Environmental Stress and the Use and Enjoyment of Marine Resources: The Future

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INTRODUCTION

> "We know that the white man does not understand our ways. One portion of the land is the same to him as the next, for he is a stranger who comes in the night and takes from the land what ever he needs. The Earth is not his brother but his enemy, and when he has conquered it, he moves on."
> - Chief Seattle, writing to President Franklin Pierce in 1855.

Chief Seattle, were he reincarnated today, would find very little to suggest that he was wrong in his earlier assessment of the white man's approach toward stewardship of the earth. His criticism was based not only upon an understanding of the white man's attitude toward the Earth's resources. He also comprehended the first rule of ecology, for he went on to say "All things are connected. Whatever befalls the earth befalls the sons of the earth." It seems especially appropriate to preface this discussion of the environmental factors underpinning our "use and enjoyment" of marine resources with the wisdom of this "savage" chieftain, whose words so remorsefully highlight the cause of the problems we face today and in future resource management.

As a preface to this essay I will first dwell on the primary problem facing the world: how to manage our affairs prudently, with a human population capable of increasing exponentially beyond the apparent support capability of the available resources. Stated another way, can we restrain our apparent urge to self-destruct and instead create a socioeconomic system that can allow posterity to look forward to an existence above the subsistence level? There seems to be little doubt that in the short term of the next century we will run the risk of seeing Malthus vindicated, but there are other indications that suggest a Malthusian outcome is not inevitable. There are signs and omens that suggest there can be improved protection for the world ecosystems and thus, continued use and enjoyment of marine resources.

DEMOGRAPHIC BACKGROUND

In the United States, the population doubled nearly 5 times in the 19th Century, beginning with a population of 5.3 million and ending with 76 million. By 1950 it had doubled again,

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to 150 million; and all projections indicate there is no way to escape a population of less than 300 million by the year 5000 (Brown 1981). Experts consider us a "developed country"; that is, one which has enjoyed the blessings of the industrial revolution. We have seen our average standard of living improve in parallel with increases in the Gross National Product. Our experience, until we recently began to realize that "there is no free lunch" especially as regards petroleum, has been vastly different from that of much of the world. In many countries populations have increased with little, if any, improvement in the standard of living.

At the time of the Birth of Christ, the world contained about 250 million people. It took 17 centuries for the first doubling after that, in 1650. Then, in less than two centuries, in 1830, we reached one billion. We doubled again in 1925 to two billion, in less than half a century; and we doubled again, to four billion in 1974, in just half a century (Cook 1980). If we were to continue breeding the way we have, and there were no interference, benign or catastrophic, the world would contain some 30 billion by the end of the 21st Century.

RESOURCE AVAILABILITY

Given the rate at which the developed countries, particularly the United States, are consuming resources, there is no apprehension that the world's population will ever reach that level. We would have exhausted our essential resources long before approaching that point. In fact, the world appears already to have achieved a population resource equation that is stressed by under-supply rather than over-supply. Demand has outstripped availability of many resources in many parts of the world; thus per capita production of essentials is down, even though gross or total production may have increased.

The Global 2000 Report of the Council on Environmental Quality projects a 90 percent increase in food production, but only at much greater cost in fertilizers and other developments. That increase would be counterbalanced by a population increase that will reduce the increase in per capita food availability to 15 percent.

Petroleum production will peak in the 1990's and fade away early in the 21st Century; fuelwood demand will exceed supply by 25 percent before the end of the century. Other finite fuels are maldistributed throughout the world and will continue to be controlled by the more affluent nations. Nonfuel minerals, with some exceptions, will be readily available at century's end, but costs of extraction and of refinement may make some of them prohibitively expensive.

The outlook for water is grim. It is being wasted by those who have plenty and used to the last drop by those who have little. Deforestation and overgrazing add to the already complicated picture by hastening runoff and limiting the recharge of dwindling underground reserves.

Forests are disappearing throughout the world to supply timber and firewood and to open land for agricultural development.

Soil losses in most parts of the world are excessive and will require large expenditures to bring them under control. A recent study by the Department of Agriculture suggests that

even in this country, where we have had governmental support for prudent soil care for at least 50 years, it would cost $103 billion over the next 50 years to reduce soil losses to acceptable levels.

FACTORS AFFECTING PRODUCTION OF FISHERY RESOURCES

To bring this discussion closer to the symposium theme, the projections for the world's fisheries are not much brighter. In the 1950's and '60's there were forecasts that the oceans would "feed the world" with production of as much as 300 million metric tons (t) annually. There is every indication that fish production has levelled off and that world catches in the order of 70 million t are a more reasonable expectation. Should management succeed in bringing catches to the level of 85 million t by the end of the century, the catch per capita would still drop 30 percent because of the increased population (Council on Environmental Quality 1981).

As this symposiuum will doubtless reveal, various factors (some independent, others acting together) have tended eventually to limit or decrease production from the marine fisheries. Several of the most important of these factors, especially overfishing, fall in the category of fisheries management and will be reviewed in a later session. Political stricture on size or volume of fish taken and consumer rejection based on prejudice against particular species or products, are others. In the long view, however, the most important factor affecting the sustained production of fish is that of sustained habitat viability. Neither economic, social, nor technological problems mean much if habitat is lost.

One of the most serious contemporary habitat problems affecting marine resources is that of petroleum pollution. It is well known that oiling causes various reactions among the living species of sealife; Malins (1979) suggests that the magnitude and persistence of damage in any location is a function of:

1. the chemical composition and physical properties of the petroleum;
2. the quantity and duration of the oil spill;
3. the seasonal, oceanographic, and meteorological conditions existing during the exposure;
4. the nature of the exposed ecosystem;
5. the type of habitat involved;
6. the geographical location; and
7. the type and extent of cleanup undertaken (Malins 1979).

The world has been fortunate that there has been only one large scale oil spill in the last few years. This is undoubtedly due to recognition of the immense cost of clean-up, the cost of oil wasted at $33 or more per barrel, and the cost of dealing with an outraged public. While major spills have declined there are still numerous ones of a minor nature, 1127 having been registered by the Coast Guard from January 1974 to August 1975 (Marx 1981).

Of particular interest and concern to the residents of the Pacific Northwest is the loss of fishery wealth due to the impoundment of transit or spawning streams used by anadromous species. Dr. Ebel has just reported that a major function of the scientists at Montlake has been to determine the factors affecting the lives of salmon and

steelhead in the Columbia River system. Particular emphasis has been on the effects of the construction and operation of the 27 dams that have been built on the Columbia and its tributaries since the first major barrier, Rock Island Dam, was erected in 1933. To say the least, the Columbia River program has inherited the experience of Sysiphus. That there are any salmon left in the Columbia drainage at all is a tribute to the scientists, managers, and engineers whose work must have been tinged with feelings of frustration and desperation as one problem solved was replaced by another equally difficult (Ebel 1981).

When one considers the immensity of the changes that have occurred in the Columbia River Basin, the problem of the dams falls into perspective as but another in a long series of growing insults to the river environment that have decimated the River's commercial salmon production from a high of near 50,000,000 pounds in 1916 to but 5,000,000 pounds in 1979. Prominent among these are changes in land-use due to agriculture, forestry, mining, and urbanization that have resulted at one time or another in dewatered spawning streams; death of spawners and returning young through irrigation diversion; increased temperature and turbidity; changes in rate and time of runoff; log and logging debris jams; deteriorated chemical nature of water; introduction of toxic materials and exotic predator species; and channel and estuary modification by dredging and filling (Howard 1981). It is obvious why the anadromous species of the Columbia River are in dire straits; equally apparent is why the continued scientific study of means for the preservation of salmon in this system is imperative (National Marine Fisheries Service 1981).

Many if not all of the same factors to a greater or lesser degree have been faced by the managers of anadromous fisheries in other parts of North America. The distress of the salmon runs of the Sacramento drainage in California has become increasingly severe. Adverse changes in water quality in the Sacramento and the estuary of that river and of the San Joachin have recently been brought into prominence by plans to divert virtually the entire flow of the Sacramento around the estuary, there to be pumped southward to supply water demands in southern California (Yocom 1981). To further complicate the problem most of the upstream flow of the Trinity River, accounting for 90 percent of its upstream spawning area, is already diverted into the Sacramento. The Trinity is a principal tributary of the Klamath River, whose salmon runs have been impaired by this reduction in available spawning grounds. The same fate hangs over the Eel River, whose upper reaches are scheduled to be diverted to the Sacramento.

Some have assumed that the critical problem was the transport of immature salmon in the Sacramento River downstream into the estuary. However, in recent years there has been a notable decline in the numbers of striped bass spawning and using the estuary and San Francisco Bay. The deterioration of water quality in the estuary as a result of the large diversions may well be the cause not only of the decline of the striped bass, but also another factor in excessive mortality of juvenile salmon. Moreover, there are other species of fish in the Bay whose requirements are little known that may be adversely affected by the changes in water character in the estuary upon the consummation of this gigantic diversion.

On the east coast of North America, many of the same problems described above have been present for many years. Until the period of the 1960's there was little done to restore the anadromous fisheries of the northeastern United States. An integrated program of improvement of spawning streams through both pollution abatement and removal of, or passage over, fish barriers plus greater stocking efforts seem to have been successful in starting the restoration of salmon in the Penobscot and Connecticut Rivers.

In the Chesapeake Bay, however, the anadromous species including the American shad and striped bass have suffered a severe decline in the last few years. There has not been a highly successful survival of bass larvae since the large year class of 1970, and the last 3 years have seen a collapse of the spawning shad population. The precise cause of these declines has not yet been determined. However, since the exploitation of these two species has never been deemed to be excessive in relation to estimated populations, it is assumed that environmental changes are responsible.

The destruction or impairment of estuaries has been a critical problem of major dimensions for years. They have been ruthlessly dredged for sand, gravel, and oystershell on the one hand and as thoughtlessly filled with dredge spoil, trash, and toxic wastes from industrial development and housing and restoration projects--resulting in all types of rural, urban, and industrial pollution. It is remarkable that any have survived as natural components of the marine ecosystem, despite substantial interest in their preservation even up to the halls of the United States Congress. Until recently, it appeared that the estuaries would have a respite from their despoilers, but even now there are schemes afoot to permit attacks on them and other wetlands by lowering the governmental wetland protection standards.

Demands for these changes stem from a variety of exploitative commercial activities, but those related to our coastal resources come primarily from the energy problems caused by the imminent exhaustion of petroleum supplies. Nearly every major port in America is being examined from the standpoint of its potential as a coal shipping center. The Congress has already authorized dredging of Chesapeake Bay to a 52-foot depth (a large project that, despite the comments and conclusions in the environmental impact statement, will have profound environmental effects). In the Strait of Juan de Fuca plans are brewing near Port Angeles, Washington, to establish a major oil terminal to serve as the port for the Northern Tier Pipeline Company (Larkins 1981). Up to the present, the potential for environmental disaster due to an oil spill has been largely waved aside or ignored.

Still another area of concern related to the energy problem is the sudden growth of interest in the development of small hydroelectric generating plants. A major problem that had to be overcome before anadromous fish restoration could progress in New England was the presence of numerous dams originally built without regard for fish passage. A common activity in the early days of the Federal Aid in Fish Restoration Program was the identification and removal or laddering of these structures. Under the impetus of new federal legislation, which mandates that the major utilities buy the power produced, there has been an

avalanche of applications for small hydro installations. In most instances there is adequate technology to insure the movement of spawning fish past the structures. The real problem will be whether there will be state and federal funds to enforce conservation stipulations and whether policies will be changed to permit construction without essential passage facilities (Chasan 1981).

Alaska, to return to problems of more immediate concern to this symposium, is not exempt from looming threats to the viability of its natural environments. Active planning is under way for power plants on the Stikine and Susitna Rivers, and there are many other smaller hydroelectric developments that are in some stage of planning. All will have some impact on Alaska's fisheries.

It is well known that the edges of the land masses surrounding the Arctic Ocean are considered to be among the more promising regions for oil exploration and exploitation. A few years ago a study conducted by the Council on Environmental Quality identified those areas most subject to oil development that also had uniquely high fish and wildlife resource values. The two most important such areas were in the Bering Sea and Prince William Sound. To date, formal steps to lease these offshore areas have been delayed, and it is to be hoped that leasing can be held off until there are more sophisticated techniques available for both the actual drilling and dealing with accidental spills. Both environmental deterioration and interference with fishing activities would result from premature activity in these highly important fishing areas.

Meanwhile, also in Alaska, another threat to the anadromous fisheries is looming as a result of the requirement in the Alaska National Interest Lands Conservation Act that 4.5 billion board feet of timber be harvested from the Tongass National Forest in southeast Alaska over a 10 year period. When the acreage set aside for native use, state claims, and rocky or protected wilderness have been subtracted from the total acreage of harvestable timber in the Tongass, there is some question whether enough timber remains to meet the statutory mandate and at the same time protect the old growth timber adjacent to several hundred miles of salmon and trout spawning streams in the forest. Certainly, it can be done only if the Forest Service and the State of Alaska provide the funds both for basic research on quality characteristics and for annual planning and surveillance of cutting.

This essay makes no pretense to present a comprehensive review of the environmental stresses that are affecting the fisheries around the world. It is fair to assume that the same factors are at work in other regions. Indeed the popular environmental and fisheries periodicals seldom fail to include an item about some disappearing habitat somewhere in the world. Recently the magazine Sea Frontiers contained an article reporting the destruction of mangroves in the Malay Archipelago. All mangrove forests except those in New Guinea are considered to be endangered. In the Philippines, less than a quarter remains of the country's original 1,112,000 acres of mangroves. Interestingly, 435,000 acres have been converted to fish ponds. At current rates of destruction, 59,300 acres per year, or all of their mangroves, will be gone within about 5 years (Scott 1981). Who knows the consequences to marine animals that find the mangrove habitat essential to their survival?

What I have described represents but a small sampling of the broad assault upon the ocean environment. The most obvious effects are those in the estuaries and streams where human activities are visible to the public. By virtue of their immensity there has been a tendency over the years to consider the oceans immune to the effects of unrestrained use. Men have used the oceans in a dozen ways and doubtless more will evolve in the future to fill the demands of an expanding population. Many of these are neutral in terms of their environmental impacts, but incremental effects of others could spell ruin. It is hoped that the tendency to view the oceans as convenient dumping grounds for all kinds of wastes that we have no ready place for on shore is finally coming to an end.

PUBLIC POLICIES AND THE MARINE ENVIRONMENT

It is no surprise that the great promise of the bounty from the sea so loudly heralded in the 1960's has dwindled in today's harsh economic realities. The widespread interest in ocean development has settled down to the over-riding search for oil and a few minerals, notably manganese. Current government preoccupation with achieving a balanced budget while promoting immense outlays for defense leaves little room for more than the most essential and sometimes mundane housekeeping chores related to marine resources.

To those of us in the profession, it sometimes seems that public interest in and support for ocean exploration, development, or protection seems to range from complacency to ignorance. An effort to stimulate broad public concern by a coalition of national conservation organizations under the program "The Year of the Coast" did little more than cause a few stifled yawns. The warnings of marine ill-health by such well-know celebrities as Cousteau and Heyerdahl seem to be brushed aside for what are perceived to be more urgent matters. Underneath this general public apathy lies the unspoken feeling that the oceans are too big to be hurt by man's activities. The great oil spill tragedies have been all but forgotten.

Those who "use" the ocean continue to see it as a resource to be mined rather than managed. Some of the experiences of the regional fishery management councils exemplify that attitude, especially where hard decisions between a conservative policy and one of exploitation have been involved. The tragedy of the common still stalks our oceans.

In the process of determining the benefits and costs of competing resource uses as, for example, the use of flowing water to support life in a spawning stream versus its use in irrigation, economic analytical techniques seldom provide a comprehensive balancing of all the benefits or all the costs. Not only must the techniques of evaluation be improved and the basic theory itself developed so that amenity values and societal costs can be adequately considered, there must be a strong governmental concern for these matters.

These needs can only be recognized and dealt with effectively in two places, academia and government. The reason is simply that the ocean resources are public resources; there is no incentive for the investment of private capital in either the essential research or the

development of the programs needed for securing the future of the "wealth of the sea." If government at either the federal or state level fails to recognize this basic responsibility, we indeed stand on the threshold of marine resource disaster. The difference between today and 1931, I would remind you, is a matter of some 2.5 billion more people in the world. We in the United States have nearly doubled our own population in that same period.

The other option available for the financing of essential ocean fisheries programs is to plan for the imposition of royalties for the extraction of the publicly owned sea resources. This concept was considered and rejected in the debate leading to the enactment of the Magnuson Fishery Conservation and Management Act of 1976. If indeed the government disavows its responsibility for fisheries management, protection, and enhancement, the only other alternative would be to establish a fee system for domestic as well as foreign participants in the fishery.

Certainly it is time that the commercial fishing industry engages in some original and far-sighted thinking about its future. The ability of the oceans to produce food, especially the protein-rich varieties that a hungry world so badly needs, must be protected and extended in the very basic interest of the future of mankind. We can no more turn away from the support of scientific management and protection of the ocean's condition than we can ignore the lessons of the past with respect to soil erosion and fertility losses. In the minds of many, these have become issues that are non-debatable.

THE LONG-RANGE OUTLOOK

The extent of growth in the human population vs resources of this country and the world was sketched in the earlier paragraphs. The purpose, of course, was to provide a basis for considering the role of the marine resources in the world's future. It would be too much to say that all of the problems besetting our use and enjoyment of those resources would be eliminated if we were successful in stabilizing the human population at something better than starvation levels. However, the fact remains starkly and inevitably, that unless we do succeed in levelling off our population growth, there will be little hope for mankind in general and none whatever for marine resources. Hungry mobs provide little support for prudent resource management.

Many have viewed the future of mankind with great alarm. The Roman historian Livy, nearly 2000 years ago, wrote that "Contemporary history displays our nation suicidally eating up its mighty resources." We too, are living in a world dependent on finite resources. The specter of a race whose powers of reproduction have remained undiminished while building an immunity to the ravages of the "Four Horsemen of the Apocalypse" is cause for genuine concern.

There seems to be little doubt that most of the world's leaders are aware of the ominous portent of an unlimited population/limited resources equation, yet because it must be dealt with in terms of some of humanity's most revered and personal liberties, few have been motivated to strong action. In certain instances, governmental efforts to slow population growth have not been overly successful, but in

still others, dramatic results have been achieved in a remarkably short time. China, Indonesia, Costa Rica, and Barbados, an interesting variety of nations, have all achieved an essentially stabilized population. Their success depended on forthright government efforts to promote family planning. Incentives for limiting children, disincentives for having children, provision of family planning assistance complete with birth control devices, and the availability of abortions have proved to be effective. Other countries have begun to embark on the same programs and are beginning to see immediate results.

In other countries, those with higher standards of living, greater freedom for women to move into the mainstream of economic and professional life, and higher education levels, birth rates levelled off without government assistance. Austria, Belgium, East Germany, Luxembourg, Sweden, United Kingdom, and West Germany are in this group (Brown 1981).

Our use of resources has already taken decisive turns. In this country alone we have reduced our petroleum consumption significantly since 1973, which is important when it is realized that we are by far the largest single consumer of petroleum in the world. This trend will continue as more and more of our home heating and industrial demand switches to coal. The coal option will not be an unmitigated blessing; lower air quality would seem to be an inevitable accompaniment of increased coal use. However, it is at least a source that may keep the world's wheels turning until we have moved into the era of solar energy.

No thoughtful person can pretend to predict with precision what will happen in the long-range future. However, we can suggest those things that must be done if we are to achieve certain social or economic objectives. With respect to our marine resources, we know that we must carefully guard against thoughtless destruction or deterioration of the environment. As a generality, nearly everyone would agree to that. The questions are what constitutes intolerable destruction or impairment, and how do we go about preventing it?

The answer to those questions can be found primarily in a continuation and expansion of the scientific research that has brought civilization to its present levels. We will continue to need to know more about how the oceans work, the relationships between their components, and what the effects of human-induced changes are in both the parts and the whole.

Moreover, what we learn must be communicated to the public in ways that will do more than merely enlighten. It must motivate action by individuals to make rational decisions in relation to resource issues. There was a day when it was enough for the scientist to publish his results; his peers would subject his finding to appropriate reviews and ultimately they would be incorporated in public policy or not, as the political fates would have it. Today, those who will be affected by the results of research are becoming more involved in identifying problems, observing the course of studies, and finally supporting the evident conclusions. This has happened on the Great Lakes where water quality progams were developed in this way (Alexander 1980); that process is being duplicated by the Environmental Protection Agency to implement the results of its water quality studies on Chesapeake Bay.

Finally, to prevent special interests

from forever dominating the political process of making resource allocations, there must continue to be a vital force of citizen opinion marshalled in support of prudent resource use. Contrary to what some have thought, the environmental movement is far from moribund. At the moment it seems to be growing from the stimulation of adversity. The Sierra Club has just delivered its million-signature petition calling for the ouster of James Watt as Secretary of the Interior. The National Wildlife Federation now boasts 4.5 million members and has set its sights clearly on the need to protect the world's resources from avaricious interests. The same may be said for most of the other national conservation organizations. Despite comments earlier about the apathy of the public concerning threats to the marine resources, experience has shown it can be dissipated when a major issue, however local, is clearly presented.

Realistically, it must be recognized that not all of the environmental battles will be decided in favor of prudent resource use. Therefore, one might assume that we must continue to anticipate a gradual decline in the quality of the environment. That such is not the case is demonstrated by what has happened to America's surface waters over the past decade. Save for the "acid rain" problem there has been a demonstrable improvement in quality over much of the country. The threat of chlorinated hydrocarbons permeating the ecosystem has been moderated, and the fish-eating birds that were on their way to extinction 15 years ago have at least been reprieved. That end would not have been realized in the absence of a strong alliance between scientists, administrators, and the public. The example persists, and what has been done can be repeated.

The full extent of conversion to a population stabilized in relation to its resource base, marine or otherwise, will require profound and extensive changes in life styles, economic parameters, social relationships, land use, and every conceivable aspect of human life. Brown (1971) outlines what has been and is being done. We are indeed facing a revolution; whether it will be constructive or destructive depends on whether we learn to live within our global means.

There is a role in this revolution for the scientists at Montlake, as there is for all those who strive to explain the complex working of the world, as we look ahead to the next 50 tension-fraught years. You and people like you who have the knowledge, the intellect, and a dedication to a livable earth can continue to contribute to our understanding of the vital role of the natural systems on which mankind depends. You and your associates have the ability as scientists, and the obligation as responsible members of the human race, to interpret your knowledge and your insights to promote greater public understanding of the significance of the resources with which you deal; you and your colleagues can provide a critical technological leadership to support the growing body of the public that increasingly understands that a healthy natural environment is vital to man's future. You, and all of us, can echo the words of Chief Seattle, "And what is it to say goodbye to the swift and the hunt, and the end of living and the beginning of survival?"

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