What Future for the Oceans?

John Temple Swing

TROUBLED WATERS

Oceans, which move in deep connected currents over nearly three-quarters of the globe, have historically been slow to exhibit change. Altered oceanic conditions have often been measured in centuries, not decades. More recently, however, oceans have begun to undergo an accelerated transformation that has caught most people, even in this scientific age, unaware and unprepared.

Some changes hold particular dangers for those who live within 50 miles of a coastline—already nearly two-thirds of the world's population and expected to reach three-quarters by 2025. Other changes, if unchecked, could adversely affect all human and animal life on the planet. Among the most problematic of these developments are rising temperatures and water levels, unprecedented damage to coral reefs, disappearing salt-marsh and mangrove swamps, a sharp decline in fish stocks, and rising levels of pollution.

Thirty years ago the international community was just beginning to worry about the dual effects of technological change and population growth on the biosphere. Oceans were on the agenda at the 1972 UN Conference on the Human Environment, held in Stockholm. At that time, however, a growing dispute over restrictions on free navigation and ownership of the oceans' resources was already stalling progress and cooperation. It took another ten years for the countries of the world

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to arrive at the 1982 UN Convention on the Law of the Sea, which enshrined both the principles of a global approach to ocean problems and the rights to oceanic resources in nothing less than a "constitution for the oceans." The convention's interactive set of commitments holds benefits for and is binding on all of the 142 countries—plus the European Union—that have since ratified it. Yet in spite of this international pledge to the oceans' future, today there is growing cause for concern.

Both the adverse trends and the potential of newly discovered resources have received scant public note and, until recently, woefully insufficient attention from U.S. policymakers. In fact, the United States and Canada, alone among the major industrialized and coastal states, have remained holdouts to the 1982 convention. And even Canada is expected to ratify by the end of the year. This brewing crisis of the oceans thus presents a rare window of opportunity for the United States—to help stem the tide of unwelcome oceanic change and, along with the rest of the world, to reap the benefits of healthier oceans and their resources.

HORN OF PLENTY?

FOR MOST OF HISTORY, people thought oceans could provide a limitless supply and variety of fish. But that assumption has been sharply undercut by the explosion in human population—now forecast to crest at 9.4 billion people by 2050—and by advances in fishing technology.

In just a century, commercial fishing has evolved from single-hooked lines and hand-cast nets to enormous trawl nets, drift nets that are miles long, and "longline" gear with thousands of hooks hanging from a single boat. Grand Banks schooners, sailed by compass and sextant, have given way to factory ships, each capable of producing 40,000 to 50,000 pounds of product per day and guided by global positioning satellites. With improved technology such as sonar tracking, but due more to poor management, half of the commercial stocks are being fished to capacity and another quarter are being seriously depleted. Cod, tuna, salmon, and swordfish are among the worst hit.

As pressures on fish stocks in coastal waters became apparent in the early part of the twentieth century, conflicts arose between local fishing communities and fishing fleets from other countries, many of which had been fishing in the same coastal waters for centuries. Cod wars began in 1958 when the United Kingdom challenged Iceland's unilateral declaration of a 3-mile exclusive fisheries zone beyond its traditional 3-mile territorial sea. The situation was only exacerbated when, in 1972, Iceland extended its claim for exclusive fishing rights to a full 50 miles.

The 1982 convention dealt with these problems by extending the customary 3-mile territorial sea to 12 miles and giving coastal states additional 188-mile exclusive economic zones that encompass the habitat of close to 90 percent of the world's fish. Major maritime states, which had feared that this extension of coastal jurisdiction would jeopardize their "high-seas" rights of free passage, were given a special "transit-passage" regime through the 116 straits that would otherwise have been closed off by expanded territorial jurisdiction. Similar passage rights were created for archipelagic waters. Both included the rights of overflight and both were deemed vital to reliable shipping and security. Beyond the new coastal zones, high-seas fishing and navigation rights remained, but all states were firmly placed under a duty to conserve fish stocks and, with them, the marine environment.

Nonetheless, the creation of fixed boundaries between various zones left an immediate problem. Fish, even coastal varieties, do not live neatly in exclusive economic zones. To make matters worse, highly migratory species that include tuna, swordfish, and salmon swing through thousands of miles of ocean in their search for breeding grounds and food.

Unfortunately, in exclusive economic zones, policy tends to be dominated by local fishers interested more in maintaining their own livelihood than in the health of the fish stocks they control. As a result, overfishing continued unabated after 1982, with improved gear and subsidized vessels, until several important species, particularly cod and haddock, were fished almost to extinction. Americans and Canadians could no longer accuse the Russians, Japanese, Spanish, or Portuguese of plundering North American coastal stocks. They appeared to have done it themselves.

Worldwide, the capture of wild fish grew rapidly from 16 million tons in 1950 to about 90 million tons in the late 1990s and has since leveled off. But this rapid increase has not come without a price. Tuna and cod supplies as well as those of shrimp and other animals lower in the food chain have all come under threat.

The expansion of fish farming, or aquaculture, threatens another crisis. In the late 1990s, Turkish trawlers were fishing out the anchovy population in the Black Sea. Thousands of miles away, Thai "pirate trawlers" were taking in as much as ten times the sustainable yield of anchovies for Thailand's coastal area. Ironically, most of the anchovies are ground up and exported westward to become a major food source for salmon raised and fed in tight pens. In 1998, it took an estimated 1.8 million tons of wild fish ground into fishmeal to produce 544 tons of farm-fed Atlantic salmon for market. By 2000, aquaculture was already producing one-quarter of all the seafood consumed by humans, and the figure is expected to rise to more than one-half by 2030. Such a rise in the aquaculture of carnivorous fish could hasten a collapse of the fish stocks in the lower half of the food chain. Ultimately, to be sustainable, aquaculture will have to depend more and more on herbivorous fish such as carp, catfish, and tilapia.

More than 36 million people currently depend on wild fisheries and aquaculture for their livelihoods.

Another growing problem is the intentional discard of unwanted species known as the by-catch. In 1998, scientists estimated that approximately 44 billion pounds of fish, the equivalent of one-quarter of the total landed catch, are discarded annually worldwide.

Not all the news is bad. Since the 1982 convention, international agreements have emerged to implement and strengthen its conservation principles. The most important of these was the 1995 agreement "relating to the conservation and management of straddling fish stocks and highly migratory fish stocks," which has been ratified by 34 countries, including the United States, and which entered into force in December 2001. In one instance of success, conservation measures adopted in 1998 by the International Commis-

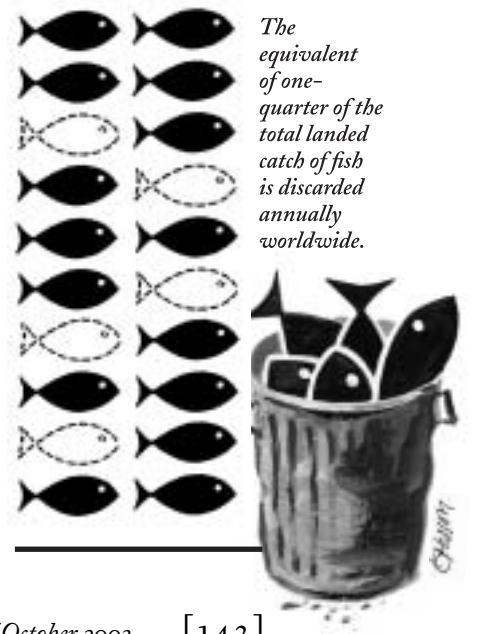
sion for the Conservation of Atlantic Tunas (ICCAT)—which also regulates sharks and billfish—have stimulated a recovery of North Atlantic swordfish stocks, which had fallen below 60 percent of sustainable yield in 1996. In just four years, the swordfish stocks rose to 92 percent of the optimum level. Last fall, however, ICCAT raised the catch quota for swordfish by 40 percent, which brings into question how long the recovery will last.

THE POLLUTION MENACE

THE TOLL of unrestrained fishing is being compounded by another serious problem. Oceans are being bombarded almost daily by land-based pollutants that include river runoffs, the dumping of untreated sewage, toxins carried by the atmosphere, and even innocent-seeming dredge waste. Collectively, these represent an ongoing threat to ocean stability and human welfare. More than 36 million people currently depend on wild fisheries and aquaculture for their livelihoods. In Asia, 80 percent of coral reefs are at risk and could suffer total collapse within 20 years. Likewise, 70 percent of the Asian mangrove cover is already gone and could disappear entirely by 2030. In the United States, where coastal tourism and recreation is the fastest growing service-sector business—contributing almost $600 billion yearly to the GDP—salt marsh is disappearing at a rate of 20,000 acres per year. Approximately 180 million people now visit U.S. coasts annually. Sadly, pollution and the pressure of development may make it increasingly less attractive to do so in the near future.

In dealing with land-based pollution of marine environments, the 1982 convention called on states to adopt laws and regulations to prevent such damage. Although to date the international

By-catch



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system lacks enforcement mechanisms, the convention enhanced recognition of a growing world problem and set the stage for further international action.

To cope with vessel-source pollution, the 1982 convention empowered the International Maritime Organization (IMO) to set minimum antipollution standards to be binding on all vessels. At the same time, the convention permitted port states to enact even higher standards for vessels entering their harbors. This was particularly important to the United States because 90 percent of all shipping off U.S. coasts is on its way to or from U.S. domestic ports.

The 2002 oil spill from the crippled tanker *Prestige* off the Spanish coast caused the European Union to pressure the IMO to move up the date of its ban on single-hulled fuel tankers, originally set for 2015. Even so, it remains questionable how much good this ban would do. Double-hulled tankers can minimize spills but do not prevent them. Tanker traffic has doubled in the past 15 years, an increase that in part reflects the rise in U.S. dependence on imported oil from 40 percent to 50 percent of total consumption over the past two decades. The increase in tanker traffic alone suggests that the world will see even more major spills in the years to come.

Another threatening source of pollution is the "Asian haze," a huge brown cloud that formed over the Indian Ocean and southern parts of Asia in the summer of 2002. This cloud, as large as the continental United States, consists of pollutants from biomass burning and industrial emissions. It adversely affects the phytoplankton involved in the carbon-oxygen transfer by reducing by some 10 percent the solar radiation reaching the oceans. The haze also increases solar heating of the lower levels of the atmosphere, thereby directly affecting the winter monsoon cycle. This could lead to a drought with devastating effects on the hundreds of millions of people living in the northern sections of South Asia, while increasing precipitation over the oceans.

Finally, there has been a marked increase in the "red tides" and other algal blooms that poison animal life both on land and in the oceans. Exacerbated by the whims of winds and currents, these blooms emerge as floating red, blue-green, or brown ink spots on the

ocean surface, extending hundreds of square miles and temporarily halting the economies of coastal communities. Off the coast of China, poisonous algal blooms increased tenfold between 1975 and 1995. And in 1995, South Korea's aquaculture industry lost $100 million worth of fish to a devastating algal bloom. More than 50 different species of toxic algae have been identified, which have been known to destroy not just fish but entire sea-floor communities.

VALUABLE PROSPECTS

ALONG WITH growing threats to the health of the oceans come emerging prospects for harvesting nonliving resources, many of which have existed in their present form for millenniums. Oil was the first of these resources to attract attention as soon as it became possible to drill for it under shallow coastal waters.

Thirty percent of the world's oil and 50 percent of its natural gas now come from offshore production. Over the past 20 years, underwater oil production has risen by 37 percent to 18,600 million barrels a day and that of gas by 27 percent to 35,900 million cubic feet a day. New fields are constantly being discovered, and with improving recovery methods and an increasing ability to move farther from the shore, that growth in production will soon exceed 50 percent.

Within the past two decades, there has been a growing recognition of the oceans' potential to yield other resources. At the top of the list are methane clathrates, in which a single molecule of methane is trapped in a cage of frozen water molecules. Although chemists have known about methane clathrates for nearly two centuries, only following the initiation of the international ocean-drilling program in 1992 did their potential as a future hydrocarbon reserve begin to be examined.

Traditional theory holds that methane clathrates devolve from bacteria living in the sediments on the ocean floor, where they consume organic debris (animal and plant remains). Their digestive process produces and then releases methane. A newer theory postulates that some methane clathrates owe their origins not to organic matter, but to the fiery inorganic cauldrons that were

present as the earth began to evolve. If this were so, then methane clathrates could eventually be found in the oceans under the abyssal plain, well beyond the edges of continental margin, where organic matter is scarce.

A common estimate places the energy potential of methane clathrates at more than two to three times the energy potential of all known global reserves of gas, oil, and coal combined. In 1995, the U.S. Geological Survey estimated that methane clathrates under U.S. jurisdiction contain more than 200 trillion cubic feet of natural gas, enough to supply the country's energy needs for two millenniums at current consumption rates. Despite this enormous potential, however, extracting methane from clathrates remains problematic. Large-scale or commercially viable recovery, and the techniques that will make it both possible and environmentally safe, is perhaps 20 to 50 years away.

Another promising resource is polymetallic sulfides, which are very large ore-like deposits of sulfur combined with several important metals—principally copper (20 percent), zinc (20 percent), and measurable amounts of iron, gold, and silver (3 percent). In 1997, an Australian company, the Nautilus Minerals Corporation, acquired licenses from Papua New Guinea to explore and develop polymetallic sulfide ores in an area of ocean bottom that is almost 2,000 square miles in size. Exactly how this will be done will depend on the assessment of the size and shape of the deposits within the claim. Other mixes of valuable minerals, found at various locations in the oceans, also offer long-term commercial possibilities.

COMMON SENSE

In the 1960s and 1970s American-led consortia were among the first to develop and test technology to recover polymetallic nodules from ocean depths. But the effort floundered due to high recovery costs and collapsed mineral prices. Mining consortia were also constrained by an international agreement to regard deep seabed resources beyond national jurisdictions as "the common heritage of mankind" and not available for exclusive expropriation by any country. This principle was passed by the UN General Assembly

by a vote of 106 to 0 in 1970. At that time the United States voted in favor, and only the Soviet bloc abstained.

Central to the common-heritage concept was the principle that net profits were to be distributed to all the countries of the world in inverse relation to their dues to the United Nations. This meant that although all countries would eventually benefit from the common heritage, the poorer countries would benefit proportionally more than the rich. At the time, some advanced industrialized countries did not think that this was such a bad idea, as it might ultimately have relieved them of the foreign aid burden on their domestic economies.

During four presidential administrations, the United States took the lead in developing a widely accepted universal convention that would encompass a stable law of the sea while protecting many U.S. ocean interests—scientific, environmental, commercial, and military. The Reagan administration, however, because of its dislike of the common-heritage principle, abandoned this bipartisan tradition and refused to sign the convention in December 1982.

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Instead, the United States pressured the advanced Western industrialized countries to join in a special relationship. Its members would have the power and the capability to take deep seabed resources at will, without regard to the interests of other countries as embodied in the common-heritage principle. This club of rich nations, however, did not work out in practice. Twenty years later, nearly all of the advanced industrialized countries—except for the United States—had ratified the 1982 convention.

Still, the implementation of the common-heritage principle in practice has been long in coming. Although the convention purportedly settled the question of who has the rights to the oceans' resources, the International Seabed Authority—established under the 1982 convention to represent the world's interest in the development of resources found in the "common-heritage area"—came into operation only in 1994. That same year, the United

States partially overcame its earlier reluctance when President Bill Clinton signed an "annex" that dealt with and resolved each of the eight principal points to which the Reagan administration had most objected when the International Seabed Authority was being negotiated.

This past year, the authority acted on applications filed by seven international consortia to conduct detailed explorations of carefully defined deep seabed mineral areas that lie in the common-heritage area. Deep seabed investments, which are by definition long term, require security of tenure to offset the risk. The only way to guarantee such security is through the claims-recognition mechanisms established under the convention. As with real estate on land, the only way to assure clear title is to register with the local authorities, and in today's oceans the only recognized registrar is the International Seabed Authority. The principles embedded in the 1982 convention will thus likely remain central to the future management of the oceans' resources. Yet both the annex and the 1982 convention, submitted to the U.S. Senate for its "advice and consent" in 1994, are still awaiting ratification.

THE FINAL FRONTIER

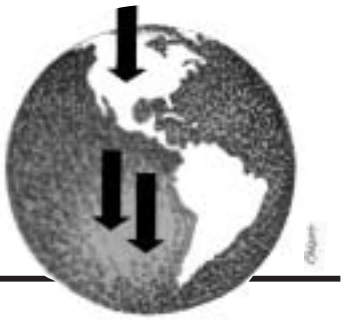
In spite of recent efforts, the earth's oceans remain largely uncharted territory. Today, more is known about space than about the oceans, and ten times more research dollars are spent on the former than on the latter. Worse yet, the portion of the U.S. science budget devoted to oceans has been cut in half over the past 15 years. Only five percent of the ocean bottom has even been mapped, and only recently have scientists begun to understand what goes on at great ocean depths. Yet the few existing quantitative samples of biodiversity at the bottoms of the oceans indicate a range of species rivaling that found in tropical rain forests.

Although navigational charts have been improving for centuries, in reality they are little more than ocean surface maps with depth measurements. Still lacking is full knowledge of the space in between—how its masses of water move and how life interacts within it. Research scientists together with governmental agencies concerned

with marine operations in the United States and abroad are now developing a global ocean observing system (GOOS). This could do for the oceans what the satellites, balloons, and radars observing world weather have done for the atmosphere: provide timely, complete pictures and increasingly reliable forecasts. GOOS would integrate data from networks of buoys on or below the surface of the oceans as well as from satellites and other observational devices. When fully in place, perhaps 15 years from now, GOOS should make it possible to call up a detailed cross section for any part of the oceans.

Biological Pump

An estimated one-third of man-made carbon dioxide in the atmosphere is absorbed by landmasses, whereas two-thirds dissolve in the oceans.



A worldwide census of marine life involving leading research institutions is also under way. Although it may never be possible to count every fish in the sea, baselines established by the census will provide scientists and regulators with the kind of data needed to set accurate sustainable yields. For species such as tuna, that information cannot come too soon.

A major advance of the past 20 years has been a growing understanding of the alchemy that exists between the atmosphere and the surface of the entire globe. One central concern is the rapid accumulation of carbon in the atmosphere from burning coal, oil, and gas, which is likely warming the earth's surface. An examination of the past 20 or even 200 years reveals that ocean temperatures, and with them ocean levels, are slowly but steadily rising. Although consensus on greenhouse effects may never be reached, most experts and politicians agree that it is prudent to reduce the accumulation of greenhouse gases, especially if the cost of doing so can be kept low.

Another proposition worth examining is whether the oceans' natural "biological pump" that moves carbon from the surface to

the bottom of the oceans can be speeded up. People are familiar with the idea that plants growing on land absorb carbon dioxide in the process of photosynthesis. But land absorbs only an estimated one-third of the man-made carbon dioxide in the atmosphere. The other two-thirds is believed to dissolve in the oceans. The key question is whether the capture of carbon dioxide in the oceans could be accelerated by something akin to foresters planting more trees on land.

Similar to their land-based counterparts, small plants near the ocean surface called phytoplankton consume carbon dioxide as part of their ordinary diet. As the plants remove carbon dioxide from seawater, the seawater in turn can accept more from the atmosphere. Small marine animals graze on the marine plants and incorporate the carbon into their bodies. Eventually, animal remains drift to the sea floor, completing the work of the pump. Like nitrogen in an Iowa field, iron has a remarkable ability in the ocean to "fertilize" life and, in principle, increase the capture and sequestration of carbon dioxide. Experiments in iron fertilization have proved modestly successful, but on nowhere near the scale needed to suggest even a partial solution to the carbon dioxide problem. A second way to accelerate this process would be to separate carbon dioxide from the waste stream of power plants on land and pipe it in condensed form to the deep ocean. There it might collect in self-contained pools of liquid carbon dioxide for an indefinite future. Nonetheless, such proposals for engineering in the oceans properly elicit deep concern about environmental impact and about how these activities might be permitted, managed, and monitored.

One of the promising trends of the past two decades has been the creation of marine protected areas.

Counterintuitively, global warming does not necessarily lead to climate warming. Recent work done at the Woods Hole Oceanographic Institution indicates that declining salinity in the northern sections of the Gulf Stream could prevent its waters from sinking to great ocean depths, as they normally would. This interruption of the stream's normal circulation could occur in as little as 10 years,

bringing about abnormally cold winters in the northern climes for 100 years before the Gulf Stream "switched" back.

One of the promising trends of the past two decades has been the creation of marine protected areas encompassing various kinds and levels of ocean parks and reserves. The United States created its very first marine reserve, La Jolla Cove, in 1975. Marine protected areas demonstrably protect productive sea-floor habitats and restore coral reefs as well as fish stocks. In December 2002, Australia announced that it would create a 2,500-square-mile marine protected area—free of fishing and other commercial activity—around its Heard Island complex, which, once in place, will be the largest of a growing number of such areas. Yet smaller parks are valuable as well, as one recently established around a coral reef in the Philippines has demonstrated. In just two years, essential fish stocks were able to return to the reef in large numbers, thus restoring biodiversity and enhancing tourism. Equally important, local residents developed a sense of stewardship that will help to maintain such parks in the future. Some marine biologists now believe that networks of small preserves may actually produce greater benefits than a single larger one.

The omens and their implications for the future health of humanity are real cause for concern.

Another exciting prospect is to declare parts of the more prominent underwater seamounts as marine protected areas. Relatively pristine seamounts still exist, but fishing pressure on them is growing rapidly. The numerous hot springs located at tectonic-plate junctures under the oceans also merit special protection, not just for their extraordinary beauty, but for their biodiversity, which rivals that of tropical rain forests.

More than a century ago, President Theodore Roosevelt launched a conservation effort in the far west of the United States with the creation of national parks such as Yellowstone and Yosemite. The state of the oceans today likewise calls for no less than the worldwide expansion of protected areas during the coming decades. In combination with research and monitoring programs, such as the census of marine life and GOOS, marine protected areas both large and small could become key to both the national and the international management of the oceans.

Reading today's tea leaves to predict future oceanic conditions is not easy. The oceans are huge, and many of the trends they exhibit are long term. Yet the omens and their implications for the future health of humanity are cause for real concern and urgent attention. The United States should take particular heed, as the waters in its exclusive economic zone are 1.5 times the area of its surface landmass. The executive branch and Congress would thus do well to get their act together and adopt a comprehensive Oceans Act based on principles of ecosystem health and sustainability that would protect, maintain, and restore the integrity, resilience, and productivity of the oceans. This and other recommendations worth following were made in June 2003 by the privately funded Pew Oceans Commission. They are likely to be echoed by the Watkins commission, the president's own commission on ocean policy, when it reports later this fall. The time is ripe for U.S. action—and by embracing these recommendations George W. Bush could establish his own future legacy as the "Teddy Roosevelt of the oceans."