the possibility of persuading Israel and her Arab neighbors to cooperate on some major engineering projects of mutual gain.

Not until 1978 were Truman's thoughts translated into deeds. Then, the United States Congress passed, and the President signed, the International Security Assistance Act (PL 94-224), amending the Foreign Assistance Act of 1961. Included in this legislation was a funded program for regional cooperation in the Middle East. It became known as the "Regional Fund" and was directed to cooperative projects between Israel and her neighbors. Responsibility for the program's implementation was assigned to the United States Agency for International Development (USAID).

From 1978 to 1980, a small group of American, Egyptian, and Israeli oceanographers informally developed a series of projects in science and technology, which became known as the Cooperative Marine Technology Program for the Middle East. The program was officially accepted by the United States Agency for International Development (USAID) in 1980 as the first endorsed enterprise under the Regional Fund's auspices. At that time a body of scientists convened formally to identify future projects.

Program and Project Descriptions

The scientists (eventually numbering 12 each from Israel, Egypt, and the U.S.) based their program on fundamental needs: food, water, and land protection. Its project areas came to consist of ocean productivity, seafood toxins, aquaculture, waste water usage, shoreline protection, climate prediction, and lakes management. Teams of scientists and engineers from two dozen institutions in the three countries subsequently agreed that all projects would be conducted cooperatively, either trilaterally or bilaterally. More recently, they have also agreed that the Egyptian Academy of Scientific Research, the Israeli Institute for Oceanographic and Limnological Research, the New Jersey Marine Sciences Consortium, and Texas A&M University are to be the coordination points.

The Ocean Productivity Project seeks quantification of the eastern Mediterranean Sea's capacity to sustain intensive fishing. The Haifa Institute and the University of Alexandria, assisted by Texas A&M University and the Bigelow Laboratories, conducted a series of cruises over the first six years. Those operations featured a complete suite of physical, chemical, and biological observations, leading to intensive analyses of the phytoplankton and zooplankton populations.

The scientific objectives of the Shoreline Protection Project are to (1) determine the wave and current "climate" in nearshore waters that provide the potential for sediment transport; (2) understand the budget of sediments in the Nile Littoral Cell and the sediment sources, transport paths, and sinks; and (3) apply the principles of shore processes to the solution of erosion and other coastal engineering concerns.

The Aquaculture Projects have been aimed at accelerated and cheaper production of commercially important fishes. In addition, trading of tilapia species between Israelis and Egyptians is aimed at development of a tastier and faster-growing fish.

The Israelis were motivated to Lakes Management Research by the need to preserve Lake

Kinneret (the Sea of Galilee) as their primary freshwater source and to increase fish production therein. The Egyptians wished to apply the same technologies to increasing fish production in lakes Manzellah and Burulos and to modernizing fishing regulations.

The Wastewater Recycling Project is the most ramified of the series because it deals with a controversial subject—the use of waste water—which is still a repugnant topic in some quarters; and because, of all the projects, this is the only one involving bricks and mortar.

Sociological and Economic Achievements

This program differs significantly from conventional USAID programs in that social progress (that is, cooperation among Egyptian and Israeli scientists and institutions) is considered to be at least as important as the economic and intellectual accomplishments. A few highlights will serve to demonstrate the program's objectives.

1. The Egyptians and Israelis have conducted 19 joint planning and reporting conferences, mainly in Cairo and Alexandria to begin with, but increasingly in Haifa. A full-scale workshop is held each year, in which all of the project's principal investigators participate. With a few exceptions, American participation has been limited to the program coordinators.
2. As of 1989, 50 Israeli person-trips have been made to Egyptian laboratories, where scientists have cooperated in research and have assisted in classrooms and with graduate students. Visits to Israel by the Egyptian Under Secretary of State for Aquaculture and the Director of the Egyptian Coastal Protection Institute produced dramatic results. The latter, for instance, was appointed a consultant to the Israeli Government in 1987.
3. The Israeli aquaculturists have entered an agreement to transfer technology, as it's developed, to a coalition of four kibbutzim (collectives), which have already entered marketing arrangements with French and Italian consumers. An Egyptian entrepreneur is currently exploring the possibilities of a commercial aquaculture venture, using the Nile drainage lakes.
4. Exchange visits by aquaculturists have resulted in trading of Israeli and Egyptian stocks of tilapia for cross-breeding and other purposes.

Joint training of Egyptians and Israelis has been conducted in the United States under the Shore Processes and Tilapia projects.

Twenty students have obtained graduate degrees under the program's auspices, and their projects have generated more than 50 papers. The Waste Water Utilization and Management and Shore Processes projects produced the first coauthored publications.

Perhaps the highlight of the program to date occurred in 1983, when Dr. A. R. Bayoumi and Admiral Yohay Ben Nun (the original Egyptian and Israeli coordinators, respectively) were honored for their contributions to the program by being designated as the first corecipients of the International Compass Award given by the Marine Technology Society for distinguished service in international marine affairs. In 1985, Dr. El-Sayed received the Distinguished Service Award from the American Institute of Biological Sciences for his role in developing the program.

November 1988 marked another milestone in the program's career when a U.S. congressional delegation, led by Representative James Scheuer, met with the Israelis and a large Egyptian delegation in Elat, Israel, to reflect upon the program's achievements and consider its future. Because of aquaculture's central role in Middle Eastern technical development, the entire group then inspected Israel's national mariculture center.

Symbolic of the burgeoning Egyptian interest in the program, the nine-person Egyptian delegation (the largest yet to attend such a meeting) included Dr. Ibrahim Gohar, the pioneering leader of Egypt's marine program. His prominent role dates back to King Farouk's regime. Upon learning of his impending eighty-second birthday, the Israelis held a party featuring a gigantic cake, to celebrate. The emotional impact was enormous.

In summary, social gains seem to be self-catalyzing and progress to be exponential. Closer working relationships lead to better results. Better results awaken interest by scientists outside the program. The consequently improved recruiting opportunity offers more selectivity and more competent participation to the coordinators. Increasing competence leads to closer working relationships, better results, and so on. In effect, the social machinery appears to be fueled by its own achievements.

Program Management

As President of the New Jersey Marine Sciences Consortium, I provide overall management for the program. In this capacity, I (1) maintain communications among all laboratories and the Agency for International Development; (2) identify, locate, and recruit scientists into the program; (3) procure ships, vehicles, and equipment for the Israeli and Egyptian laboratories; and (4) collaborate with the Egyptians and Israelis in planning their conferences and other meetings.

The program's chief scientist, Dr. Sayed Z. El-Sayed, of Texas A&M University, is, effectively, the soul of the program. He has maintained responsibility for the annual reports and collaborated with me on the program proposals. His technical leadership has included designing and promulgating guidelines for all project proposals and reports. Dr. El-Sayed—by virtue of his academic prowess, reputation, and natural charm—provides the focus of admiration and affection so essential to a complicated, intercountry, multidisciplinary program. Dr. Colette Serruya, Director General of the Israeli Institute of Oceanographic and Limnological Research (IOLR), acted until very recently as coordinator of the Israeli program. Her place was taken in 1987 by Dr. Yuval Cohen, a graduate (Ph.D.) of Oregon State University. Upon the death of Dr. A. R. Bayoumi, Director of the National Institute of Oceanography and Fisheries and Coordinator of the Program for Egypt, Dr. A. M. Eisawy assumed that role.

Early in the program's development, it became evident that traditional doctrines of management simply must be discarded. For instance, while total authority is vested in me as president of the New Jersey Marine Sciences Consortium, almost from the program's inception I adopted a laissez-faire approach in which my authority was delegated to the two country coordinators to the maximum degree possible. Now, I submit planning documents to Cohen and Eisawy. I encourage maximum review and discussion of the budgets, which I introduce for the respective projects, and I attempt wherever possible to maintain the consortium's role as a sort of service agency.

The Future

In the coming years, we hope to

1. Add new technologies, institutions, and people to the program, to spread its beneficial influence throughout as many communities as possible in the two countries.
2. Encourage as many Egyptians as possible to visit Israel. Dr. Eisawy is attempting to "sell" a team (that is, to the Egyptian Foreign Office) of up to 20 personnel.
3. Convey the program's benefits to other Middle Eastern and African countries in an effort to persuade them to join the program.
4. Translate the scientific achievements into economic and cultural gains.
5. Persuade U.S. Government officials that this program's charter, motivation, and progress merit at least one-fifth of one percent of the $5 billion this country spends annually on aid to the Middle East.

As we look to the future, we, the program's leaders, don't envision a smoothly rising curve of acceptance and participation. We prognosticate, rather, a sort of stepwise motion as, one after another, the social and financial barriers give way to good fellowship, beneficial technology, and—above all—common sense.

In summary, we believe we are in the process of demonstrating what history may term the ocean's greatest gift to humankind: peace.

Existential Governance—The Ocean as Modern Manor

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Oregon Coastal Zone Management Association

> . . . Oregonians have never envisioned themselves as settling the future of the nation. What they have tried to do is to retain the past, and to a large extent they have been successful in this quest. Oregon has always been like an eighteenth-century club whose members value highly the qualities of self-restraint, cohesion, loyalty, trust, and exclusiveness. Yet the club will admit new members to replenish its ranks and also, although grudgingly, to introduce new ideas, at least those that will enable it to adjust old values to present pressures. Oregon's uniqueness lies in its success in retaining the commonplace and its adventuresomeness in pursuit of the ordinary. The state is, paradoxically, a progressive anachronism, and the story of its dogged resistance yet successful accommodation to the forces of national development furnishes the central theme of its history and remains the state's principal legacy to the American experiment.
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> —Gordon B. Dodds,
> *Oregon: A Bicentennial History*

Oregon's ocean has been rediscovered by Oregonians, and the marine region, once the nearly private bastion of hardy mariners and fisherfolk, is changing guards.

The traditional maritime uses, fishing and transportation, are witnessing overlays of management and regulation. Those overlays arise from a land-based, but distant, public perception—a perception heavily influenced by the recent applicability of stewardship of natural resources by governments. In a sense, the ocean open range is giving way to a marriage of Lockean *tabula rasa* and the modern manor—the blank tablet commons becoming inscribed by an extension of inquiry, regulation, and planning, and by a new perception of what ought to be.

The Uses of the Past

The northeastern Pacific beckoned adventurers seeking the various utilitarian values of trade and transportation, differing forms of exploitable wealth, and a means of securing claims to sovereignty over newly discovered areas. Early Spanish, English, and American exploration in the Pacific Northwest centered on establishing claims to new territories and on obtaining suitable waterway corridors for commerce. Despite the scientific exploits of the redoubtable Cook, much of the exploration came serendipitously with the trafficking in furs and other natural commodities.

Except for some forms of transportation, these marine activities were largely out of sight and out of mind for most Oregonians. First the fur trade and then agricultural and timber enterprises focussed on land-dominated domestic considerations. Early Oregon leaders centered on "progress" based on prosperity from the private ownership and use of natural resources—especially those on the land side. Ocean and internal waterways were considered thoroughfares of commerce, and early commercial fishing concentrated on river net fisheries for salmon. The cause of change was economics, even as the ocean off of Oregon became more and more the occupied province of maritime trade, whaling, and—in more recent time—commercial and recreational fishing.

During the twentieth century, Oregon witnessed a major increase in commercial ocean fishing by net, pot, and troll, as well as a growing ocean recreational fishery. Coastal ports and marinas provided a tangible sign of oceanic activities only vaguely acknowledged and little understood by the general public. For those actually working on the marine frontier, there were considerable advantages to this anonymity.

Well into the present century, government was relatively limited in its roles and functions, often passive, and seldom intrusive. Navigation was the most conspicuous marine interest of government; and Oregon's ocean and its uses, so mysterious and seemingly off-limits to ordinary activities, appeared to find this neglect salutary.

The Ocean as Manor

During Oregon's first century, the ocean was an open range where government was often illusory, partly as a result of the political theories and practices of the time and partly because of the enormous spatial and intellectual separation from traditional home, farm, forest, and city concepts. However, if the nation's and state's landward past serves as a guide, concepts about the ocean off the Pacific Northwest are in transition. Jurisdictional boundaries that reflect interest in offshore waters, initially inspired by foreign fisheries activities, have been translated into new governance regimes. Likewise, the recent consideration of offshore oil and gas and marine minerals has inspired interest in the management, if not the actual use, of ocean resources.

The period of salutary neglect is weakening, not because of fences—the privatization on land—but through the emergence of research, planning, and regulatory zeal. A maturing and affluent society, interested in the quality of life, bolsters the spiralling growth of government size, influence, and ability.

When translated from land to ocean, new governmental interests that were honed on land interact with a very different scene. Unlike the usually cluttered landscape of private property, homes, municipal corporations, and counties, the ocean represents a vast, uninhabited commons witnessing only transient sojourners with limited rights of occupancy and use. Since the early 1970s, rights to the use of the ocean manor have been held by state and federal jurisdictions in the form of public trust "vassalage," with users seeking permission to husband or glean the resource.

The grandfather in Steinbeck's *The Red Pony* laments that "westering," in Frederick Jackson Turner's concept of free land to be settled and owned, was blocked by the Pacific Ocean. In the marine world, the private rights of ownership, use, control, and exclusion—concepts deeply entrenched in the landward pioneers—are clearly in governmental bodies.

The Future of Fisheries

How do old uses like fisheries mesh with the emergence of the public trust and the modern manor? Few subjects elicit the conservative nature of Oregon and the ambivalent exercise of modern governance as clearly as the management of salmon. Protection of *wild* salmon stocks has become a litmus test for holding onto the past, and while public hatcheries are grudgingly accepted as useful and perhaps necessary, private salmon ranching is seen as threatening the symbol of salmon in Oregon.

The first salmon ranches released chum salmon and were initially perceived as not violating the basic tenets of salmon harvest and management. However, the extension of the ranching concept to coho and chinook and its growth from small enterprises to megahatcheries and releases clearly threatened the gleaning, subsistence, and recreational uses of salmon. The mystique of salmon allowed their portrayal in the carpet of the State Capitol in Salem, yet they cannot be mass produced for private profit. Private salmon ranching remains in limbo as it struggles against the flow of Oregon's past.

While the private use of ocean resources has been largely thwarted, governance has expanded. The passage in 1976 of the federal Fishery Conservation and Management Act and the subsequent founding of the Pacific Fishery Management Council formally established a regional governance process for ocean fisheries. Driven by the threat of foreign fishing, the regional council approach produced an impressive apparatus for making decisions among federal and state fish resource managers, tribal interests, and ocean fishermen. During winter and spring deliberations on salmon quotas and seasons, council meetings attract a retinue of people at the court whose lives and livelihoods hinge on the decisions. Jockeying for a position on the council, or on one of its many subgroups, is often intense.

The prospect of a change now hovers over the council. At present, most of its appointees come from the fishery communities. If trends in resource management continue, representation by the fishing industry will shrink. In the past five years the Oregon Board of Forestry, once dominated by timber industry members, has been reorganized to increase general public representation.

With more public participation in ocean issues, the seafood industry's influence on its destiny, including how the harvestable yield is determined, is certain to be threatened. Once largely ignored, traditional harvesters can expect to find new overseeing forces on the modern manor, just as the timber industry has witnessed the growing influence of conservation groups and the intervention of the courts.

Oregon will also continue to watch the Balkanization of its fishery resources, particularly salmon. For example, despite the regional

council approach, areas and subareas and zones within zones are interlaced with the conservation of multitudes of species and allocation decisions of harvestable numbers by each fishery. And unless judicial relief is secured under the equal protection clause of the United States Constitution, tribal influence and uses of the ocean fishery resources will grow at the expense of other groups—a remarkable method to "adjust old values to present pressures."

Governance—Its Own Reward?

Fishery management represents an early, pervasive, and expanding form of governance over an *existing* use of ocean resources. The possibility of new uses of marine resources, including those petrochemical or mineral uses termed nonrenewable, has prompted an extension of governance into arenas not now experiencing actual uses.

The recent impetus for comprehensive offshore planning came from the potential inclusion of federal offshore marine areas in oil and gas leasing. Given the initial flurry of activities surrounding the deepwater exploitation of polymetallic minerals on the Gorda Ridge, the direction of change seems clear.

Oregon's nonfishery interests in its ocean are a direct outgrowth of its planning and regulating activities on land and particularly in the coastal zone. The state's ocean planning goal, Goal 19 of the statewide planning goals, has been held in abeyance as agricultural, forest, estuarine, shoreland, beach, dune, and other natural resources have been inventoried and planning decisions have been made. Senate Bill 630, passed by the 1987 Oregon Legislature, established a specific requirement for an ocean resources plan to be completed by a broad-based task force by mid-1990 and submitted to the Land Conservation and Development Commission for adoption. Although focussed on the state's three-mile territorial sea, it will also provide guidance for the state responses to activities in the federal Exclusive Economic Zone—from the western edge of the territorial sea out to 200 miles.

Extrapolating from previous coastal planning, what is the likely nature of the ocean planning effort? Most of the territorial sea will be off-limits to new uses of nonrenewable resources. This will be accomplished either by the establishment of special natural or conservation management areas or by the creation of buffer areas for significant wildlife, scenic, or existing economic activities. Those areas remaining from this first cut will have considerable conditions attached to the development of new uses.

However, while planning and the attendant regulations have shown a remarkable ability on land to protect natural resources from additional alterations and to institutionalize the status quo, they fail to provide for more predictable and streamlined decision making within designated development areas. We know what to exclude; but whatever is included for possible development continues to be subject to considerable speculation, multi-agency review, and uncertainty.

Successful but Impertinent?

Importantly, in contrast to land planning, the ocean commons provides a vacuum for modern governance—a remarkable opportunity to study, plan, and regulate areas held in trust and fairly unobstructed by existing human institutions. What adjustments might we see? In place of spontaneity there is reflective consideration. In place of unbridled and exploitative laissez faire, there is the conservatism of state planning. In place of the risks of dynamic change, there is governmental caution or inertia.

Old uses will be tentatively confirmed; new uses will be, de facto, largely prohibited. The ocean as laboratory will be maintained as long as federal funding continues. More and more emphasis will be placed on interpreting and appreciating marine resources. We will govern more, regardless of the actual level of regulated uses. State involvement in ocean activities and issues will increase, while existing ocean uses will remain basically static. Some fishery harvests may be reduced, and other uses effectively prohibited. There is always the threat that governance becomes increasingly existential, creating and defining its own reasons for being. The need to know, inextricably coupled with the desire to effectively govern, becomes its own justification.

There is little doubt that the people of Oregon will be successful in governing their ocean, perhaps because of their conservative nature. This is especially true if the overriding popular and governing objective is to prohibit or thwart significant change. The historian of revolutions, R.R. Palmer, wrote that the American revolution was the most successful and the least pertinent in European history. It was successful because it gained what it sought: independence under existing local institutions. However,

as a model for other revolutions seeking and needing significant changes, it offered few insights.

The State's Marine Legacy

In its own way, Oregon may be in the vanguard of a national movement that says, despite discussions of marine aquaculture to the contrary, the ocean domain is a protected public manor with severely restricted individual rights to its use. Perhaps more than in the land-based agriculture and timber industries, the consumptive uses of ocean resources is lessening as the intrinsic value and the expenditure for governing those resources are increasing. But like other natural resource industries, new marine economic opportunities, aside from transpacific shipping and several underutilized fisheries, appear to be severely limited.

Reflecting an aging or ripening society, Oregon's evolution in how it approaches its ocean is moving from occupation and exploitation to appreciation and conspicuous governance. However, like James Fenimore Cooper's Natty Bumpo, who in escaping civilization helped sow the seeds of doom for the more primitive society into which he fled, we run the risk of accepting governance as a substitute for more creative uses of the marine environment. In a very conservative way, we may love a place and be dangerous to it—or to ourselves. Therefore, whether viewed from the beach, a headland, a boat, or an easy chair, the state's principal legacy to the American experiment in the handling of its ocean manor may be as a symbol of what Wallace Stegner called the "geography of hope." Or it may be a saltwater Malthusian scene where inquiry and governance expand exponentially. Either way, it will bear watching—and influencing.

Ocean Ownership in the Twenty-First Century: Public or Private?

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We put many demands on the ocean. We use it as a resource to support human activities as varied as fishing, mining, transport, hydrocarbon development, waste disposal, and recreation. Technological advances enhance our ability to exploit the ocean; economic development and population growth create pressure to escalate our exploitation. We can expect these pressures to continue. As they do, various ocean activities will affect each other with increasing frequency. Friction between user groups will increase. We are already observing biological degradation from ocean misuse. As we approach the end of the twentieth century we face some tough choices about ocean use.

How will we meet the challenge of preserving the biological integrity of the ocean under increasing human pressure? How will we resolve user conflicts? The end of this century is a fitting time for some fresh thinking about the nature of ocean resource management problems and their solutions. What we need is a model for self-restraint. The place that we find it may be in the past.

The State of Ocean Management

Because many of us are dissatisfied with the process and results of our current ocean management systems, we spend a lot of time thinking about institutional alternatives. There is a surprising level of agreement among economists, biologists, and managers on the nature of the problem of ocean management. We take it as received wisdom that the problem of ocean use is the "tragedy of the commons." We propose new management systems designed to forestall the tragedy. But is the tragedy of the commons really the problem?

The phrase "tragedy of the commons" receives such widespread use that we rarely stop to examine either its origins or its applicability to ocean problems. Garrett Hardin (1) popularized the term in 1968 when he used the example of the English village commons to argue the case against unrestrained population growth. His argument goes like this. Picture a pasture open to all. Each herdsman wants to graze as many animals as possible on it. He sees that the benefit to him of adding more animals to graze on the commons outweighs the costs, since the benefit of an additional animal accrues to him alone but the cost is shared by all the users of the commons. The tragedy is that the system encourages each user to increase his herd without limit, and the commons becomes overexploited. "Ruin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons. Freedom in a commons brings ruin to all." The answer? "Mutual coercion, mutually agreed upon." Hardin argues that an inability to restrict individual use was the reason the commons was abandoned in favor of private property in eighteenth-century England.

Hardin's argument has spread far in its influence. His representation of the tragedy of the commons has been applied to all publicly owned natural resources, and to ocean resources in particular. Hardin refers specifically to ocean problems as falling within the category of tragedy. "Likewise the oceans of the world continue to suffer from the survival of the philosophy of the commons." Despite documented evidence of successful common property performance throughout the world (2, 3), the accuracy of Hardin's metaphor is so widely accepted that common property is rejected as a viable institution for resource use.

As solutions to the commons problem, Hardin lists two basic options: sell common resources as private property or keep them public but limit the number of users. Economists have tended to favor private property systems, arguing that only with exclusive use rights will people have the proper incentives not to overexploit the oceans. A wide range of proposals are now being made for solving the "commons problem" in oceans, rangelands, and forests (4, 5, 6, 7). These proposals all have at their core some form of private property right. Pressures are mounting to take action that will slow the deterioration of the oceans. We are at a turning point for ocean ownership and management, and general sentiment is favoring private property rights.

Privatization represents a radical departure from our historical institutions of ocean use. We need to ask ourselves whether selling pieces of the ocean as private property is the best we can do. How sure are we that privatization is the answer to the problems we face in ocean management?

A Second Look at Common Property

Common property, rather than being the problem, may instead be our best hope for a solution. Hardin's example of the commons which has so influenced our thinking about ocean management is in fact based on a misreading of the historical record. It has contributed to widespread confusion about the definition of common property. Black (8) defines common property, *res communes*, as property common to all. It is owned and controlled by a specified group. It is not "nobody's" property, as it is often called. "Nobody's property" is *res nullius*, which we typically call open access. Common property and open access have very different meanings, but the loose substitution of the two terms for one another has led us to consider them one and the same.

For a period of several hundred years in European history, common property was the dominant form of land ownership. We pay particular attention to the eighteenth-century English commons because we have detailed historical records about how it worked. The eighteenth century is also of interest because its second half was a time of radical change in the ownership of common lands.

What in fact was the eighteenth-century English commons and how did it work? All arable land in the village was divided into great fields, usually three, used in rotation. After harvest, these fields were open to common grazing. Decisions about sowing, planting, and grazing were made collectively by all landholders in the village. Access to nonarable land, pastureland, and waste was also controlled through the distribution of rights. The "commons" wasn't a single plot of grazing land, but in fact described a wide array of access rights to fields, forests, streams, and peat bogs. Common property systems varied in detail over different regions of the country.

Through the distribution of common rights, every aspect of resource use was controlled, from the number of animals in a pasture to the cutting of trees and bushes, the timing of fishing, the right to hunt, the repair of roads, the right to glean, and even the payment of the molecatcher's wages (9, 10). The rules of the commons reflected customary practice modified to changing environmental conditions and community needs. For example, to balance pasture resources with increasing numbers of livestock, seventeenth-century husbandry agreements required each farmer to lay down pasturage for community use proportional to the size of his holdings (12). Regulations controlling the use of the commons were called stints, and almost all commons were stinted. Offenses against the commons were punished by fines. Users were fined for various kinds of damage to the commons, but the most frequent offense was turning out more animals on the common pasture than a grazing right allowed.

One problem that economists associate with common property is the "free rider"—a person who receives benefits without paying for them. Hardin refers to the same problem by describing the commons as a free-for-all. But in the detailed historical record of the commons, it is difficult to find examples of free riders and free-for-alls. Anyone who has ever lived in a small town will appreciate the difficulty of increasing the size of one's herd without the neighbors' knowledge.

Instead, we see that common property functioned as a complex set of mutual privileges and obligations, with rights of use regulated by the community. In contrast to the way we think about common property today, common property was in fact a stable system of collective ownership, designed to maintain sustainable resource use. To do this, its regulations had to be flexible to accommodate changing conditions and had to be based on broad community support. It represented the very "mutual coercion" outlined by Hardin as a necessary condition for sustainable resource use. The stability of the commons provided at the same time an obstacle to radical change in use practices and a safeguard against extreme negligence (11). The commons functioned for hundreds of years before its demise, providing sustenance to the entire community through rights of access to land and water. Was the commons invariably successful? No, but when it failed, its failure was due to a complexity of causes that transcended common ownership.

The Enclosure of the Commons

The commons as the dominant system of resource management came to an end in the

late eighteenth and early nineteenth centuries. From 1760 through the early 1800s, over 6 million acres were transformed from common to private holdings through acts of parliament (11). Many more acres of land had been privatized earlier by "agreement," but the period of the Industrial Revolution was a particularly active time for enclosure sanctioned by the government (12).

Several factors contributed to this trend. The commons had long been resented by some landowners as sources of support for a breed of "masterless men" indisposed to honest labor (13). These same landowners chafed at collective management and the sharing of rents which kept their profits in check. When wool prices were high, grazing sheep was a more attractive venture than raising crops. In the 1700s the spirit of agricultural "Improvement" swept the land. This brought opportunities to change crops and cultivation techniques to increase profits. Large landowners argued that the common property system with its collective decision making was too rigid to adapt to these changes.

Enclosure united the interests of large landowners and Improvers, who greeted the change with enthusiasm. Enclosure involved eliminating common rights, consolidating scattered holdings, and fencing in properties (14). Proponents of enclosure argued that it would have the double benefits of increasing agricultural efficiency and forcing the idle poor to work. Opponents of enclosure argued against the necessity of privatizing land to increase productivity and against the disenfranchisement of large numbers of common rights holders. In most cases, large owners held the political power, and enclosure proceeded despite violent protests.

In every enclosed village there were winners and losers. The winners were those who had maintained or increased their holdings. The losers were left with smaller holdings or the loss of access rights altogether. The large-scale change in land ownership resulted in the loss of subsistence to a whole class of people, the depopulation of some rural villages, a decline in agricultural wages, and in many cases the disappearance of the small landowner (15, 16).

Hardin, and others since, view the inequities created by enclosure as an unfortunate but necessary condition for ending the tragedy of the commons. Defenders of enclosure have argued that the benefits of enclosing the commons are increased efficiency and productivity. However, both past and recent investigations indicate that the relation between enclosure and productivity is not at all clear. It appears now that claims of increased productivity at the time of enclosure may have been nothing more than "landlord ideology" (17).

An Ocean Policy for the Future

The commons has some lessons for us as we prepare for the twenty-first century. Understanding the commons is important to us because the tragedy argument is in active use once again to bolster privatization efforts in publicly owned resources.

Three centuries later, what does the eighteenth-century commons offer us for the challenge of ocean management? It would be unrealistic to expect to adopt unchanged an institution developed within the context of the sixteenth to eighteenth centuries. But the commons does provide an example of a management system that reflects the values of the community and embodies public ownership and control.

The essential characteristic of the commons was community ownership and responsibility. The authority to manage resource use, enforce regulations, adjudicate user conflicts, and punish violations was vested in the tenants and owners of land through the manor court. The exploitation of the commons was under strict control; levels of use were monitored and varied in response to changing environmental conditions. All resource-use activities were coordinated and centrally managed.

American economists don't know very much about collective institutional arrangements because arguments for the superiority of private property have convinced us that there is little point in delving into alternatives. The arguments are intuitively powerful because we live in a market economy dominated by private property rights. Private property is an efficient and effective arrangement for many types of transactions. But not all. There is nothing inherent in private ownership that prevents overuse of resources when the economic conditions are right. If the present value of the harvest is high enough, resource users may ignore long-term conservation needs in favor of short-term profits.

The danger in wholesale acceptance of the supremacy of private property is that we turn a blind eye to institutional alternatives that have the potential to perform well. The variety of arrangements possible under common property

has escaped us. In order to know how to apply the lessons of the commons to our future ocean management needs, we need to ask certain questions. How broadly can we define a "community" as a unit of management and control? What is the optimal size of the community responsible for resource use? It will have to control ocean space large enough to incorporate multiple use, but small enough to monitor and enforce regulations. How can we ensure that community goals of long-term resource viability will be met? How can we broaden the involvement of various user groups and provide them with a vested interest in management success?

In addition to understanding the example set by the commons we should also pay close attention to its elimination through the enclosure process. The relevance of enclosure to us is apparent when we reflect on contemporary designs for creating private property rights for public resources. These proposals parallel arguments made for enclosing the English commons 300 years ago. Proponents of privatization then and now speak with a common voice.

> The magic of property turns sand into gold.
>
> Young, 1771, in Pike (18)

> Private people and private property can be the best of friends to Mother Nature.
>
> Reed, 1988 (6)

> It may be laid down as a maxim that . . . while a country is laid out in open fields, every farmer is tied down to the husbandry of his slovenly neighbor and there can be no good husbandry.
>
> Young, 1771, in Pike (18)

> When the property rights to a resource are communally held, the resource is often abused. In contrast, when the rights to a resource are held by an individual or family, conservation and wise utilization generally result.
>
> Gwartney and Stroup, 1988 (5)

The tragedy of the oceans is the tragedy of overuse. Overuse results from fragmented and ineffective ownership; it is a red herring to link it to common ownership. When we think of the future of ocean management, our best hope may be to recapture the commons. Powerful arguments are being advanced in favor of the privatization of our ocean resources. Part of their power lies in our superficial acceptance of their underlying assumptions. A reading of history tells us that we have been through all this before, with sobering consequences. Then, as now, we should look for the ideology behind the privatization arguments. Who stands to gain, and who will lose? The earlier privatization movement that our ancestors lived through had enormous distributional effects, only questionable efficiency effects, and no documented moral advantages.

Do we really want to undergo another age of enclosure? And, more important, is it necessary to lose public control of the ocean to save it from ourselves?

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Marine Extension—A Keystone to Conservation and Development in the Twenty-First Century

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The twenty-first century, a mere 11 years away, is being tagged with many names and imbued with much promise. Sea people are calling it "The Ocean Century" or "The Pacific Century." Nearly everyone agrees we are on the brink of "The Communication Century." By whatever name, I contend that the new century will rely on extension education as a primary force in conserving and developing marine resources and that this will occur mainly through adaptations of people in their spheres rather than through more shifting of resources around the globe. But first, traditional extension must change in its emphasis and delivery in preparation for the kickoff of the next millennium.

Setting the Stage

Recall the uncertainty that stalked the land in the recent summer of 1988. Why the drought and heat? Were the burning forests normal? Why didn't it rain in the western United States instead of flooding in Bangladesh? Why were the Midwest and the East sweltering (and using up all our winter antifreeze as summertime coolant)? Was the greenhouse effect real? How about sea level rise? Can anyone foretell what's coming?

By the year 2000 we should be better prepared to answer some of these questions. But the symptoms, if real, are probably irreversible. And the problems of the twentieth century, which we have steadfastly refused to address, much less solve, will still be front and center. So, let's recognize some of them before we move on.

Human population growth. We have refused to face the fundamental problem of the world's population explosion in the twentieth century. It will not go away until we uncouple it from ethnic concerns, religious beliefs, and just plain stupidity. World starvation will provide an answer if we don't. Remember the bumper sticker—"Nature Bats Last."

Energy waste. Americans, of course, set the world's bad example. We can always find reasons for someone else to save energy. We respond rapidly to pocketbook pain. John Anderson of Illinois was right to propose a four-bit-per-gallon gasoline tax as an inducement to conserve energy—but he was doomed to lose for suggesting it.

Waste disposal. We can be taught to recycle and are pretty good at it. But the lesson has to be learned all over again for each generation. It is a long trail with no end in sight.

Destruction of the forests. Someone has to plant trees, and it might as well start with us. The real need is in the tropics. Let's reduce demand for imported hamburger and thereby reduce the cutting of tropical forests. Everything's connected, remember? We need more O_2 and less CO_2.

Flooding. By devegetating and blacktopping the land, we have replaced slow percolation with rampant flooding. Instead of recharging watersheds we erode them. The result: less year-round water, less life, more waste.

Unemployment. We need to reduce capital expenditures and capitalize on an abundance of labor. It goes against modern lifestyles to exchange a bit of sweat for the ability to push a convenient button. But in a world where grocery stores have seven aisles of instant everything and one row of produce plus a few bins of whole grains, I wonder what that convenience is costing us.

A successful twenty-first century will require a complex mix of advanced and traditional technology. This presumes, of course, a reasonable continuation of "normal" climate and limited war and pestilence. Perhaps few realize how interdependent and international our economy has become. Check out a small truck from Asia, and you find the footprints of a dozen nations on the headlights, bumpers, windshields, wipers, and so on. Better yet, check an all-American brand and try to identify the origins of its components. But such production requires the worldwide shipment of resources. The twenty-first century will bring changes. We will revert, in some ways, to ecosystem people rather than keeping the patterns of acculturation that have made us globally dependent. Information and technology will show large-scale movement across national boundaries—but movement of materials, food,

and energy will slow. Information will be the central high-tech commodity. A few generations of one-child families will stabilize the world standard of living. Small will indeed become beautiful and energy self-sufficiency will be realized. Either these revolutionary changes occur, or we disappear.

I submit that extension agents and specialists will help us make these changes, and in the process they will change themselves.

What Are Extension Education Programs?

Extension and education programs are, first, a function rather than a discipline. The fundamentals can be taught but the conduct of programs is more art than science. The Cooperative Extension Service of the American land grant colleges (whose grant-in-aid parent is the U. S. Department of Agriculture) speak of extension as "helping people to help themselves." Oregon State University elaborates by stating that the "Extension Service provides education and information based on timely research to help Oregonians solve problems and develop skills related to youth, family, community, farm, forest, energy, and marine resources." Extension agents often refer to "changing people between the ears." W. T. True in 1923 described the county agent as an "itinerant rural philosopher."

I describe the main goal of an extension program as using information, often of a technical nature, as a medium through which people are developed. Developed, in this case, means improving people's ability in their daily life, work or citizenship. Thus, the snippet of knowledge is the means rather than the end of the process. Cooperative Extension has developed many processes for conducting educational programs with voluntary and unorganized clients and audiences across the nation. *The Journal of Extension* and other publications detail many of these efforts. Through the years, Cooperative Extension has evolved from a technical production orientation toward the larger arena of public policy.

Cooperative Extension, as the de facto parent of emerging extension activities in the ocean realm, is a land-based, university-attached program in a largely rural setting. The lessons and precepts from Cooperative Extension are only partially transferable to the marine environment and become seriously flawed when applied to the cultural practices of other nations. As we move into the twenty-first century, international in its ocean orientation, we must adapt to the changing environments of distance and culture.

Marine extension educational programs have suffered from false starts, misdirection, incompetence, and suspicion—and they still do. I do not pretend to know the entire history but will share examples where I have been personally involved. As we design our ocean program for the twenty-first century, this history may be useful.

In 1940, the establishment of the Seafood Laboratory in Astoria, Oregon, as a cooperative venture of Oregon State College, Clatsop County, and the Oregon seafood industry resulted in the region's first solid marine extension activities. Through the leadership of Dr. Ed Harvey and Professors Sinnhuber and Law, the Seafood Laboratory logically extended results of research on seafood processing, quality control, and utilization to industry and the general public. Laboratory scientists worked closely with county home demonstration agents to extend new ideas on seafood nutrition and cookery.

A 1956 agreement between the U.S. Department of Agriculture and the U.S. Department of the Interior (Fish and Wildlife Service) gave Interior the obligation to conduct fisheries extension services. This resulted in an increase in seafood marketing and the use of fish in the school lunch programs but did not support a broad fisheries extension service. The agreement even constrained the Cooperative Extension Service from developing a fisheries extension service. When I began work as a county extension agent in Tillamook County, Oregon, in 1960, I was called a natural resources agent because of the 1956 agreement between the USDA and the USDI, even though my educational program quickly veered toward fisheries.

The early 1960s was a period of groping. There were three of us pioneering the U.S. attempt to define a fisheries extension service. In addition to my Oregon work on oysters, estuaries, mink farming (they eat fish), and public understanding of fisheries, John Doyle was commencing a state-supported program at the University of Alaska, and the late Don Harriman was beginning a program for the state of Maine funded by PL 88-309, the Commercial Fisheries Research and Development Act of 1964. PL 88-309, by the way, continues to have extension elements, as of 1989, through support of fishery utilization and marketing programs in Florida and other Southern states.

The short-lived State Technical Services Act (STS) of the U.S. Department of Commerce provided the first real muscle for development of the fisheries extension programs in Oregon, New Jersey, Alaska, and other areas. STS was discontinued by the 1970s but left a lasting mark through development of extension agent and specialist positions that were continued as the Sea Grant marine advisory programs came on line. In fact, STS activities provided a running start for Sea Grant in several states.

The National Sea Grant College and Program Act of 1966, PL 89-688, finally concentrated most elements of the marine extension effort and provides the basis for developing a twenty-first century international ocean-oriented program (1). Section 204(b) (3) cites "encouraging and developing programs of . . . practical demonstrations, publications, and otherwise, by sea grant colleges . . . through marine advisory programs . . . imparting useful information . . . to persons currently employed or interested in . . . the development of marine resources, the scientific community, and the general public." The term "marine advisory programs" has been judged to be sufficiently generic to find expression in a variety of ways. Those of us with a Cooperative Extension background found it to be simply a wet analogue of land grant extension. Others caustically railed against confusing the new saltwater "Marine Advisory Program" with the "Agricultural Extension Service."

Still, of the 29 Sea Grant colleges and programs, about two-thirds of the marine advisory efforts are partially or totally integrated with the land grant Cooperative Extension Service. Although varying in size and style, the Sea Grant advisory (extension) programs contain an amazing concentration of marine educational talent among the agents and specialists. The programs and associated faculty are recognized on the docks, by marine businesses, and by the general public as forces for development and conservation of America's marine resources—admittedly a schizophrenic task.

Sea Grant college programs in the Pacific States recognized the need for cooperation among themselves and through outreach to the Pacific Rim as early as 1969. Our first efforts were to share talent with each other as we built the marine advisory educational capabilities of each institution. Soon we visualized a common ocean, the Pacific, covering a major share of the earth and realized that artificial political boundaries confused rather than solved common problems. In 1973, the Pacific Sea Grant Advisory Program (PASGAP) sponsored a consultative visit to five Pacific Rim countries: Japan, Hong Kong, Singapore, Australia and New Zealand (2). The trip was international from the start when Graham Drew of the University of British Columbia and I were chosen to conduct the project. Our goal was to locate "kindred souls," those who saw the extension method as a means for helping to properly develop marine resources and businesses.

Early in 1973, we discovered that Japan had begun a fisheries extension service in 1953 and now counted more than 300 extension workers. Funding came from the federal and prefectural governments and was a function of the fishery agencies and laboratories.

In Hong Kong, the British had established a fishery extension service at the end of World War II. Operated through the fishery agency, extension had been instrumental in helping the boat people move ashore and establish villages, schools, and fishing cooperatives.

Australia's program was almost nonexistent, although the federal Fisheries Division in the Department of Primary Industry supported *Australian Fisheries*, a top-notch fisheries education magazine.

New Zealand interest was latent at best, but faculty members at two universities were interested and at least one sabbatical exchange was arranged.

Since this period, International Sea Grant has sponsored several more visits, exchanges, conferences, and workshops involving a number of the national states on the Pacific Rim. These confirm our belief that marine extension programs can be a major element in progress for the twenty-first century. Now, let's turn our attention to the task of predicting how to get the job done in the face of political, language, and cultural barriers.

Designing a Pacific Marine Extension (Advisory) Program for the Twenty-First Century

First, let's learn to label the program in commonly acceptable terms. Labels are important. Some people seem to make a career out of trying to change the name for informal outreach education from "extension" to something else. I'm willing to add "advisory" because the Sea Grant Act mandates the term. But, please, no more arguments about "integrative out-

reach" or similar asininities. Michael Quinn Patton, reflecting the thoughts of Walter Hahn, has pointed out that labels help to make distinctions, make associations, attract attention, and establish identity (3).

Another label that seems important is the word "marine." Marine or ocean-oriented people, to me, are more international and certainly less provincial in their thinking than their land-based colleagues.

With our mind's eye on the Pacific, perhaps we visualize the romance of leaving one shore on a picturesque tramp steamer, stopping to exchange greetings with friendly natives amid the coconut palms en route, and eventually washing up on the far shore—nearly half an earth away. And, maybe, that was the case in days gone by. The jet plane has changed the scene. Now, the main view from tropic isles is of a contrail passing overhead. A large and growing "donut hole" (most of the central Pacific ocean) has developed. As Don Frisbee points out in this volume, "Telecommunications and jet travel have, in effect, wiped out the ocean." This effect on Fiji and Tahiti, as former fuel stopovers, is well documented and many new Pacific-spanning planes are joining the world's airlines.

So, as extension educators we are faced, again, with two main client groups—commercial producers and subsistence operators.

An important goal is to create global awareness among our U.S. extension professionals. We must at least try to change those elements in extension that tend toward the provincial (4). Either we choose to do it now, through expanded and perhaps mandatory training in culture and languages, or the avalanche of international students on our campuses will do it for us.

We should adopt the "global village" idea while recognizing that in the Pacific there is complex heterogeneity in culture, social systems, language, and economic and political systems (5, 6). I often hear people say that we must learn foreign languages, but to me, cultural aspects and a base understanding of political and economic factors may be more important. Greater involvement of anthropologists and other social scientists in the design of marine extension projects is important (5).

As noted previously, there are good extension programs underway in several sections of the Pacific area. They are designed to fit local situations and, although they tend to be operated from the top down, seem to be providing valuable help. Where such programs exist, regional expansion should be encouraged. For example, cultural similarities occur throughout southeast Asia among the "boat people," and Hong Kong has had success in addressing some of their unique needs (2). A U.S. role might be one of encouragement and communication. In the mid-Pacific, the Hawaii Sea Grant College is developing a regional extension and more formal education program for its farflung islands. Japan and the Philippines maintain active fisheries extension programs. And U.S. Peace Corps efforts have been especially successful in improving aquacultural practices.

How can we contribute in those areas where extension education is nonexistent or underdeveloped? We have worked in some of the Spanish-speaking areas of Central and South America for more than a decade (7). There is great interest in the extension idea and a need for program applications, but there are cultural barriers against linking the program with universities. Nevertheless, we have conducted several successful workshops in Chile and Mexico involving a number of other Latin American countries. We have had the opportunity to provide graduate degrees for faculty in their universities. Resources are limited in these countries, but the extension idea seems to be growing. The lesson is that training, both formally on U.S. campuses and informally in workshops abroad, are important in establishing programs. A key here is for the cooperating country to provide a major share of the cost of the program.

Extension programs in the U.S. will change in the twenty-fist century. These changes will be reflected in our work with other nations. We must become more flexible in staffing. About 90 percent of extension resources are now tied up in salary. Extension futurists have predicted that the technical program elements will be largely privatized; that specialists' needs will be handled mainly through grants and contracts; and that county offices will go the way of the buggy whip. These major moves will obviously not occur overnight. But they will happen and the result will be a leaner extension operation focused on the important elements of public policy and decision making.

How can we work with the many nations of the Pacific Rim and Basin to jointly advance our marine extension education program? As stated in the beginning, the twenty-first will be a communications century. Some of our efforts will revolve around the use of advanced com-

munications—satellites and computers (8). Interactive video will come into its own (5). Electronic journals will reduce the need to ship reams of paper (9). These journals will be produced simultaneously in several languages.

Obviously, high technology will not totally replace face-to-face personal contact (10). The "smell of the hide" will still be a vital element of extension. We must combine "high-tech with high-feel."

Marine extension programs will be an important element in twenty-first century Pacific Ocean conservation and development— if we care enough to make it happen.

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Resources, Culture, and Capitalism

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Resource Crisis and the Need for Critical Understanding

Max Weber argued that man is an animal suspended in webs of significance of his own making. Clifford Geertz (1), accepting this concept, took such webs of significance to be *cultures*. He went on to argue that men and women are born "unfinished animals," and that children become human through culture. Moreover, they become human in the very particular ways of their subculture as well as in the ways of their national culture. To be human is not simply to be American or Javanese or some other nationality. We first become human through material and social conditions in our families, neighborhoods, communities, and their subcultures. We become Bostonian, millworker, Irish, Catholic American; or lower Columbia River, gillnetter, Finnish American; or Sweet Home, logger, Swedish, Lutheran American. Penetrating such local cultures are the universalizing tendencies of the American political economy and technocracy, the systemic and cultural tendencies of modern liberal capitalism.

Entering into becoming human are the natural conditions and the other material and social conditions making subculture and culture possible. Resources, then, are the material and social conditions of individual, institutional, and societal constitution. Most generally, resource crisis prevails when the material and social conditions necessary for individuals to become human, according to the norms of their culture, are endangered or no longer exist. Although we usually think of resource crisis as a breakdown in some material-provisioning system, it is important to understand the deep way in which resources, broadly understood, are involved in our becoming human in our communities, culture, and society. Thus, resource crisis may manifest itself through the failure of a dominant world view or ethos, the failure of communicative or critical understanding, or the loss of legitimacy, participation, or distributive justice, as well as through simple loss of material provisions.

I will argue that resource crisis is immanent in the political economy and technocracy of the United States and other modern liberal capitalist societies. Far from dealing adequately with resource problems, such political economies and technocracies are creating the contradictions between individual, local, and societal expectations and possibilities that are experienced as crises or, even more tragically, as loss of hope. When resources are understood to be the material and social conditions of our becoming human according to the values, goals, and norms of our culture and society, the human consequences of systemic degradation of resources through the imperatives and the failures of liberal capitalism become terribly apparent. Moreover, as the ideologies of the political-economic and technocratic spheres distort and displace the values, goals, and norms of the practical-cultural sphere of everyday life, we come to willingly and even enthusiastically participate in the destruction of the material and social conditions of our own ways of life. Understood critically, resource crisis can be seen to be in large part a problem for democracy: Are people to be free to choose and practice their ways of life and to have substantial control over the necessary material and social conditions? Or are such fundamental liberty and sovereignty to be lost to the systemic aspects of capital, the market, and managerial technocracy? Reconstitution of the now badly eroded conditions for democratic citizenship, community, and society will come, if ever, only through universal participation in the determination of resource use and allocation, participation based on critical understanding by all members of each of our culturally diverse communities.

But any such argument and conclusion are certainly not obvious to many or even most people. Entangled as we are in the ideology of modern liberal capitalism—in its culture or "web of significance"—it is exceedingly difficult to see our institutions as other than natural and, though perhaps flawed, as other than the best possible. For to understand difficulties in our political economy and technocracy and to

appreciate the possibilities of change require some shift in world view and ethos, as an aspect of what I have just referred to as "critical understanding."

Any critical understanding of society must be concerned with revealing conditions and aspects of societal organization that impede or prevent the realization of democratic citizens, communities, cultures, and societies. Critical understanding is further concerned to determine those material and social conditions or resources making possible the self-constitution of democracy, its citizens, and institutions. It is concerned not simply with how people do, in fact, interact socially, but with how they might possibly interact and how they should interact, in the most human of undertakings: the reproduction of culture and society. All this entails continuous reexamination of what it is that we think we know and how it is that we act. Within our received or given world view and ethos, any reexamination of knowledge and practice is difficult. Thus we must endeavor to articulate the fundamental propositions of our social understanding as well as propositions making other understandings possible. It follows, then, that critical understanding must employ the methods and problematics of philosophy as well as those of theoretical and empirical science. It must also entail the moral, aesthetic, and everyday understandings of the practical-cultural sphere of everyday life, in which all other forms of understanding ultimately are grounded.

Colonization of the Sphere of Everyday Life

The foundation for our humanity is laid in the practical-cultural sphere of everyday life. Here, first in the family, the baby begins to take on those ways we value as human. Later, in the neighborhood, the developing child participates in play often symbolic of ways of life in that part of the community. Still later in school, as much with peers and others as from the classroom, the young human being participates in and identifies with a local culture. Because the local culture is penetrated by the regional and national cultures, the gradually sociated individual becomes a particular expression of the larger culture as well as the local culture. With increased participation in society, this individual, born "unfinished," becomes a complexly cultured human being.

Becoming human, then, involves acquiring human intentions, orientations, experiences, norms, ideals, goals, and social interactions including language and other symbolic systems of meaning. This is all grounded in the systemic and (subjective) lifeworld aspects of the sphere of everyday life. Here, in full everyday life, moral, aesthetic, and otherwise practical-cultural ways become part of each of us. Here the natural environment and resources, ways of producing things, and their associated social relations find their expression in our different ways of becoming human. But in becoming human in a community and local culture as well as in the larger society, each individual develops different evaluative systems and languages—with their different norms, ideals, and goals from the different spheres of society.

Frantz Fanon (2), on the basis of his experience in French colonial Algeria, found colonization to be, in an important sense, the imposing of the language and value system of the colonizers on the colonized. This distorts and displaces the language and values of the colonized to the extent that, following revolution, the new leaders continue to impose on their own people the colonial value system. No longer do these people have their own unique understanding of the world and their own culture and society fitting this understanding.

Colonization of the lifeworld has been seen to be distortion and displacement of the orientations, language, norms, ideals, and goals of the practical-cultural sphere of everyday life by those of the more systemic economic, political, technological, and bureaucratic spheres of society. It is this distorting of the roots of the systemic aspects of society in the lifeworld aspect that leads to the "crisis of modernity," with its breakdown in traditions, alienation, withdrawal of legitimation and motivation, and other manifestations we all recognize (3, 4, 5).

In its orientations, norms, ideals, goals, and language, a community with its local culture becomes an expression of local and regional geography including climate, other natural resources, and surrounding subcultures. Succeeding generations, who have fished, or logged, or farmed, or mined, or worked in the factories, come to expect that their ways of life can and should continue, and that they should have some say or control in this. But in modern society, the practical culture of the local community has been colonized by systemic aspects of the economic, political, technological, and bureaucratic spheres. These other spheres may not only control the resources (the material and social conditions of these ways of life), they may

determine whether these ways of life are still possible. Liberty to choose and live a way of life, and sovereignty or control over the conditions of that way of life, may be compromised.

Capital and the market will determine the rate of forest or mineral use; the liberal political system will determine the political conditions required for this; and the level of technology will determine methods of exploitation. Professionals in the bureaucracy may very well use their theories and models to legitimate rates and means of exploitation determined by the political economy and technology. The norms, ideals, and goals of these other spheres are apt to have so distorted and displaced those of the resource-dependent local culture and community that inhabitants participate willingly and even enthusiastically in the demise of their culture—in destroying the material and social conditions of their own individual, institutional, and societal self-constitution. This is the ultimate cost of colonization of the sphere of everyday life.

The Political Economy of Liberal Capitalism

Liberal capitalism is a kind of society in which Enlightenment liberalism, capital, and the market are organizing principles. During the centuries of the English and European Enlightenment, there developed against the background of traditional feudal society a new conception of man, but not yet of woman or servant or child. Political-economic man was regarded as autonomous, self-constituting, utilitarian, rational, and responsible—as man the individual. Between liberal man, the state, the economy, and society, there was little else in the way of institutional structure, or so liberal understanding and practice developed. There were the family and the firm, of course; but these too were understood atomistically. And society was the aggregation of atomic entities. The economy, the polity, and the bureaucracy also were understood to be autonomous, free of each other and of society as a whole.

The immanence of resource crisis in liberal capitalism lies in part in contradictions in the practice and ideology of liberalism, in part in contradictions in capitalism. To its everlasting credit, liberalism established the conception of the individual, rational, responsible, self-constituting human being. But it was never very clear what the material and social conditions of this self-constitution might be. And in separating and protecting the individual from traditional society, liberalism built barriers between personal rights and property rights, between public and private, and between supposedly rational, responsible individuals and the not yet rational and responsible—the not yet fully human (6). With the evolution of society, these liberal distinctions in practice led to resource crisis. And with liberalism in developmental interaction with the organizing principles and imperatives of capital and the market—especially growth in primary resource use, private production and investment decisions, private accumulation of capital, competition, market allocation of resources, and profit as well as the making public, or socializing, of the resource and human wreckage left by the corporate structure (7)—the potential for resource crisis was enormously magnified. These imperatives of capital and primary reliance on the market for resource allocation, given the nature of political economy in liberal capitalism, led to far-reaching environmental, public-private, social, intergenerational, and intersocietal imbalances. These "external" consequences of the economy are supposed to be problems for the state.

But in liberal capitalism, where the means of production are largely corporatively held, state resources for dealing with social problems come mainly from taxes. Even where there is demonstrable need and demonstrated will, and even in relatively good times, social problems do not compete adequately for resources with corporate and other private interests. When hard times come with the business cycle, and social needs are even greater, tax revenues decrease and remaining taxation is felt as a burden on productivity. If the business climate is not good, businessmen—without collusion—will simply choose not to invest (8). The state is seen as being responsible for the economy, but even the Keynesian accommodation to the contradiction between property rights and personal rights has come to be inadequate, as have earlier accommodations (9). This aspect of resource crisis has been called the "crisis of the welfare state" (10).

The political sphere of liberal democracy has by some theorists been characterized as a way of choosing a government, not as a morally preferable sort of society (11, 12). Those who do the governing are a self-nominated elite, who do not and could not represent the varied and self-cancelling interests of most individuals and groups. Periodic voting selects and replaces

governments and so minimizes the danger of tyranny. People recognize the inadequacy of representation, so even participation through voting tends toward a minimum. But when groups marginal to society fail to participate, the stability ("equilibrium") of the system is enhanced. Add to this the privileged access of businessmen to government, together with the already existent concern in government for conditions favorable to economic performance (13), and a liberal capitalist society will "not be able to afford" to deal adequately with even its most pressing environmental and social problems.

How then do we account for the seemingly patient accommodation of a large percentage of the public to what would otherwise appear to be social injustice and other resource crises? In the liberal democracies, social control is achieved more by ideological hegemony than by coercion (14, 15). Ideological systems exist not as fictions but apparently as evidential and moral truths by which dominant classes understand, explain, and justify political economies (7). Freedom, equal opportunity, individual responsibility, rationality, utility, business efficacy and efficiency, and maximum production and distribution of goods and services as well as human dignity and justice: these and other liberal values (table 1) are understood to explain and justify the political economy of liberal capitalism. The tendency of members of the underclass to identify their interests with those of the upper-class reinforces this veil of ideology.

This understanding and the imperatives of the political economy of liberal capitalism allow and demand capital and the market to determine investment and production, location, rates, and ways of primary resource utilization, and employment or plant closure, with little or no concern for the environment, the community, resources for future generations, and other peoples. Government policy in general supports this system and intends to deal with the natural and social wreckage that follows, the latter with minimal success at best. That the economy must do well before even the most pressing environmental and social needs can be dealt with, that the market allocates resources with maximal economic efficiency (17), that government is primarily responsible for environmental and social consequences of corporate practice, that corporate affairs are private, not public (9), that future generations and other peoples will have the resources and technology to continue their ways of life—these facets of the ideology of liberal capitalism are in fact more myth than truth. They result from failure in communicative and critical understanding. And they hardly veil consequent resource crisis.

Table 1. A value hierarchy for liberal policy decisions. (Adapted from the original with permission of the author and the publisher [16].)

	DECISION CRITERION	GOALS OR OBJECTIVES
LEVELS OF VALUES	4. The individual	Individual welfare Freedom Opportunity Self-realization Human dignity
	3. Society	Social Welfare "The good life" Culture Civilization Order Justice
	2. The economic system	Consumer Welfare Efficient allocation of resources Maximum production and distribution of goods and services
	1. Business	Ownership Welfare Profits Survival Growth

The Technocracy of Liberal Capitalism

We look to technocracy—that is, governmental and corporate technology and bureaucracy—to solve resource problems and to deal with resource crises. In continuing this argument on resource crisis in liberal capitalism, I now contend not only that technocracy is unable to deal adequately with resource problems but also that technocracy itself generates resource problems and crises. This failure to solve and this generation of resource problems are very much owing to the machine-like atomic organization of technocracy and to the prevailing mechanist-realist world view and representational-realist theory of knowledge. A brief account of this theory of the world and theory of knowledge will help to understand technocracy and, indeed, liberal capitalism, for early liberals and later progressives intended to rationalize society as Newton had rationalized the universe.

In the realist view, the world is organized in some singular, ultimately knowable way. (1) There exist universal forms and laws. (2) The world of experience consists of imperfect exemplifications of these forms and laws. And (3) there are (scientific) principles interrelating forms, laws, and their exemplifications. In the mechanist-realist view, that singular and ultimately knowable way of the world is as a vast, complex, yet comprehensible machine or system having the properties of a (Newtonian) machine: (1) The behavior of a system (machine) is determined by interaction of its elements largely independently of its environment or field of location. (2) A system is analyzable into discrete atomic elements. And (3) interactions of these elements are only superficial and do not lead to changes in their nature (18).

The standard theory of knowledge, apparent in both the organization and practice of technocracy, is representational realism. The real forms and laws of the world, in this theory, become evident in our objective observational experience, which is uninfluenced by world view, ethos, language, intentions, or other cultural elements. Scientific laws are induced from experience and represent real or natural laws. We know this because there is exact correspondence between exemplifications of natural laws and our scientific laws or deductions from these—this being the "correspondence theory of truth."

This theory of the world and this theory of knowledge are apparent in the technocratic definition of resource problems. Resource problems are abstracted from experience of persisting, troubling, interpenetrating resource events. This is done by defining resource problems as scientific and technocratic problems—that is, so they can be solved separately and definitively, as though in isolation from other circumstances natural and cultural. But in this abstraction, the scientific and technocratic problem is often no longer the resource problem experienced. Accordingly, its solution does not solve the resource problem.

In resource economics and biology, a logical-empirical connection is commonly understood to exist between a conceptual system or a model and the actual system. The actual system is usually taken to "really exist" in a form determined by fundamental relations resembling those that can be mathematically modeled. The mathematical model—the conceptual system—is usually taken to represent the actual system, through the latter's fundamental relations. Because of the logical-empirical correspondence between the mathematical relations of the representational model and the fundamental relations of the actual system, the model (in the mechanist-realist, representational view) can explain the actual system and provide prediction and the formal basis for control of the actual system. But if the world is organized, in reality, according to some very different set of principles—say contextualist (see the concluding section of this paper) instead of mechanist—then our resource explanations, predictions, and management control will simply not work. We have in any such instance the world view aspect of resource crisis, rather more often than we care to admit.

Technocracy is mechanization not simply through the introduction of labor-saving machines but, equally importantly, through the division of labor and hierarchical control. Work is reduced to simple tasks individually assigned, the physical aspect of a task being separated from the conceptual aspect, this facilitating hierarchical conceptual as well as physical control by a managerial elite. In the bureaucratic aspect of technocracy, society or one of its parts is divided into problem areas, an agency being named and given the responsibility and authority for each area. But human problems are experienced as diffuse, interpenetrating, evolving difficulties, not generally

isomorphic with the mechanistic division of society into agencies. So there are "turf battles," sometimes task forces, but often the problems are addressed poorly or not at all.

Technocracy, in its mechanist-realist world view and representational-realist theory of knowledge, aligns well with the theory and practice of liberal politics and economics, which are at least implicitly understood in this world view and theory. In this understanding, the entire societal machine and any part of the machine—its economy, politics, and technology, its agencies, firms, families, and individuals—each is understood to be autonomous, self-constituted, and essentially changeless. Each can be known and managed independently of other elements of society, each as it really is. Our conception of any system or subsystem is as the system is and, reality being isomorphic with conception, can and should be managed accordingly. And so ethos flows out of world view (1).

In the technocracy of government and corporations are scientists, engineers, economists, and managers professionally trained in the university system. Those high in the corporate structure, the governmental bureaucracy, the military, and politics form what C. Wright Mills (19) called "the power elite." Throughout the hierarchy of technocracy, the professionally trained, together with the power elite, are very much in control. However named, they form an important aspect of the organization and thus the culture of liberal capitalism (13). Most of us, excluded from this aspect of liberal capitalist culture, have no substantial control over the material and social conditions of our life and work, the resources that make us the kinds of human beings we become.

We have become a society of managers and those being managed. Our socialization to this culture begins in patriarchal families and continues through schooling and into the work place. Always, someone "superior" knows best. Most of us have little control over the kinds of humans we become, the kinds of communities we form, and the kind of society to which we belong. And all in the name of objectivity, authority, control, order, efficacy, efficiency, technological and economic development and growth, general interest, expertise, and professionalism: the ideology of technocracy. This is the technocratic aspect of the trivialization of liberty and sovereignty—or loss of control over the resources that otherwise would make it possible for us to become the kinds of human beings we would choose to be.

Resource Reconstitution of Democratic Communities and Subcultures

I have argued, then, that resource crisis is immanent in the nature, practice, and ideology of the political-economic and technocratic institutions of liberal capitalism. Resource crisis comes when the material and social conditions of possibility are no longer consistent with becoming human according to the values and norms of one's community and society. Resource management, capital, and the market, in supposedly maximizing production and the efficiency of allocation of commodities, are at best insufficiently sensitive to these conditions of possibility of becoming human; at worst, they have made wreckage of them. And the liberal state, owing to its political-economic and technocratic organization and ideology, has failed in its theoretically presumed function to deal with what the economy leaves behind. After focusing on the values, ideals, goals, and norms of liberal capitalism in contrast to those of a possible post-liberal participatory democracy, I intend in conclusion to deal with the possibilities and constraints of reconstituting conditions for democratic individuals, communities, culture, and society.

We must begin by articulating the values, ideals, goals, and norms of liberal capitalism. The values and goals of a liberal capitalist society such as the United States might be summarized as in table 1. The norms in approaching these values and goals might be suggested to be efficacy, efficiency, stability, order, and control; the modalities being organization, law, regulation, power, and money. In pursuing these values and goals, liberalism and capitalism have not sufficiently attended to the infrastructure and institutions mediating between the individual, the economy, and the state—they have not attended to the institutions directly providing the material and social conditions of becoming human. Directly and indirectly out of this come resource crises in their various manifestations.

Much can be said for the values, goals, and norms of liberal capitalism. Yet many within liberal society, and many peoples colonized by such society, are far from realizing its benefits. Moreover, liberal values, goals, and norms make not at all clear the material and social conditions that favor their realization. "Maximum production and distribution of goods and services" and "efficient allocation of resources"

(table 1), as understood and practiced in liberal capitalism, have been a recipe for resource crisis, certainly not for the development and maintenance of democratic communities and subcultures.

What, then, might be the values, ideals, goals, and norms characterizing a post-liberal, participatory democratic society? How might participatory, democratic, resource management proceed? Perhaps somewhat as in table 2, where values such as participation, understanding, community, mutual respect, and love become norms. Where liberty is understood positively as choosing and practicing, within broad limits and without interference, a way of life. And where sovereignty is understood to be individual, community, and societal control over the material and social conditions or resources of diverse democratic ways of life. Resource management goals and norms for a post-liberal society follow clearly and consistently (table 2).

Such a society is conceivable, but is it in any important degree realizable? C.B. Macpherson (12), in his classic *The Life and Times of Liberal Democracy*, noted that "A political system that demanded, for instance, that the citizens have more rationality or more political zeal than they now demonstrably have, and *more than they could be expected to have in any attainable social circumstances*, would not be worth much advocacy." His emphasized stipulation is important, for a citizenry in an evolving society need not and would not be changeless.

But where to begin? "Even those who find the ideal of post-liberal democracy appealing may wonder how it might come about. The answer, we think, is that the joint project of popular sovereignty and liberty will come to fruition, if at all, not through the substitution of the unprecedented for the familiar, but in the transformation of the present and in the development of structures and meanings already prefigured in today's society and discourse." Bolles and Gintis (9) go on to emphasize that much that would characterize post-liberal democracy is prefigured in liberal society and the radical potential of liberal discourse. Thus we can speak of "reconstitution of conditions" for democratic communities.

To the extent that the values, ideals, goals, and norms of the practical-cultural sphere of everyday life have been distorted and displaced through colonization by the systemic aspects of the political economy and technocracy of liberal capitalism, some educational and other "decolonization" of everyday life needs to take place. Recall, the language, goals, and norms of the systemic aspects of society distort and displace those of the lifeworld, much as Fanon (2) saw the language and values of an imperial power displacing those of a colonized people,

Table 2. Values, ideals, goals, and norms in participatory democratic resource management.

VALUES	IDEALS	GOALS	NORMS
Participation Subsistence Security Identity Understanding Love Kinship Community Respect Equality Freedom Creativity Acquisition Power Justice	Individual and community liberty to choose and practice within broad limits and without interference, a way of life. Substantial individual and community sovereignty over the material and social conditions of chosen ways of life. Necessary societal sovereignty over the material and social conditions of the diverse ways of life in society.	Substantial participation in all spheres and levels of society. Diverse democratic citizens, families, communities, institutions, and societies. Nonexploitive development and maintenance of the material and social conditions of chosen ways of life.	Participation Understanding Enlightenment Facilitation Sincerity Rightness Truthfulness Collaboration Development Individuality Community Respect Morality Friendship Love Richness Coherence Transcendence

with resultant alienation, loss of identity and legitimation, and other manifestations of resource crisis. Only as this is healed can reconstitution of democratic communities and subcultures begin.

Paulo Freire (20) made a distinction between the professional and the expert that is of particular relevance to our concern about technocratic colonization of the lifeworld within a society. The professional, believing all knowledge is scientific or technological, has no respect for the lifeworld knowledge of people, because the professional has no respect for his or her own preprofessional knowledge. Experts, on the other hand, recognize different kinds of knowledge and strive to make their special knowledge a part of the common culture. In the effort to reconstitute a culture or subculture through reconstitution of its material and social conditions or resources, it is important that the development of communicative and critical understanding be not for some special few but emphatically for the average man and woman.

This is necessary because it is the community as a whole that must be politically and culturally active, to deal with resource crises. The need is to develop "critical communities" (20), constituted by what Schutz (21) called the well-informed citizen, "who considers himself perfectly qualified to decide who is a competent expert and even to make up his mind after having listened to opposing expert opinion." Such a far cry from the "managed and marginalized" men and women of liberal capitalism may seem unrealizable. And yet, world view, communicative understanding, critical understanding, and legitimation aspects of resource crisis derive in large part from professionals and their largely unaccountable communities. More democratic participation by critical communities of well-informed citizens may be the last best hope of controlling resource crises immanent in the political economy and technocracy of liberal capitalism.

For liberal capitalism to evolve toward post-liberal participatory democracy, a major shift from the mechanist-realist world view toward the contextualist world view must occur. The shift from the mythic world views of traditional societies to the Newtonian world view made liberal capitalism possible. This was essential not only for the development of modern technocracy but also for the theory and practice of the political economy of liberal capitalism. But the machine theory and practice of society and its elements is now the basis not only of a world-view crisis but also of crises in communicative understanding, critical understanding, and legitimation. Remember, in the mechanist-realist world view, all resource problems are seen as isolatable from social experience and divisible into elements that can be solved and reconstituted into a workable whole.

In the contextualist world view, and with the coherence theory of truth, scientific, technocratic, and everyday problems would not be understood, approached, or believed to be "solved" in this way. In contextualism (1) the behavior of a system is determined jointly by its elements and its context; (2) a system, its context, and its elements interpenetrate in such ways as to make abstraction and analysis fundamentally distorting; and (3) interactions of system, context, and elements lead to qualitative changes in all. Rather than the correspondence theory of truth, employed in the representational-realist view, the "coherence theory of truth" is employed in contextualism. In coherence theory, propositions are evaluated on the basis of their universality, economy, coherence, and utility.

Rather than engineering and controlling (ideals of the mechanist-realist world), enlightenment and facilitation of social action could be ideals in a world understood more in a contextualist view. Our knowledge of the natural and social world is much less useful in resource management than the involved professions continue to claim (22). Everyday experience does not support such claims, and legitimation and other aspects of resource crisis become part of the common experience. A more modest view of the nature and utility of resource knowledge would help to encourage more general participation and thus a degree of popular sovereignty in resource management.

The liberal barriers between personal rights and property rights and between the public sphere of the state and the private sphere of the family and the corporate economy have left public goods and the personal rights of working people terribly vulnerable. Their liberty to choose and practice a way of life is insecure; and their sovereignty over the material and social conditions of their ways of life is largely nonexistent. Being treated as a private concern

rather than as the public concern that it is, the corporate economic structure is unaccountable for its production and investment decisions, as well as for the natural and human wreckage it so often leaves. This most fundamental of resource matters can be altered only by much more extensive public (state, community, and worker) participation in production and investment decisions.

Not only the corporate structure but the intrusive state coupled with utilitarian individualism has led to social policies and programs destructive of the material and social conditions of democratic citizenship. Measures of economic performance are mainly national. And social welfare programs generally assist individuals directly, in this way by-passing mediating structures of neighborhoods, communities, and regions. Thus the very conditions of becoming human in our communities and subcultures have tended to break down, even while employment and welfare practices tend to leave individuals not only isolated but mobile.

A more facilitative state, one working to maintain local and mediating infrastructure, could encourage democratic and other social participation in society and its subcultures (23). Policies and programs could enhance communitarian individualism rather than the utilitarian individualism that so characterizes our society (24). Concern for public as well as private goods, and for citizenship itself, would be the responsibility of the individual together with the facilitative state, in a kind of civic republicanism (25).

That any such post-liberal participatory democracy would be in the future of liberal capitalism is by no means probable. Prefigured in present society and its tendencies is a kind of "neo-Hobbesian liberalism," a strongly hierarchical managerial society putting not only political but economic freedoms in danger, as the price of law, order, and managerial and economic efficiency. Alternatively and also very much prefigured in present society is a "global economic liberalism," in which not only individuals and communities but also nations give all control over their resources to corporations operating and moving internationally—they give up liberty and sovereignty in the name of "free trade" (9). While by no means probable, post-liberal participatory democracy still offers the greatest hope for individual, community, and societal liberty and sovereignty and for the diverse cultures within which we become human.

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