

Principles of Oceanography

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CHAPTER 5

Towards Sustainable Oceans

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In 1992, 1700 scientists, including most living Nobel laureates in the sciences, issued the World Scientists' Warning to Humanity: Human beings and the natural world are on a collision course. Human activities inflict severe and sometimes irreversible damage on the environment and on critical resources. If unchecked, many of our current practices put at serious risk the future that we wish for human society and life on Earth and may so alter the planet that it will be unable to sustain life in the diversity that we now know. Fundamental changes are urgent, they conclude, if we are to avoid the damage our present course will bring about.

The solution to these environmental problems is sustainability.

What Is Sustainability?

Sustainability, or sustainable development, was defined in 1987 by the World Commission on Environment and Development¹ (also known as the Brundtland Commission, named after its chair, Gro Harlem Brundtland) as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Sustainability transcends and in many ways supersedes environmentalism. It involves a transformation from a wasteful linear model of resource use in which natural resources (be they living or nonliving) are extracted, used, then thrown “away” to a cyclical model built around reduction, reuse, and recycling.

Quantifying Sustainability

In 2005, the Environmental Performance Measurement Project at Yale University issued an Environmental Sustainability Index (ESI), ranking nations on the extent to which their societies approached sustainability. “No country is on a sustainable trajectory—and the ESI demonstrates this,” said Gus Speth, Dean of the Yale School of Forestry and Environmental Studies. In most cases, insufficient data exist to determine each nation's ESI accurately. Their rankings are, therefore, only crude comparative measurements of societal sustainability. For national rankings and details, go to www.yale.edu/esi/.

The Sustainable Communities Network sets general targets for a Sustainable Planet Earth. They are as follows:

- Creating community
- Growing a sustainable economy
- Protecting natural resources
- Governing sustainably
- Living sustainably

1. World Commission on Environment and Development (Gro Harlem Brundtland, Chair). 1987. *Our Common Future*. Oxford: Oxford University Press.

Achieving a Sustainable Marine Environment

In our view, achieving a sustainable marine environment requires addressing a number of seemingly unrelated issues. These include fisheries, forests, energy, biodiversity, climate change, manufacturing and industry, and justice and equity.

■ Fisheries

Eventually, the impact of our growing demand for fish protein must be addressed. Contemporary industrial-style fishing methods impose significant environmental costs. For example, deep-ocean trawling has been compared with clearcutting a forest, only on a much larger scale. Moreover, per capita yields from global fisheries are declining, and expansion of aquaculture often occurs at the expense of coastal ecosystems and wild fish stocks (see Issues 12, 13 and 17–21).

Many fish species are in precipitous decline. Thriving and diverse aquatic wildlife are necessary for healthy marine and freshwater ecosystems (see Chapter 6). It is therefore critical that those dependent on fisheries and aquatic ecosystems use these resources responsibly. This can mean creating marine protected zones that are large enough to maintain species diversity, away from human interference; however, protected zones alone may not be enough. Large fish and marine mammals characteristically have dangerously high levels of toxic artificial chemicals in their tissues, from pollution sources perhaps thousands of kilometers away.

Protecting aquatic wildlife could be aided through sustainable aquaculture. For example, growing plant-eating (herbivorous) fish such as carp and tilapia puts less strain on resources compared with growing carnivorous species like salmon, which usually must be fed feed made with wild-caught fish.

Shrimp farming puts great stress on coastal ecosystems, as mangrove communities are often destroyed to make room for shrimp ponds, especially in developing countries such as Honduras and Vietnam, which in turn export the farmed shrimp to the United States. Populations of many oceanic species are at critical levels because of industrial-style fishing practices as well as massive national subsidies for fishing fleets. Ironically, the destruction of ocean fisheries coincides with an increased demand for fish resulting from its recognition as a health food.

■ Protecting Terrestrial Ecosystems

Although trees have economic value as a raw material, the environmental services provided by forests far transcend the economic value of trees in many cases. Mature trees maintain desirable microclimates and retard sediment loss that can poison near-shore marine ecosystems such as coral reefs. Forests store carbon, mediating climate change and thereby reducing excess carbon dioxide dissolved in seawater, which can lead to acidification of the oceans.

■ Energy

Sustainable societies cannot be built on nonrenewable energy resources. Humans use almost unimaginable amounts of energy and generate vast amounts of pollution from it. Fossil fuel burning emits pollutants like SO_x and NO_x (oxides of sulfur and nitrogen), particulates, and heavy metals such as mercury. These have now been distributed throughout the oceans from airborne fossil fuel emissions.

Moreover, the transport of petroleum by tanker inevitably results in oil spills that degrade and may destroy sensitive marine habitats. Energy conservation and the use of renewable fuels provide cost-effective and sustainable alternatives that generate little if any air and water pollution. Subsidizing the production of coal and oil-based nonrenewable energy makes little sense in a world threatened with rapid climate change and accelerating species loss. Here, too, change is coming. Wind energy is the fastest growing energy source in Europe and North America, supported by government subsidies, which partly offset subsidies for fossil fuels. Large-scale development of offshore “wind farms” is planned for Britain and elsewhere in Europe. Such developments, while offering virtually pollution-free energy, must be carefully constructed and monitored so as to avoid harming the local marine environment. Likewise, offshore oil and gas development, a fixture in the oceans since the 1950s, must be restricted and, where conducted, more carefully undertaken in marine environments already stressed by overfishing, climate change, sediment pollution, and so forth.

■ Biodiversity

Our very survival could ultimately rely on maintaining the integrity of marine and terrestrial ecosystems that we barely understand. An ecosystem is a geographic area that includes all living organisms with their physical surroundings and the natural cycles that sustain them (such as the hydrologic cycle). All these elements are interconnected. Altering any one component affects the others in a particular ecosystem. Biodiversity, the mix of organisms within an ecosystem, is particularly critical for sustainability because of the specialized and often little-understood roles each species plays in maintaining the dynamic state of ecological balance. Moreover, little is known about key ecosystems like soils and the deep ocean.

Esthetics and ethics must also play a part, as humans can probably survive on an Earth with drastically reduced species diversity. The question then becomes this: Do we wish to make a decision to eradicate species and ecosystems without the input of our descendants? That our ancestors did so in ignorance is no excuse for our perpetuating such behavior.

■ Climate Change

We consider climate change more fully in Issues 4–7. Although climate change is a well-documented fact of planetary history—the Earth has gone through several megacycles of

“greenhouse” and “icehouse” conditions—the speed with which human-induced climate change is occurring is virtually unprecedented. Too-rapid change overwhelms the ability of natural ecosystems to adapt. For example, rising sea levels may flood and destroy coastal salt marshes if sea level rise is too fast for these communities to migrate inland, and rising shallow-water ocean temperatures can lower oxygen content and threaten communities like coral reefs already operating throughout the oceans at temperatures near their thermal maxima. The impacts of climate change are imperfectly understood, but on the whole will test the capability of a human species that “subdued” a seemingly limitless Earth. Moving to sustainable societies may be essential to address the impacts of climate change.

■ Manufacturing and Industry

The Industrial Revolution generated wealth beyond humanity’s dreams but also generated waste in unprecedented quantities, some of it artificial chemicals never before seen on Earth. Processing this waste is rapidly exceeding the capacity of natural systems, which did not evolve in the presence of many of these chemicals.

In nature, waste eventually becomes something else’s food. In human societies, waste is everywhere, and it indicates inefficiency. Pollution is one form of waste. Approaching “wasteless” production must become the norm in human activity, as it is in the marine realm, and progress is being made: The European Union has set a goal of ending landfill disposal by 2025. Many businesses have found that waste reduction and even elimination can enhance profitability, and progress has been made here as well—humans have agreed to phase out or eliminate the most harmful kinds of Persistent Organic Pollutants (POPs; see Issue 8); however, the growth of human populations and the universal association between increasing wealth and increasing waste pose critical problems for a world, five sixths of whose population is trying to develop along Western-style free-market lines.

■ Justice and Equity

The pursuit of justice and equal opportunity are key ingredients in building a sustainable society. Examples of injustice are a lack of adequate housing, a lack of access to education, poor sanitation, an inadequate supply of pure water, exposure to environmental toxins, and environmental degradation related to industrial pollution. Rich societies ignore these issues at their peril. Furthermore, injustice often drives rapacious and unsustainable use of natural resources such as coral reef fisheries and mangrove wetlands.

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Sustainable Consumption: An Oxymoron?

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We are in the twilight of the era of the “myth of unlimited resources.” Sustainability involves adopting responsible patterns of buying, consumption, and reproduction, thereby consuming minimal energy and fewer resources. Responsible consumption is based on education, not coercion, in a democratic society. Unfortunately, industrial and postindustrial

societies are philosophically based on the myth of ever-increasing consumption, in turn driving ever-increasing production—the “growth” concept. Detoxifying society from this “unlimited consumption” myth may be one of our greatest challenges.

Sustainable Population

Human numbers must eventually become stabilized, as it is physically impossible for population growth to continue forever. The only questions are at what level will growth end and whether growth will end as a result of human actions or by natural processes like famine, disease, and war. Ageing societies are typical of developed nations. Populations dominated by the young are typical of developing ones. Large numbers of young people provide great promise for societies, but also impose great costs. The readers of this book are mainly young, and it is they who will address, or not address, these challenges. The next century should prove to be one of the most interesting and potentially rewarding centuries in the entire span of human history.

Development

Here we use development to refer to a complex set of changes that convert the economy of a society based on subsistence agriculture to one in which most of the employed inhabitants work in manufacturing or services.

Here are two hypotheses, much simplified, that purport to explain such relationships as may exist between development and the environment.

1. *Development harms the environment.* Many environmentalists assert that development leads to some or all of the following: destructive land-use practices, mining of marine resources, injurious levels of air emissions and fossil-fuel use, and water pollution. Moreover, high levels of population growth in many developing countries exacerbate environmental degradation, leading to misery, child prostitution, civil wars, and the like and encouraging large-scale emigration.
2. *Development eventually improves the environment.* Many economists and some environmentalists, while acknowledging harmful levels of environmental pollution in countries in early stages of development, cite considerable empirical evidence that (1) population growth rates decline as development proceeds and (2) rates of some forms of environmental pollution decline as per capita income increases, a supposed corollary of development, as we noted previously. Newer forms of technology tend to be less polluting than older forms, but also tend to require high capital expenditures. Countries with higher per capita incomes tend to have cleaner environments along with increased consumption of goods and services. As nations become richer and middle classes expand, demands for scarce goods such as wild fish stocks expand, and tougher environmental standards may also; however, in many cases, passage of comprehensive legislation to preserve the coastal environment in a rich country simply leads to mining of marine resources

for export from poorer countries. Most recently, the decline in fish stocks from the Atlantic off Northwest Africa has been due to increased exports to Europe and a concomitant decline in traditional fisheries (see Issue 18 for details).

Global Trade and the Oceans

Here are some examples of the adverse effects of global trade on the marine environment:

- Moving oil by tanker leads to oil spills, and the “cleanup” costs are not included in the price of oil.
- Cruise ships are a major source of untreated human and other waste (see Issue 9), often dumped at sea.
- The introduction of invasive species into new environments (see Issues 22 and 23) typically occurs by transfer of nonnative species in the ballast water of cargo ships.

The fuel of marine vessels is typically #6 fuel oil, which contains the highest levels of polluting sulfur of any form of petroleum-based fuel. Operation of marine vessels in ports during loading and unloading of cargo is often a major source of local air pollution. A good example is the Long Beach-Los Angeles, California harbor complex.

Such activities represent vast subsidies to world trade. In other words, were the traders required to pay all environmental costs associated with their activities rather than dump those costs onto the environment of the receiving country, the volumes and patterns of world trade would no doubt be considerably different.

Addressing Environmental Impact at the International Level

In the case of pollution that crosses national boundaries, addressing the problem usually means international agreements, and we give three examples here.

■ The World Trade Organization

In 1999, Seattle, Washington was the site of sometimes-violent protests against perceived policies of the World Trade Organization (WTO). We cite one example to illustrate the controversy: the issue of sea turtles. Five Asian nations challenged a US law designed to protect sea turtles from certain harmful fishing practices. The law banned the importation of shrimp from countries that did not require the use of turtle-excluder devices by their fishing industry. The WTO ruled in favor of the Asian countries, not because it disapproved of United States attempts to protect sea turtles but because the panel found the United States had discriminated among members of the WTO by granting preferential treatment to Latin American and Caribbean nations. The WTO decision infuriated environmentalists, even though it had arguably nothing to do with the desirability of saving sea turtles. Indeed, the founding charter of the WTO formally addresses

the relationship of trade to the environment. Signatories to the WTO should “allow for the optimal use of the world’s resources in accordance with the objective of sustainable development, seeking to both protect and preserve the environment.” WTO rules also allow countries to impose trade regulations “necessary to protect human, animal, or plant life or health” or “relating to the conservation of natural resources”; however, measures taken to protect the environment must not discriminate. A country may not be lenient with its domestic producers and at the same time be strict with foreign producers nor can member nations discriminate among different trading partners. Sovereign nations choose to become members of the WTO and to act by its rules. So far, more than 140 countries have joined, and others have applied for membership.

■ The Montreal Protocol

Severe depletion of stratospheric ozone has been measured for years, especially in the Southern Ocean around Antarctica. The Montreal Protocol on Substances that Deplete the Ozone Layer was adopted in 1987 to eliminate the production and consumption of ozone-depleting chemicals. Four agencies were tasked with implementing the Protocol: the World Bank, the U.N. Environment Programme, the U.N. Development Programme, and the U.N. Industrial Development Programme. The Montreal Protocol stipulates that the production and consumption of compounds that deplete ozone in the stratosphere—chlorofluorocarbons, halons, carbon tetrachloride, among others—were to be phased out between 2000 and 2005. Developing countries were given time to cap and then eliminate ozone-depleting chemicals.

■ The Law of the Sea Treaty

Passed in 1982, the U.N. Convention on the Law of the Sea became effective in 1994. More than 150 nations and the European Community have ratified it. The United States has signed the treaty, but as of 2008, the Senate had not ratified it.

The treaty, among other things, defined certain territorial limits to which nations may exert influence. It further established EEZs, or Exclusive Economic Zones, within which nations had exclusive rights to exploit natural resources. It established a general framework for addressing environmental degradation in the oceans and set rules for exploitation of seabed resources outside of any nation’s EEZ. It provided for access to the sea for landlocked nations.

■ The Next Steps

To eliminate the adverse environmental impacts of global trade on the world’s oceans, many environmental scientists recommend additional international or multilateral agreements. They include proposals to

- Eliminate invasive species from the ballast water of vessels using international waterways
- Regulate international transboundary air and water pollution

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- Require marine vessels to use low-sulfur fuels
- Require “double-hulled” tankers for the shipment of petroleum—already required for shipment of oil in United States territorial waters
- Provide that industries that exploit marine resources must adhere to a similar set of environmental regulations globally

■ **A Final Word**

International maritime commerce has enormous potential to foster the objectives of development but can also be the source of serious environmental degradation, absent multinational, and international agreements to “level the playing field.” The Montreal Protocol and U.N. Convention on the Law of the Sea are examples of the types of international agreements that could serve as templates for new initiatives.