# Marine Conservation

## *Science, Policy, and Management*

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# CHAPTER 3

# MARINE CONSERVATION MECHANISMS

> If the misery of our poor be caused not by the laws of nature, but by our institutions, great is our sin.
>
> Charles Darwin

## 3.1 THE TOOLKIT

Roman law declared that air, running water, the sea, and its shores were to be shared among all people. Ocean policies have evolved from this basic tenet into *freedom of the seas*, for use as a global commons. The development of nations, government, laws, and policies have increasingly claimed control of this global commons, with uses of the coastal foreshore evolving from traditional claims of property. Usage rights triggered debates of ownership claimed by the state, community, or individual as the value of marine assets intensified. The littoral zone and nearshore waters became battlegrounds that required resolution through agreements, laws, and regulations. As conflicts increased and resources diminished in the 20th century, calls for marine conservation intensified. Today, marine environmental change is forcing society to confront a paradox: protect and restore diminishing marine assets *and* preserve traditions as economic and social uses intensify. Society's response to the growing loss of marine and coastal assets is tied to culture, economics, and social benefits in an arsenal of tools—the toolkit.

The purpose of this chapter is to present an overview of the legal and social mechanisms that have achieved widespread use for conservation and management of coastal and ocean systems. As public awareness of the importance of biotic services grows, marine environmental policy is slowly moving from sector-based actions to ecosystem-based approaches. Thus, the resultant conservation toolkit of socially approved tools is evolving with conservation practice by means of science, public participation, governance, law, administrative processes, politics, and dedicated action of governments, individuals, communities, and committed organizations.

## 3.2 BIOLOGICAL CONSERVATION

Wildlife protection originated in Roman law. It evolved into the modern era of the early 20th century when protestors sought to protect decimated individual and groups of species from industrial slaughter, ushering in the modern era of conservation. Under Roman law, *ferae naturae* were regarded as property of no one, like the air or oceans. Yet, species could become the property of anyone who captured or killed them (Bean and Rowland, 1997). In early American law: "The wild bird in the air belongs to no one, but when the fowler brings it to the earth and takes it into his possession it is his property" (Blumm and Ritchie, 2005). "Wildlife" as a conservation objective under law was not yet conceived.

### 3.2.1 Species conservation

In the early 20th century, outraged protestors sought to protect species from massive industrial exploitation for fur, oil, and fashion. Henry Wood Elliot, who studied the northern fur seal (*Callorhinus ursinus*) in the Pribilof Islands, Alaska (Ch. 7), in the late 1800s, revealed unsustainable exploitation and sought protection. Government officials and commercial interests failed to act, forcing Elliott to seek an international mechanism that became the first international wildlife treaty, the *North Pacific Fur Seal Convention* (*Fur Seal Treaty*) of 1911 (NOAA, 2006). This Treaty initiated the restoration of fur seal and sea otter populations. Concurrently in 1910, the *U.S. Lacey Act* prohibited trade in wildlife, fish, and plants illegally taken in violation of state law. This Act is considered the first example of the U.S. federal government using its power to preserve species by addressing illegal trade in wildlife (Anderson, 1995).

Protection for other migratory species soon followed (Table 3.1). The international *Migratory Bird Treaty* (1918) protected shorebirds, waterfowl, and others by forbidding market hunting for the feather trade. But species and their habitat were better secured by governments, as agreed upon at the *Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere* in 1940 (56 Stat. 1354, 161 U.N.T.S. 193). This Convention sought to protect not only migratory birds and natural landscapes, but also encouraged spatial-area protection through government establishment of national parks, national reserves, nature monuments, and strict wilderness reserves. The acknowledged unregulated depletion of highly migratory whales in international waters brought international pressure to the commercial whaling industry that agreed to provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry by

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**Table 3.1** Examples of marine species protection: national laws, regional councils, international agreements.

| Protection | Instrument (date in force) | Intended action |
|---|---|---|
| Fur seals | *North Pacific Fur Seal Treaty* (1911) | First international treaty for wildlife protection. Ended fur seal harvest; protect sea otters. |
| Birds | *Migratory Bird Treaty* (1918) | Regulates taking, selling, transporting, and importing migratory birds. |
| Whales | *International Convention on the Regulation of Whaling* (1946) | Regulates harvest and industry; moratorium on commercial whaling established, 1985–1986. |
| Marine mammals | *U.S. Marine Mammal Protection Act* (1972) | Established concept of "optimum sustainable population" placing a moratorium on taking most marine mammals. |
| Antarctic seals | *Convention on Conservation of Antarctic Seals* (1972) | Adopted standards for conservation of Antarctic seals. |
| Polar bears | *Agreement on Conservation of Polar Bears, Oslo* (1973) | Limits hunting to sustainable levels. |
| Dolphins | *Agreement to Reduce Dolphin Mortality in the Eastern Tropical Pacific Tuna Fishery* (1992) | Regulates dolphin "bycatch" to the lowest possible level, with an objective of zero take. |
| Endangered species | *Convention on the International Trade in Endangered Species of Wild Fauna and Flora* (CITES: 1973) | Prohibits or controls all trade of listed species; however, few marine taxa in active fisheries are on the CITES list |
| Endangered species | *U.S. Endangered Species Act* (1973) | Forbids jeopardizing listed endangered or threatened species or adversely modifying critical habitats. |
| Endangered migratory species | *"Bonn" Convention on the Conservation of Migratory Species of Wild Animals* (l979) | Forbids take of listed migratory species of wild animals, including sea turtles, birds, and marine mammals. |
| Sea turtles | *Inter-American Convention for the Protection and Conservation of Sea Turtles* (2000) | Protects sea turtles and their nesting habitats in the Americas. |
| Fisheries | *Convention for the Establishment of an Inter-American Tropical Tuna Commission* (IATTC: 1949) | Regulates catch of tunas in the tropical Pacific Ocean. |
| Fisheries | *International Convention for the Conservation of Atlantic Tuna* (ICCAT 1966) | Regulates catch of tunas in the Atlantic Ocean. |
| Fisheries | *Convention for the Conservation of Salmon in the North Atlantic Ocean* (1982) | For regulation of catch of salmon and for their conservation in the Atlantic Ocean. |
| Fisheries | *Convention for the Prohibition of Fishing with Long Driftnets in the South Pacific* (1989) | Prohibits use of longlines in designated areas. |
| Fisheries | *Convention for the Conservation of Anadromous Stocks in the North Pacific Ocean* (1992) | Principally directed towards regulation and conservation of salmons. |

means of the *International Agreement on the Regulation of Whaling* (1946). Conservation of marine mammals as a whole became fully established in 1972 with the U.S. *Marine Mammal Protection Act*, the first instrument to legally recognize species as "wildlife" (Ray and Potter, 2011).

Wildlife laws stir strong passions and intense controversy, not only for marine mammals but also for such commercially valued, endangered, migratory species such as Atlantic salmon, bluefin tuna, and sea turtles, today debated as to whether they are to be classified as resources or wildlife (Bean and Rowland, 1997). This resource/wildlife issue was contentious at the *Convention on International Trade in Endangered Species of Wild Fauna and Flora in the 2010* (CITES), which determined that threatened species of commercial fish are not considered wildlife but are traded commodities that require different instruments (Doukakis *et al.*, 2009).

Instruments that protect species now have wide social and ethical appeal. Species protection is established in social traditions, legal regulation, and in numerous international agreements that attempt to curb the crisis of species and biodiversity loss. The deep personal attachment towards individual species (e.g., polar bears, whales, flamingoes, butterflyfish, corals, and even oysters) is used to catalyze action around symbolic icons, which when faced with extinction heighten public attention and conservation action (McCay, 1998). Public outcries had prompted Congress to pass the *Endangered Species Act* in 1973 (ESA, Section 3.5.1.7), and more than 160 countries to agree on the *Convention of International Trade in Endangered Species of Wild Fauna and Flora* (CITES 1973), intended to prevent trade of species threatened with extinction. It brought bookkeeping of depleted species with IUCN's (2010) Red List of Threatened Species. However, such lists lack important information needed

for action, especially information on the status and trends for a host of individual species critically in need of management, most importantly wide-ranging species of sharks, oceanic fishes, sea turtles, marine mammals, and others (Wallace *et al.*, 2011).

Many highly mobile, valued marine organisms venture outside of national boundaries and into international waters, causing management problems. These "transboundary" species also cross nations' Exclusive Economic Zones and are designated "straddling species" (Fig. 12.10b). To protect such species requires knowledge of their entire life-history distribution, and mandates negotiation between coastal nations, distant-water nations, and contiguous coastal nations (Caddy and Seijo, 2005). In particular, all seven species of sea turtles are listed as endangered or threatened worldwide, and each have different movement patterns (Fig. 8.16), which requires different conservation options and close working relationships that need to be addressed through diplomatic channels, capacity building, and scientific exchange. Conservation efforts have mainly focused on turtle nesting beaches, mostly in protected areas that have proved successful for some populations. However, outside of protected areas regional and international mechanisms often remain vague and ineffectual; e.g., the voluntary, non-binding United Nations Food and Agriculture Organization (FAO) *Guidelines to Reduce Sea Turtle Mortality in Fishing Operations* (2005) is based on a series of "soft-law" fishery instruments.

Protection of large, commercial, oceanic fishes depends on international cooperation. The largest and most commercially valuable of all fishes is bluefin tuna (*Thunnus thynnus*), which has declined more than 80% since 1970 as overfishing and international trade continue (Ch. 2) under soft-law instruments. The Atlantic population's life-history pattern encompasses international and coastal waters and is monitored by the International Commission for the Conservation of Atlantic Tunas (ICCAT). Their critical spawning occurs in the Gulf of Mexico. The species is managed as a bycatch issue under the U.S. National Marine Fisheries Service (NMFS), and the international *Code of Conduct for Responsible Fisheries* attempts to control bycatch. For greatly depleted sharks (Ch. 2), FAO's Committee on Fisheries adopted IPOA-SHARKS (1999), which addresses not only bycatch but also de-finning, which continues to decimate shark populations worldwide. Such international soft-law instruments fail to curb depletions.

Whales are highly migratory species with a long history of exploitation. The International Whaling Commission (IWC) since its formation in 1946 has been responsible for setting catch quotas, but whales continued to be depleted largely due to lack of information on natural history and habitat and a need for better management procedures (Schevill, 1974; Box 3.1). In 1972, the U.S. passed the *Marine Mammal Protection Act* that placed a moratorium on US commercial whaling, and the IWC followed suit in 1986. Since then, the disputed international moratorium is negotiated annually by the IWC, with species being treated unequally with different degrees of success. Under the earlier IWC moratorium, the eastern North Pacific gray whale (*Eschrichtius robustus*) had recovered fully by the end of the 20th century to become the first marine mammal to be removed from the U.S. *Endangered Species Act* list (Section 3.5.1.7), but in recent years it has declined steadily for unknown reasons (Keller and Gerber, 2004). The most

### Box 3.1 The era of excess: Soviet illegal whaling and the failure of the IWC

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The signing, in 1946, of the *International Convention for the Regulation of Whaling* presaged what was supposed to be a new era of management in the exploitation of whales. Faced with the industry's excessive catches in previous decades—more than 150,000 blue whales were killed in the 1930s alone—the whaling nations brokered an agreement whose principal aim was to provide for the proper conservation of whale stocks and thus make possible the orderly development of the whaling industry. The Convention established the International Whaling Commission (IWC), whose Scientific Committee was to oversee research on whales and recommend quotas that, in theory, would allow sustainable whaling into the future.

What began as a good idea inevitably fell victim to the desire to maintain profits. Faced with the uncertainties about whale numbers that typify the perpetually difficult field of cetacean research, the whalers consistently gave the benefit of the doubt to their revenues rather than to their resources. Despite mounting evidence of declines in some whale populations, the whaling industry continued to take record numbers of animals; in the decade following implementation of the Convention, over a quarter million fin whales were killed in the Southern Hemisphere, together with tens of thousands of whales of other species. Regulation, such as it was, came too little and too late for many populations, and by the early 1960s it was becoming increasingly clear that the IWC was failing to fulfill the objectives of the Convention (Clapham and Baker, 2008).

(*Continued*)

As it turned out, the situation was far worse than anyone could have imagined at the time. In addition to the known and publically reported excesses of the industry in the years following the Second World War, one nation had been conducting a huge campaign of illegal whaling that was to devastate already over-exploited stocks of whales, and bring at least one population to the brink of extinction. The USSR, driven by an absurd system of domestic industrial planning, made more than 150,000 unreported catches in the Southern Hemisphere alone, and another 26,000 in the North Pacific (Ivashchenko *et al*., 2011; Ivashchenko *et al*., 2013).

In the USSR of Joseph Stalin and his successors, everything was about reaching and exceeding the production targets of the endless plans—monthly, annual, five-year, ten-year, and regional—that were created for every aspect of Soviet industry. High production numbers meant much-coveted bonuses, awards, and recognition for workers and managers alike. In the beginning, when whales were plentiful, it was easy for Soviet whalers to exceed their production targets, which were supposed to be based upon a rational, scientific assessment of the abundance of the resource. In reality, however, the following year's targets were often set at the level achieved the previous year, regardless of what industry scientists said about the ability of whale populations to withstand these ever-increasing catches (Ivashchenko *et al*., 2011). The result was an utterly predictable collapse of populations, as Soviet whalers took more and more animals and ranged ever further in the oceans in their attempts to fulfill their quotas. Nor was the resource even utilized well: all that counted was the number of whales killed, and in their zeal to take more and more animals, carcasses were sometimes left to rot before the factory ships of the Soviet whaling fleets could process them.

The Soviets took everything, regardless of size, age, or protected status. Among their many excesses, a few examples stand out as particularly egregious. In Antarctic waters south of Australia and Oceania, Soviet factory fleets killed nearly 25,000 humpback whales in just two seasons (1959/60 and 1960/61), an unparalleled catch which caused the immediate crash of the populations concerned, and precipitated the closure of shore whaling stations in Australia and New Zealand. In the eastern North Pacific, Soviet fleets killed 529 right whales in the 1960s, almost finishing off an already small population that was struggling to come back from the excesses of 19th century whaling (Ivashchenko and Clapham, 2012); today, the right whales remaining in this region are estimated to number only about 30 animals (Wade *et al*., 2011), and they may not survive.

Sperm whales in the North Pacific were hit particularly hard, not only by the USSR but also by Japanese land station and pelagic whaling operations. The USSR alone killed almost 160,000 sperm whales in the period 1948–79 (Ivashchenko *et al*., 2013). The devastation wreaked on sperm whales led the Soviet scientist Alfred Berzin to note that as a result of the catches, some breeding areas for sperm whales became deserts.

The truth about Soviet whaling was finally revealed following the collapse of the Soviet Union (Yablokov, 1994; Berzin, 2008). In subsequent years, the true catch record—an essential component of assessments of the status of whale populations today—was reconstructed through release of previously secret data; in many cases, these records had been saved and hidden for years, sometimes at considerable personal risk, by biologists working on the factory fleets (Clapham and Ivashchenko, 2009).

In 1972, following years of disagreements and obstruction—not least by the USSR—the IWC finally passed an "International Observer Scheme" aimed at independent monitoring of catches through placement of foreign observers on factory ships. In a final irony, Soviet vessels were monitored by inspectors from Japan (and vice versa), a country that was buying large quantities of whale meat from the USSR. We now know that this "monitoring" was weak at best, and that Japanese inspectors were in some cases fully aware of continued illegal catches, while in others they were taken off the factory ship's flensing deck and treated to "hospitality" involving food and much vodka before illegal whales were processed.

Today, the IWC is revisiting the issue of catch monitoring as the organization discusses a possible resumption of commercial whaling. Once again the discussion is characterized by assurances from the whaling nations that the widespread violations that occurred are part of a history that has been put to bed, and that things are different today—and therefore that a truly independent system is not needed. It remains to be seen whether the IWC will agree, and in so doing ignore the grave lessons of a shameful and excessive past.

abundant of all baleen whales, the minke whale (*Balaenoptera acutorostrata*), remains hunted by Japan under the IWC clause of "scientific whaling" and by Norway as a traditional activity. The North Pacific right whale (*Eubalaena glacialis*), depleted to near-extinction by illegal commercial whaling, now numbers only a few dozen. The depleted southern right whale (*Eubalaena australis*) has shown encouraging signs of recovery in both South Africa and Argentina. A notable success story concerns the once heavily exploited Arctic bowhead whale (*Balaena mysticetus*) that today has recovered and supports subsistence harvest by native Iñupiat people. And, while Antarctic whale populations may also be recovering, some are vulnerable to expansion of a global fishery for their major food item, krill (*Euphausia superba*), currently under current weak management (FAO, 2011).

Among pinnipeds, all species of fur seals have made remarkable recoveries. Since passage of the *Fur Seal Convention*, North Pacific fur seals (*Callorhinus ursinus*) have recovered fully, although recently are showing decline (Ch. 7). And since their decimation in the 18th to early 20th centuries, Antarctic and

sub-Antarctic fur seals (*Arctocephalus* spp.) and Pacific walruses (*Odobenus rosmarus divergens,* Ch. 7) have all expanded almost throughout their historic ranges. So successful has been the recovery of some *Arctocephalus* spp. that the Antarctic Treaty Consultative Meeting (ACTM) has been prompted to revise their legal protection (Jabour, 2008). However, Pacific walruses are again declining, this time due to climate change and sea-ice loss (Ch. 7).

Like marine mammals, highly migratory, transboundary, threatened and endangered species have distributions that rarely coincide with a nation's political/jurisdictional boundaries, thus requiring some form of inter-jurisdictional cooperation for protection. To meet life-history demands, the vast majority of species depend on multiple habitats, where threats at any one life-history stage may threaten their survival. For fish, numerous international agreements are intended to regulate, restrict, or prohibit certain commercial fishing methods and reduce fishing effort, but unfortunately, non-commercial species are relatively neglected while very high profits from fish exploitation prompt over-exploitation.

### 3.2.2 Habitat conservation

Association of species with habitat is traditional practice for subsistence users, sportsmen, and others, but is poorly documented in lists of threatened or endangered marine species. However, listing highlights the need for habitat protection, with a prescription for how that species can be restored or how the threatening activity can be changed. This approach is widely endorsed by national and international agencies and organizations, and is explicit or implicit in numerous laws and agreements (Table 3.2). Thus, listing species under the U.S. ESA (Section 3.5.1.7) legally forces its habitat to be preserved, unlike IUCN's

**Table 3.2** International instruments for ocean/habitat,wildlife regional protection. Examples (Nowlan, 2001; UNEP, 2005; Prideaux, 2003).

| Region or habitat type to be protected | Instrument | Purpose |
|---|---|---|
| Oceans: continental shelf; high seas; territorial sea, contiguous zone. | *UN Convention on Law of Sea* (UNCLOS III: 1982) | Ocean jurisdiction and conservation. |
| Antarctic/Southern Ocean | *Antarctic Treaty* (1959); *Convention for the Conservation of Antarctic Seals* (1972); *Protocol on Environmental Protection to the Antarctic Treaty* (1991) | Specially protected land and ice habitats areas for scientific research. Extends Antarctic Treaty to the Antarctic Convergence; adopts ecosystem management. |
| Arctic Ocean/Northeast Atlantic | *OSPAR Convention* (1998); *Arctic Environmental Protection Strategy* (l991); *Global Program of Action for Protection of Marine Environment from Land- based Activities* (l995) | Protect Arctic ecosystems: protect, enhance, restore natural resources; recognize traditional-cultural needs of indigenous peoples; review state of Arctic environment; address pollution. |
| Mediterranean | *Barcelona Convention* (1976); *Protocol Concerning Specially Protected Area and Biological Diversity in the Mediterranean* (1995) | For establishment of a network of protected areas for habitats and wildlife. |
| West/Central Africa | *Abidjan Convention* (1984) | Protect marine, coastal environment. |
| East Africa | *Nairobi Convention* (1985) *Protocol Concerning Protected Areas and Wild Fauna and Flora in the Eastern African Region* (1985) | For establishment of a network of protected areas for habitats and wildlife. |
| South Pacific | *Noumea Convention* (1990); *Protocol for Conservation and Management of Protected Marine and Coastal Areas of the South-East Pacific* (1989) | For establishment of a network of protected areas for habitats and wildlife. |
| Caribbean | *Cartagena Convention* (1983); *Protocol Concerning Specially Protected Areas and Wildlife* (1990) | For establishment of a network of protected areas for habitats and wildlife. |
| Wetlands | *Ramsar Convention* (1971) | Protect wetlands and waterfowl habitat. |
| High-seas fishery | *UN General Assembly Resolution 61/05* (2010) | Manage deep-sea fishes on high seas (seamounts, deep-sea habitat) |
| Regional seas for migratory species | *Convention on Conservation of Migratory species of Wild Animals* (1983) | A global environmental treaty to conserve and manage migratory species and habitats throughout range; facilitated through Multilateral Agreements. |
| Coastal waters | *Convention on Biological Diversity, Agenda 21* | UNEP Program to Protect Marine Environment from Land-based Activities Implement *Agenda 21*. |

*Red List of Threatened Species* that carries no such regulatory function, leaving habitat protection to individual nations.

Habitat conservation is advocated to protect, restore, or manage natural areas that species depend upon for their survival. Species and/or higher taxa targeted for protection have become synonymous with protection of wetlands, seagrass beds, seashores, mangrove forests, coral reefs, and other habitats. Habitat protection is often extended to protect communities, i.e., multiple species that depend on these habitats at one or more stages of their life histories. The *Ramsar Convention* is the only international agreement specific to a particular habitat type (wetlands), and it came into being to protect birds that use wetlands as major habitats, rather than to protect wetlands per se.

Preserving habitat or potential habitat (a habitat lacking a target species, but capable of supporting it in future) is essential for recovery of depleted or endangered species. Designation of such areas requires that the area be of sufficient size to restore or sustain the species in the ecosystem. Habitats have also become recognized as important for conservation science as control areas for studies in natural history, community interactions, ecosystem function, responses to environmental change, and for their esthetic and recreational values. Habitat protection thus has moved species and wildlife conservation into spatial conservation, and into jurisdictional arenas granted by social tradition, constitution, and law, with established rules of conduct administered through systems of governance.

### 3.2.3 Biodiversity conservation

Although species and habitat protection are critical for conservation, that form of protection is insufficient. Experience with species- and habitat-specific laws, agreements, and other mechanisms supports the need to manage units larger than individual species and their habitats. The rate of species loss has forced recognition of a problem much larger than loss of single species, i.e., loss of biodiversity and genetic uniqueness important to ecological function. Species require well-functioning ecosystems in which to live and ecosystems depend on complexes of diverse species to maintain their functions. Hence *biodiversity conservation* and *ecosystem-based management* (EBM; Section 3.6.6; Ch. 13) have become new catchwords in the vocabulary of natural resources management.

Biodiversity, literally the diversity of life, includes species and their genetic variability, habitats, and ecosystems (Ch. 5). In 1992, 159 nations met in Rio de Janeiro, Brazil, at the "Rio Summit" to discuss conservation of biodiversity and natural resources. The results were the *Rio Declaration on Environment and Development* and the *United Nations Convention on Biological Diversity* (CBD). Some 190 countries consequently pledged to reduce the rate of biodiversity loss by 2010—the year designated by the UN as *International Year of Biodiversity*. That year has passed with some progress, but biodiversity continues to decline (Millennium Ecosystem Assessment, 2005).

Biodiversity conservation is a broad-spectrum approach to protection, restoration, and sustainable use for species, habitats, and ecosystems. It uses many of the same mechanisms as for species and habitat protection, but involves a broader, more holistic, ecosystem-based perspective encompassing species, habitats, ecosystems, and humans. Biodiversity research has increased dramatically in recent years, but less than 10% of that research has been devoted to marine biodiversity (Hendriks *et al.*, 2006). Terrestrial predominance creates a severe imbalance that percolates through national and international programs. Efforts are underway to promote conservation of marine biological diversity through a series of conventions and other international instruments, most notably, the UN Law of the Sea (LOS). LOS offers a critical international framework for enforcing conservation and sustainable use of marine biodiversity, and for increasing marine scientific research in international, oceanic areas. However, challenges remain, especially that no nation can effectively prevent ecological harm perpetuated by others. Construction of large-scale dams (e.g., Egypt's Assam High Dam, China's Three Gorges Dam, etc.) can affect ecological processes beyond national borders, but current mechanisms among nations cannot effectively conserve biodiversity or prevent introduction of alien (exotic) species across international waters.

Marine biodiversity conservation is in its infancy. A current deterrent to its progress is lack of information on numbers, distributions, and life histories of the vast majority of marine species; the *Census on Marine Life* attempts to confront this problem (Box 5.1). The inertia of some governments, notably the U.S., to become signatory to the CBD and LOS deprives the Convention of necessary commitment and resources. Yet the ocean provides reliable goods and services to humanity, with many potential tools for conserving marine biodiversity, e.g., through sustainable fisheries management, pollution control, maintenance of essential habitats, and creation of marine spatial reserves (Worm *et al.*, 2006). The goal to reduce the rate of species loss can be targeted by tracking the net balance of species improvement and/or depletion of species listed on IUCN's *Red List of Threatened Species* (Sachs *et al.*, 2009; Walpole *et al.*, 2009). And from this list, the loss and rate of habitat and ecosystem change can be inferred, but only after the fact.

## 3.3 SPATIALLY EXPLICIT CONSERVATION

Efforts to protect or restore any species and/or its habitat require spatially explicit approaches, especially through "protected area" designation. Preserving habitats, e.g., reefs, seagrass beds, estuaries, lagoons, the benthos, seashores, sea ice, open waters, seamounts, and more, as protected areas, aims to sustain valued species, recover depleted or endangered species, and protect ecosystems. Protected areas can support scientific research needed on natural history, community interactions, ecological function, and also can serve as control areas to investigate responses to environmental change. Where spatial extent is important, designated protected areas often fall within the jurisdiction of multiple authorities, some by tradition, constitution, law, or social contract, with separate established rules of conduct and governance.

During past centuries, Marine Protected Areas (MPAs) were established to perpetuate traditional uses such as hunting

**Fig. 3.1** Cultural Marine Protected Area at Manono, Western Samoa, honoring Samoans who defeated and expelled the Tongans in battle 25 generations ago, or about the year 1250. As they left, the Samoan chief cried out, "*Malietoa melietau*" (*Brave heroes, well fought!*). The sign indicates the location of the battle. Photograph © Ray & McCormick-Ray.

or fishing, or for cultural reasons (Fig. 3.1). In the early to mid-20th century, governments established MPAs almost solely for species and habitat conservation or for scenic or cultural values; e.g., Glacier Bay National Monument in Alaska (1925), Fort Jefferson National Monument in Florida (1935), Green Island in Queensland, Australia (1938). The modern era of MPA establishment arose with the establishment of the Exuma Cays Land and Sea Park, The Bahamas (1959, Ch. 8). In 1962, the International Union for the Conservation of Nature and Natural Resources (IUCN) hosted the First World Conference on National Parks and Reserves. A prescient recommendation for the first time encapsulated several concepts that remain relevant today: a land-sea approach, no-take fishery reserves, the need for research, and habitat protection (Box 3.2). Shortly thereafter, the need for MPA guidelines became evident. The total known list of marine parks and reserves by the early 1970s was only 125 (Björklund, 1974), making evident that MPA establishment initially was based on expediency, opportunism, and pragmatism that lacked scientifically defensible choices. In 1968, the decade-long (1962–73) International Biological Programme (IBP) held an international conference on *Man and the Biosphere* under UNESCO (United Nations Educational, Scientific, and Cultural Organization) sponsorship, which recommended development of an international network of *biosphere reserves* (Ch. 11). A MAB task force in 1974 proposed five general selection criteria for terrestrial research and conservation: biogeographic representativeness, diversity, naturalness, uniqueness, and effectiveness. These criteria were presented to the 1975 International Conference on Marine Parks and Reserves in Tokyo (Japan), which expanded concepts for MPA selection. In 1977–8, the first international effort to promote MPAs occurred when the International World Wildlife Fund and IUCN together initiated a global program, *The Seas Must Live*, to inspire the lagging need for marine conservation. The seas still seemed "healthy" then, as only a few species (some marine mammals, sea turtles, and fewer than a dozen fish) were recognized as endangered. Following the WWF/IUCN effort, in 1981 UNEP's Mediterranean Action Plan, the first of several such regional plans,

### Box 3.2 First World Conference on National Parks: Recommendation 15

The First World Conference on National Parks, held in Seattle in 1962, was a gathering of more than 60 countries and represented the first international exchange of ideas on protected areas. The following Recommendation was adopted:

> WHEREAS it is recognized that the oceans and their teeming life are subject to the same dangers of human interference and destruction as the land, that the sea and land are ecologically interdependent and indivisible, that population pressures will cause man to turn increasingly to the sea, and especially to the underwater scene for recreation and spiritual refreshment, and that the preservation of unspoiled marine habitat is urgently needed for ethical and esthetic reasons, for the preservation of rare species, for the replenishment of stocks of valuable food species, and for the provision of undisturbed areas for scientific research.
>
> THE FIRST WORLD CONFERENCE ON NATIONAL PARKS invites the Governments of all those countries having marine frontiers, and other appropriate agencies, to examine as a matter of urgency the possibility of creating marine parks or reserves to defend underwater areas of special significance from all forms of human interference, and further recommends the extension of existing national parks and equivalent reserves with shorelines, into the water to the 10 fathom depth or the territorial limit or some other appropriate off-shore boundary.

*Source*: Adams AB, ed (1962). First World Conference on National parks, U.S. Dept. Interior, Washington DC

finally provided comprehensive MPA criteria and guidelines that became widely adopted, modified, and are still applicable today (www.unepmap.org).

By the 1990s, marine species depletions and habitat deterioration rose to obvious crises. Bolstered by increasing information about species, natural history, and ecological structure and function, efforts to develop MPAs intensified. Scientific evidence increasingly revealed that marine communities plus environments constitute a viable unit needed for restoring depleted habitats and species' populations. Furthermore, the mobility of species and the openness of marine systems emphasized that the scope of marine conservation must be large, even regional. Scientists urged MPA establishment in the open ocean (e.g., Lubchenco *et al.*, 2003) for both biodiversity protection and no-take fishery reserves, urging adoption of very large MPAs (e.g., LORs, Ch. 12). IUCN (2005) proposed expansion of regional programs. By that time, the First Conference of the Parties of the *Convention on Biological Diversity* in 1994 listed 1306 MPAs (Kelleher *et al.*, 1995) with coral reefs attaining international status via the *International Coral Reef Initiative* to become the marine equivalent to tropical forests for biodiversity conservation. The CBD called for effectively managed networks of MPAs of ecologically representative areas by 2012, and to effectively conserve at least 10% of each of the world's marine and coastal ecological regions (Toropova *et al.*, 2010). This important goal sparked efforts towards global ocean conservation.

By the first decade of the 21st century, more than 5880 MPAs had been established worldwide, and since 2003 have increased in number by >150% (Table 3.3a,b). Although covering only 1.17% of ocean space, MPAs' total cover is >4.2 million $km^2$ (Toropova *et al.*, 2010; UNEP, 2009) with sizes from the smallest of 0.4 ha (Echo Bay Provincial Park, 1971, Canada) to the largest at 544,000 $km^2$ (Chagos Marine Reserve, 2010, Indian Ocean). The latter surpassed the 408,250 $km^2$ Phoenix Islands Protected Area in Kiribati. Australia's Great Barrier Reef Marine Park in 1975 that covered 340,000 $km^2$ was expanded to include Great Barrier Reef Coast Marine Park (GBR Coast MP, 2004) to help protect the Great Barrier Reef and environs, a designated World Heritage site. The Great Australian Bight Marine Park designated in 1998 protects 19,395 $km^2$ of Australia's ocean space. The 11 largest MPAs of more than 100,000 $km^2$ also include the U.S. Papahānaumokuākea Marine National Monument designated in 2008 that protects 360,000 $km^2$ of the northwest ocean of the Hawaiian Islands (also a UNESCO World Heritage Site).

## 3.4 GOVERNANCE: POLICY, STRATEGY, TACTICS

Coastal and marine issues are being addressed through a variety of governing mechanisms that involve established procedures, instruments of government, and the private sector. Inspiration and motivation for collective conservation action is captured in a vision statement, followed by agreed-upon goals to guide conservation action, as carried out in policy, strategy, and tactics. While policy is intended to set a course or principle of action through governing mechanisms, establishing policy is an art, with science and persuasion playing key roles in negotiating among stakeholders with divergent views. And as governance involves government, control, and authority, good governance involves law, science, economics, and the sovereign power of nations.

Optimally, policy goals are clear and agreed upon, options and criteria are defined, and information is complete (Fiorino, 1995). However, uncertainty forces environmental policy into the arena of politics, social norms, and spirit of the times, and when policies collide, as among public trust, property rights, and depletion of shared resources, the interaction between policy and politics can result in a series of compromises with unintended consequences. Hence, environmental policies may owe little to environmental paradigms and a lot to political expediency, often taking the form of piecemeal efforts that lack focus on ultimate outcomes, and tending to happen as much by default as by intended action.

Science provides rational arguments to help narrow uncertainty, but policy decisions are not based solely on technical information. As norms and politics play strongly into policy decisions, the core assumptions of science and policy are fundamentally different: science is empirical and requires expert interpretation, whereas policy establishes a standard among collective interests (stakeholders) that hold varied beliefs, values, and ideals (Wagner, 2001). A paradigm conflict that requires resolution thus exists between science-based assessment and interest-based policy-making (Cahn, 2002).

Once a desired policy outcome is established, the government or group creates a framework for priority action, a strategy that sets tactical targets (Fig. 3.2). Strategy is a plan of action, a military term defined as "the art of defeating the enemy in the most economical and expeditious manner" (Morison, 1958). Strategy provides incentives, establishes institutional capacity with clear accountability, exposes errors and inefficiencies, and identifies true costs. It involves inventory, research, and monitoring as well as cooperation (networking), programs (projects), and resources (money, facilities, etc.). A successful conservation strategy includes preventative action, precautionary approaches, public participation, research, and monitoring so as to incorporate feedbacks that improve the ability to lead and to adjust without losing sight of the goal. As conservation strategy is a plan of action to achieve an overall goal, as for biodiversity protection, sustainable use, and ecosystem health, it is least glamorous and most difficult to carry out, and too often the "missing link" in conservation programs.

The need for conservation strategy was foreseen in the 1970s with publication of the World *Conservation Strategy* (IUCN, 1980). Its goals were to maintain essential ecological processes and life-support systems, preserve genetic diversity, and ensure sustainable utilization of species and ecosystems by emphasizing "processes" and "systems." A decade later, its revision—*Caring for the Earth: A Strategy for Sustainable Living* (IUCN *et al.*, 1991)—contained nine "Principles" and included a chapter on Oceans and Coastal Areas with 12 recommended actions. Finally, the *Global Biodiversity Strategy* of 1992 (WRI *et al.*, 1992) was agreed upon at the tenth meeting of the CBD at Nagoya, Japan (2010), that established a new Strategic Plan for 2012–20 (Box 3.3). These documents identify aspirations

**Table 3.3** Summary of 5878 globally established Marine Protected Areas that cover ~1% of global ocean surface. From Toropova C, *et al.* (2010) *Global Ocean Protection: Present Status and Future Possibilities*. Brest, France; Agence des aires marines protégées, Gland, Switzerland, Washington, D.C. and New York, USA; IUCN WCPA, Cambridge, UK; UNEP-WCMC, Arlington, USA; TNC, Tokyo, Japan; UNU, New York, USA; World Conservation Strategy, pp. 1–96.

**(a) MPAs in marine realms/provinces with approximate MPAs area sizes and percentage covered.**

| Marine *realms and provinces* | Shelf area (km²) | Marine area under some form of protection (km²) | Percentage marine area protected (within coastal belt) |
|---|---|---|---|
| Southern Ocean | 792,253 | 28,330 | 4 |
| Tropical Eastern Pacific | 254,137 | 27,558 | 11 |
| Temperate Australasia | 1,025,333 | 56,288 | 5 |
| Temperate Northern Pacific | 3,029,022 | 74,156 | 2 |
| Temperate Southern Africa | 284,261 | 7,225 | 3 |
| Western Indo-Pacific | 2,233,848 | 39,119 | 2 |
| Temperate Northern Atlantic | 4,178,449 | 66,113 | 2 |
| Arctic | 7,636,248 | 372,132 | 5 |
| Eastern Indo-Pacific | 150,287 | 29,448 | 20 |
| Temperate South America | 1,704,401 | 6,052 | 0.4 |
| Central Indo-Pacific | 5,881,372 | 421,679 | 7 |
| Tropical Atlantic | 2,162,800 | 138,764 | 6 |
| **Totals** | **29,332,411** | **1,266,864** | **4** |

**(b) Oceanic MPAs: ocean zones, off-shelf, and regional seas. MPA coverage of the off-shelf, bathyal, and abyssal areas breaks down to 1.32% and 0.67%, respectively. The total global MPA area coverage is mostly of a relatively few very large MPAs and many very small sites.**

| Region | Type | Area (km²) | MPA (km²) |
|---|---|---|---|
| ***Pelagic*** | | | |
| Atlantic Ocean | Boundary and equatorial currents, gyres, transitional, Gulf of Mexico, Caribbean Sea, SE U.S.A shelf | 57,982,554 | 87,253 |
| Pacific Ocean | | 86,073,399 | 1,136,277 |
| Indian Ocean | | 82,816,824 | 628,926 |
| Southern Subtropical Front | | 21,837,584 | 345,893 |
| Antarctic Ocean | | 33,003,858 | 618,246 |
| ***Semi-enclosed seas*** | | | |
| Indonesian Through-Flow | Complex: straits and seas | 3571343 | 42,895 |
| Mediterranean Sea | | 1840,859 | 4,382 |
| Red Sea | | 229,964 | 2 |
| Sea of Japan/East Sea | | 740,969 | 2 |
| South China Sea | | 1,586,354 | 7 |
| Black Sea | | 292,027 | 0 |
| ***Bathyal*** | Whole oceans, plates, ridges, regions | 830,60,170 | 1,093,774 |
| ***Abyssal*** | Whole regional ocean basins | 23,7436,097 | 1,586,537 |

for a comprehensive approach, being largely goal-setting instruments for nations and conservation groups to help develop coastal-marine conservation strategies.

Tactics is the art of carrying out strategy through deployment and maneuvers of targeted actions. Tactics are unequivocally the most costly portion of conservation, involving real-world applications guided by legal (regulation, zoning, resource quotas, MPAs, etc.) and non-legal measures (e.g., partnerships, agreements, community action, etc.). Government agencies, national to local, have the authority to carry out the greater portion of marine conservation tactics, often with collaboration of international agencies, NGOs, conservation groups, and private citizens. Specifically, government tactics are carried out with legislative authority or decree with enforcement responsibility, public accountability, and taxpayer support for subsidies, direct funding, and public relations.

### 3.4.1 Law

Laws create the framework for solving environmental problems (Salzman and Thompson, 2010). Normative law is the


**Fig. 3.2** Conceptual linkages in policy, strategy, and tactics, highlighting the central role of strategy for marine conservation.

oldest code of law known to civilization, with deep roots in basic truths that govern all people everywhere and that are often taken for granted; e.g., taking a person's property or stealing is wrong; lying is mostly wrong. Environmental laws relate not only to scientific uncertainty about complex issues, but also to conflicts between financial interests, misaligned natural and political boundaries, different concepts about issues, and to clashes between competing interests.

U.S. environmental law has provided some of the most important legal innovations of the modern age through its creation of national parks, environmental assessments, and public access to information, many of which are being applied worldwide. These environmental legal innovations stem from Roman law, which is acceptable to three-fourths of the civilized world because of its equity, universal adaptability, and its applications to government (Burdick, 2004). In Roman law, the Institutes of Justinian declared that air, running water, the seas, and its shores are a commons for all people to use, a declaration that became known as the *Public Trust Doctrine*, a common-law principle passed from Romans to England and to the English Empire. In Britain, the King held public-trust authority as a benefit to all English subjects, and which was passed after the U.S. Revolution to give authority to states. State courts thus became the chief enforcers of what has remained a common-law doctrine of property (Ruhl and Salzman, 2006). Continental Europe inherited civil law from the Roman Empire, which was further developed through a code of laws established by Napoleon Bonaparte. Worldwide, common law, civil law, customary law, Muslim law, and mixed law are different forms of law. As globalization is connecting societies, the surge of international agreements and regulatory regimes now being created means that environmental-policy innovations are being transported into countries with different legal and cultural traditions. The effectiveness and enforceability of such policy innovations in some regions may be more aspirational than legally obligatory (Yang and Percival, 2009). Environmental issues and conflicts thus require resolution among different forms of law.

### Box 3.3 Key elements of the new *Global Biodiversity Strategic Plan* 2011–2020

**The vision**: "Living in Harmony with Nature" where "By 2050, biodiversity is valued, conserved, restored and wisely used, maintaining ecosystem services, sustaining a healthy plant and delivering benefits essential for all people."

**The mission**: to "take effective and urgent action to halt the loss of biodiversity in order to ensure that by 2020 ecosystems are resilient and continue to provide essential services, thereby securing the planet's variety of life, and contributing to human well-being, and poverty eradication. To ensure this, pressures on biodiversity are reduced, ecosystems are restored, biological resources are sustainably used and benefits arising out of utilization of genetic resources are shared in a fair and equitable manner; adequate financial resources are provided, capacities are enhanced, biodiversity issues and values mainstreamed, appropriate policies are effectively implemented, and decision-making is based on sound science and the precautionary approach."

**Five strategic goals, with twenty Aichi targets**: These are both aspirations for achievement at the global level, and a flexible framework for establishing national or regional targets.

- Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society.
- Goal B: Reduce the direct pressures on biodiversity and promote sustainable use.
- Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity.
- Goal D: Enhance the benefits to all from biodiversity and ecosystem services.
- Goal E: Enhance implementation through participatory planning, knowledge management and capacity building.

**Implementation:** The *Strategic Plan* will be implemented primarily through activities at the national (i.e., *National Biodiversity Strategies* and *Action Plans*), or subnational level with supporting action at the regional and global levels.

*Source*: COP (2010) Tenth meeting of the Conference of the Parties to Convention on Biological Diversity in Nagoya, Aichi Prefecture, Japan

Global environmental law is emerging through the United Nations with a set of legal principles developed from regulatory systems to protect the environment and to manage natural resources. The United Nations Environment Program (UNEP) role in international governance and policy, through its Division of Environmental Law and Conventions, plays a

key role in the development and facilitation of international environmental law (UNEP, online). International sources of environmental law are documented in UNEP's *Register of International Treaties and Other Agreements in the Field of the Environment* (UNEP, 2005). The International Court of Justice is the primary judicial organ of the United Nations, and is charged with resolving various disputes between nations (ICJ, online). A nation can recognize the compulsory jurisdiction of the Court, or it can choose to be exempt from compulsory jurisdiction for certain classes of cases. This partial exemption is controversial, but is upheld by the 15-member Court elected by the United Nations General Assembly and the Security Council.

### 3.4.2 Science

Science is a highly organized, self-correcting process that requires iterative communication among peers. As it attempts to narrow uncertainty, science provides an objective understanding of the environment, a measurement of change, and information for policy-makers, generating defensible evidence and dispelling myth through rational evaluation, e.g., that the ocean is so large that *the solution to pollution is dilution*. Lack of scientific understanding has led to fatal consequences across the socio-economic spectrum, especially for those for whom fish is a dietary mainstay (Mergler *et al.*, 2007), as in the case of Japan's Minamata methylmercury poisoning in May 1956 that killed more than 100 people (Harada, 1995). Since World War II, science has increasingly formed a basis for modern thought, judicial fairness, and democratic equity—a way of knowing about the natural world through an objective lens of rational analysis (Moore, 1993) that requires rigorous assessment and re-assessment to avoid fallacious interpretation. As such, science forms a sound basis for conservation action. But lacking complete scientific information and much complexity, marine conservation most often requires preemptive, precautionary approaches to guide policy, management, and use (Ch. 13).

### 3.4.3 Economics

Economics plays a central role in social, political, and environmental issues, and environmental economics plays a key role in marine environmental policy and conservation (Costanza *et al.*, 1999). Ecological economics is about the sustainability of healthy marine environments in an era of globalization that is shrinking and reshaping the increasingly interconnected and interrelated world: i.e., generating economic growth while increasing social disparity and decreasing resources. Economic disparity increases ineffective responses and leads to a cluster of risks involving national fragility, organized crime, corruption, and a growing illicit trade of goods estimated at U.S. $1.3 trillion in 2009 (WEF, 2011; Smith *et al.*, 2003). The World Economic Forum in Switzerland declared that the global financial crisis that began in 2008 reduced global economic resilience, increased geopolitical tension, and heightened social concerns (WEF, 2011). Economic concerns cause politically corrupt nations to adopt less protective measures for conservation priorities and species diversity than other nations (Smith *et al.*, 2003). Some call for new indicators of economic progress to be geared to the economy that actually exists (Daly and Cobb, 1994; Cobb *et al.*, 1995).

### 3.4.4 Sovereign power of nations

What makes a nation sovereign is its claim on the environment and its rights over lands, adjacent ocean space, and resources, as defined under its constitution. Nations hold legal power to determine norms of behavior and conditions of life for humans and non-humans, to conserve and manage resources and environments mostly under binding rules of law, and to enter into international agreements. International agreements are largely voluntary, lack power, and considered "soft" mechanisms, as they depend on consent or consensus among nations and parties for implementation through bottom-up procedures.

Nations, on the other hand, traditionally engage in "hard" measures, e.g., command-and-control regulatory power, to achieve conservation goals. National policies are typically administered hierarchically in a top-down, vertical flow of power, from national government to provinces to local authorities and stakeholder (e.g., native) groups. But when integration among powers is required, governments usually operate horizontally through institutions and agencies that carry out assigned duties.

Most governments struggle to balance social, economic, and political interests as they also enact protective measures to safeguard natural resources, wildlife, and the environment. When policies collide, differing values attached to resources by different subsets of society often result in contentious debate, as occurs among public trust, property rights, and depletion of shared resources. And because policies are frequently formed under conditions of uncertainty, urgency, small budgets, and other constraints, interest groups can pursue goals to fit a favorable outcome for themselves (Kamieniecki, 2006). Hence, policies for sustainability, biodiversity protection, social equity, and resource conservation must compete with policies for economic growth, pursuit of wealth, energy acquisition, and resource consumption.

Land and sea jurisdictions among almost all nations fall under distinctly different private and public domains. Use of coastal intertidal areas and shorelands immediately landward of the water's edge is usually a customary right of citizens, but varies considerably among the world's dominant legal systems. Under the English *Public Trust Doctrine*, the government holds uses of coastal waters, submerged soils, and their resources for public benefit. Because the doctrine is grounded in property ownership and "best use," it is intimately connected with the economy, family structure, and the political system. Under "nuisance law," legislative bodies can declare that certain activities constitute public nuisances. Scandinavian "rights of common access" run counter to "property rights," allowing public access to lands, beaches, and intertidal areas. Some societies do not base laws on forms of property ownership (e.g., Polynesian and Inuit cultures). Confusion and conflict can result when these traditions coexist with western law, being resolved through highly variable social and legal mechanisms and traditions that are currently evolving.

## 3.5 POLICY INSTRUMENTS FOR MARINE CONSERVATION

Policy instruments are about decision-making tools on such issues as pollution, species protection, climate change, fisheries, transboundary situations, coastal zone management, biodiversity, sustainability, and environmental conservation. Marine environmental governance incorporates not only many policy instruments, but also financing mechanisms, rules, procedures, and social norms that directly or indirectly affect marine conservation.

### 3.5.1 U.S. national environmental policy

U.S. environmental policy is ultimately about politics and government (Fiorino, 1995). Policy includes a comprehensive set of mechanisms covering all major human-caused environmental issues. Policy shifts with public attitude and private-interest persuasion, and through conflicting goals and compromises that can have unintended consequences. Policy is ultimately determined by power politics, and when power (or priority) is granted to one person, institution, or resource, another may step in to limit it, owing less to environmental paradigms and more to political expediency. Environmental policy thus is a paradox (Smith, 2004), i.e., it needs to protect the environment from users while also protecting user interests.

The right to fish and hunt came with the *Public Trust Doctrine* inherited from British customary (common) law. Natural resources are held in public trust by state authority that protects the common shared resource for the benefit of citizens to fish and hunt. Entrepreneurs challenged that basic right in court in 19th century disputes over oysters (McCay, 1998; Ch. 6). As common law lacked judicial clarity, regulatory law soon outpaced it to become the primary tool for resource and environmental protection. De Tocqueville's *Democracy in America* (1831) stated: "scarcely any political question arises in the United States which is not resolved, sooner or later, into a judicial question" (Bodansky, 1998). The fundamental function of courts has been toward democratization, but public concern and the 20th century environmental movement are moving courts in a different direction, bringing dramatic changes in law and public values (Coglianese, 2001) that reshape environmental policy. Environmental protection may be implemented through the *Public Trust Doctrine* with the need to protect ecosystem services important to the public good (Ruhl and Salzman, 2006), but is vulnerable to the will of a concerted minority that can manipulate a diffuse majority in the public-trust arena (Sax, 1970).

U.S. environmental policies thus struggle to balance social, economic, and political interests against safeguarding natural resources, wildlife, and the environment. The Legislative Branch of Congress passes environmental laws, the Executive Branch administers federal environmental regulations through a variety of federal agencies (Smith, 2004; Salzman and Thompson, 2010), and the Judiciary Branch adjudicates the allocation of resources. Federal regulation is one of the basic tools that government uses to implement public policy (Copeland, 2008) and volunteerism is not generally seen as a reliable solution (Smith, 2004). Congress has the constitutional authority to regulate commerce, become party to international treaties, and to regulate spending. Individual constitutions of states provide mechanisms to carry out environmental policies and programs critical to marine conservation. In cases of overlap or conflict, federal law takes precedence.

Some major U.S. environmental legislation illustrates legislative action for marine conservation. Almost all others are pursuant to specific issues, as for example, the *Harmful Algal Bloom and Hypoxia Research and Control Act* (1998) that established a Department of Interior Inter-Agency Task Force to assess the economic and ecological impacts of algal blooms and hypoxia. This Act was amended in 1998 and 2004 to establish a program for prevention and control of harmful algal blooms and hypoxia.

#### 3.5.1.1 *National Environmental Policy Act* (NEPA, 42 U.S.C. 4321 et seq.)

NEPA was enacted four months prior to Earth Day in 1970, over public concern over oil spills, raw sewage, and industrial pollutants contaminating lands, water, and air (Brooks, 2009). Prior to NEPA, the first federal environmental legislation involved air pollution, the *Air Pollution Control Act* (1955) and Clean Air Act (1963), but existing laws did not provide environmental protection the public demanded. Through passage of NEPA, the U.S. established its first national policy to balance environmental concerns with social-economic requirements. While it does not preserve the environment, it recognizes a rapidly changing world with diminishing natural resources. NEPA set in place procedural requirements for all federal government agencies to enhance the general welfare needs by requiring these agencies to prepare Environmental Assessments (EAs) and Environmental Impact Statements (EISs) about environmental effects of proposed actions. These gave decision-makers and the public the opportunity—not the needed action—to consider alternatives that would minimize or avoid environmental impacts. To monitor environmental policy and strategy occurring on federal land, NEPA established the President's Council on Environmental Quality (CEQ) and created the Environmental Protection Agency (EPA) to implement strategy and tactics.

#### 3.5.1.2 *Clean Air Act* (CAA 1970, 42 U.S.C. §7401 et seq.)

This Act is a comprehensive federal law for air emissions from both stationary and mobile sources, and is administered by the EPA. It resulted in a major shift in the federal government's role in air pollution control and addressed public health and welfare risks posed by certain widespread air pollutants. This Act has four basic programs: the National Ambient Air Quality Standards (NAAQS) to control air pollutants, e.g., ozone, nitrogen dioxide, particulate matter, lead, etc.; National Emission Standards for Hazardous Air Pollutants to control release of known toxins; New Source Performance Standards to regulate new sources of industrial pollution; and State Implementation Plans, authorizing states to implement CAA rules and regula-

tions. EPA establishes emission standards that require the maximum degree of reduction in emissions of hazardous air pollutants.

#### 3.5.1.3 *Clean Water Act* (CWA 1972, 33 U.S.C. §1251 et seq.)

This Act forms the cornerstone of U.S. surface-water quality protection, regulating pollutant discharges into waterways and establishing industrial water quality standards. A permitting process of the U.S. Army Corps of Engineers and EPA establishes the basic structure for regulating discharge of dredged or fill materials into waters and wetlands. CWA employs a variety of regulatory and non-regulatory tools to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters for "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water." In recent times, CWA programs have shifted from a program-by-program, source-by-source, pollutant-by-pollutant approach to more holistic watershed-based strategies, giving equal emphasis to protecting healthy waters and restoring impaired ones (Ch. 6).

#### 3.5.1.4 *Coastal Zone Management Act* (CZMA 1972, P.L. 92–583, 86 Stat. 1280, 16 U.S.C. §1451–1464, Chapter 33)

CZMA established national policy to preserve, protect, develop, and where possible, restore or enhance the resources of the Nation's coastal zone. Administered by NOAA's Office of Ocean and Coastal Resource Management (OCRM), it is largely voluntary and depends on cooperation and incentives among federal and state levels of government to achieve goals, encouraging coastal states to develop and implement coastal zone management plans (CZMPs) through federal grants. Ambitious CZMPs attempt to balance competing land and water uses while also protecting sensitive resources, encompassing two national programs: the National Coastal Zone Management Program and the National Estuarine Research Reserve System.

#### 3.5.1.5 *Marine Protection, Research, and Sanctuaries Act* (1972, 33 U.S.C. §1401–1445; 16 U.S.C. §1431 et seq.; also 33 U.S.C. 1271)

Titles I and II of this Act, also referred to as the *Ocean Dumping Act*, generally prohibit: (i) transportation of material from the United States for the purpose of ocean dumping; (ii) transportation of material from anywhere for the purpose of ocean dumping by U.S. agencies or U.S.-flagged vessels; and (iii) dumping of material transported from outside the United States into U.S. territorial seas. Title III created the National Marine Sanctuary Program managed under a National Marine Sanctuary System whereby the Secretary of Commerce may designate any discrete area of the marine environment of special national significance for conservation, recreation, and/or of ecological, historical, scientific, archaeological, educational, or esthetic quality as a Sanctuary. Fishing is permitted. Amendments in 1980 allow removal if the Governor of the affected state finds it unacceptable or if both houses of Congress disapprove.

Broadening the scope of Sanctuaries, Presidential Executive Order (EO) 13158 (May 2000) encouraged Marine Protected Area (MPA) designation. It defined MPA as "any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources within." A national system of MPAs is developed jointly by the Departments of Commerce and Interior to strengthen management, protection, and conservation of existing protected areas, establish new ones, and reduce harm of federally approved or funded activities. This scientifically based system encompasses Department of Interiors' National Estuarine Research Reserves, national seashores, national parks, national monuments, critical habitats, national wildlife refuges, NOAA's National Marine Sanctuaries, fishery management zones where use of specific types of fishing gear is restricted, state conservation areas, state reserves, and others. As of 2012, 1700 MPAs of some form cover approximately 41% of all U.S. coastal waters, with <8% of these as "no-take" fishery areas (National Marine Protected Areas Center, online). Legally, "When a nation declares a marine protected area or an exclusive fishing zone, is it exercising rights as the proprietor of marine systems or is it exercising regulatory authority?" (Osherenko, 2006).

#### 3.5.1.6 *The Marine Mammal Protected Act* (MMPA 1972, 16 U.S.C. §1361–1421h et seq.)

The MMPA set precedent by: establishing "optimum sustainable population" (OSP) for marine mammals as significant functioning elements of ecosystems by: requiring a science-based ecosystem approach for management; placing a moratorium on the taking and importation of marine mammals and marine-mammal products; calling for application of the "precautionary principle"; and by establishing a Marine Mammal Commission. Under the Commission, a Committee of Scientific Advisors reviews activities of, and makes recommendations to, agencies responsible for marine-mammal management that are also required to report results directly to Congress (Ray and Potter, 2011). Two agencies are responsible: the U.S. Department of Interior's Fish and Wildlife Service (FWS) for walrus, polar bear, sea otter, and West Indian manatee; Department of Commerce's NOAA National Marine Fisheries Service (NMFS) for all others, i.e., seals, whales, dolphins, and porpoises. The MMPA superseded all other Acts pertaining to marine mammals, most significantly the *Fur Seal Act* that supported the international *North Pacific Fur Seal Convention* of 1911, which prohibited taking North Pacific fur seals (*Callorhinus ursinus*) and sea otters (*Enhydra lutris*) except by Alaska natives for subsistence purposes or by others under permit from NOAA. Although these Acts were abrogated by the MMPA, Alaska subsistence hunters are still allowed to take marine mammals.

MMPA became the first legislation anywhere in the world to mandate an ecosystem approach to marine resource management. The controversial management concept of "optimum sustainable population" was intended to replace simplistic

"maximum sustainable yield" approaches, as applied to fisheries and marine mammals alike. The primary objective of marine-mammal management is to maintain the health and stability of the marine ecosystem and when consistent with the primary objective, i.e., to obtain and maintain optimum sustainable populations of marine mammals. The ecosystem approach has been incorporated in other U.S. statutes such as the *Magnuson-Stevens Fishery Conservation and Management Act* (Section 3.5.1.8), in legislation in other countries, and in international agreements such as CCAMLR (Section 3.5.2.4).

#### 3.5.1.7 *Endangered Species Act* (ESA1973, 7 U.S.C. §136; 16 U.S.C. §460 et seq.)

ESA takes a very different approach than MMPA, focusing on species already in danger of extinction, requiring habitat protection and species restoration. This law is one of the most powerful environmental laws for the preservation of endangered species ever enacted by any nation (Mueller, 1994) and many Americans approve of the need to save numerous species from extinction. Scientific questions about what constitutes a *species* and its *habitat* are critical. ESA defines a species as "any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature"; endangered species are "any species which is in danger of extinction throughout all or a significant portion of its range"; threatened species are "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range." With the exception of recognized insect pests, all animals and plants are eligible, and species listed are protected without regard to commercial or sport value. A species is *fully recovered* when it no longer requires protection, and then may be delisted. Often, *fully recovered* cannot be known, due to lack of a baseline (Jackson *et al.*, 2011). For example, only 39 of approximately 1800 species protected under ESA have been removed from the list, but only 15 of those are considered to be fully recovered (Keller and Gerber, 2004); thus longer-term protection is advised. Furthermore, under the ESA, the U.S. federal government is required to designate *critical habitat* for any listed species, defined as: "specific areas within the geographical area occupied by the species at the time of listing and/or specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation." However, ESA mechanisms for habitat protection are often insufficient to prevent species depletion or to protect the habitat itself. Enforcement is subject to lawsuits regarding property rights. The U.S. Supreme Court has argued that by placing limits on federal legislative authority to protect habitat, private citizens' rights may be affected.

The joint FWS/NMFS Office of Protected Resources administers the Act. Listing requires good science, yet documentation of threatened species' natural history and habitat is too often rudimentary at best, with narrowly focused wildlife agencies frequently lacking technical skills, information, and necessary budgets (Carden, 2006). For marine systems, natural-history information is especially difficult to acquire, and opponents to environmental action can use scientific uncertainty to obfuscate evidence (Oreskes and Conway, 2010). While the public strongly supports the ESA, political debates contest the extent to which the nation's natural resources should be protected, and how best to utilize them.

#### 3.5.1.8 *Magnuson-Stevens Fishery Conservation and Management Reauthorization Act* (2006, P.L. 109–479)

This is the primary law governing marine fisheries management in U.S. federal waters, having exclusive fishery management authority over all fish, but leaving to states the management of fisheries within their jurisdiction. The Act aims to conserve and manage fishery resource, supported by strong ecological considerations.

This Act has a long history of change. It began with the *Fishery Conservation and Management Act* (1976) that established 200 nmi fishery conservation zones and created eight regional fishery management councils to oversee management and to promote fisheries conservation. Amendments in 1996 phased out foreign fishing within the U.S. Exclusive Economic Zone (EEZ), and focused on rebuilding overfished fisheries, protecting essential fish habitat, and reducing bycatch. The Act thereby aided the domestic fishing industry, and intended to promote conservation. The U.S. claims exclusive fishery conservation and management authority over all anadromous and catadromous species throughout their migratory ranges and beyond the EEZ, except within a foreign nation's waters. To improve shark conservation, the *International Fisheries Agreement Clarification Act* (Public Law No: 111–348, 2011) amended the *High Seas Driftnet Fishing Moratorium Protection Act* and the *Magnuson-Stevens Fishery Conservation and Management Act*.

#### 3.5.1.9 National ocean policy

The need for a comprehensive U.S. ocean policy was made clear by the need to coordinate 140 federal laws and 18 federal implementing agencies that are responsible for managing U.S. coastal-marine systems, and to address conflicts arising among them (ICOSRM, 2008). Marine species, for example, are utilized for economic yield (*Fisheries Act*), for optimum sustainable population (MMPA), and may be listed when threatened by extinction (ESA). In the case of marine mammals, conflicts can arise in carrying out these policies. Comprehensive policy is also important because ocean-dependent industries generate billions of dollars every year, contributing 2.5 times more to the U.S. economy than the agricultural industry. And deciding whether commercial priorities take precedence over environmental and species sustainability can only be resolved in the policy/political arena under a comprehensive policy.

Until the late 1940s when industries began to expand offshore, offshore oil and gas production was mostly unregulated and land ownership beneath states' navigable waters was controversial (Office of Oil and Gas, 2005). In 1953, Congress passed the *Submerged Lands Act* (SLA) that established the federal government's title to submerged lands over most of the continental margin, giving most states jurisdiction over any natural resources within 3 nmi of the coastline. The SLA led to the *Outer Continental Shelf Lands Act* (OCSLA, 1953), the cornerstone of offshore legislation that defines the outer con-

tinental shelf (OCS) as any submerged land outside state jurisdiction. However, ocean policy remained confused and uncoordinated.

"Who owns the coast?" (McCay, 2008). Customs and policies inherited from traditional practices and historical policies have divided the coastal system into separate domains (Armstrong and Ryner, 1980), with different management regimes that follow separate policies for submerged land, the water column, pollution, and resource use. Thus, the coastal land-sea zone lacks legal "distinctiveness" for management. Furthermore, marine species that utilize both land and sea fall mostly within the public domain as "common-pool" resources, where a number of people lacking incentives for conservation have access (NRC, 2002). Considering fish and other marine organisms as *wildlife* rather than *resources/commodities* is an option, protection under the ESA being another. However, increasing species listing is already over-loading administrative capacity, with the result that some potentially endangered species cannot get listed (e.g., Pacific walrus, Ch. 7; Woody, 2011). Furthermore, those advocating property rights resist protection of critical habitat, as required under ESA.

National ocean policy remains a work in progress. The *Oceans Act* of 2000 (P.L. 106–256) established the U.S. Commission on Ocean Policy to make recommendations for a coordinated and comprehensive national ocean policy. It and the Pew Oceans Commission created the bipartisan collaborative Joint Ocean Commission Initiative that called for a national ocean policy to improve federal coordination, considered climate change and acidification, protection of ocean resources, development of a unifying policy framework, and acceding to law-of-the-sea (UNCLOS) principles (JOCI, 2008). In July 2010, Presidential Executive Order EO 13547 gave ocean policy a boost by calling for stewardship of the ocean, coasts, and Great Lakes, to protect, maintain, and restore their health and biological diversity, and to increase scientific understanding of coastal and ocean ecosystems as parts of globally interconnected air, land, ice, and water systems. The National Ocean Council created by this EO recommended implementing the nation's first national ocean policy for stewardship, but remains challenged both by lack of ecosystem understanding and by the laws, authorities, and governance structures intended to manage the nation's coasts and oceans (CEQ, 2010).

### 3.5.2 International governance and cooperation

Policy-making at the international level is an integral part of international governance and cooperation, but among the greatest failures of international cooperation is the inability to manage ocean resources (Weaver, 2010). Analysis and assessment of data and self-interests of nations feed into foreign policy decisions, under mechanisms defined by international law (Box 3.4; Table 3.2). Primary tools include treaties, which are binding (hard law) and involve norms or principles made explicit and documented, and cooperative agreements that are non-binding (soft law). Differences between hard and soft law can be debated, but soft law is gaining influence, for example, the *Rio Declaration on Environment and Development* and agreements on the deep seabed, sovereignty over natural resources, codes of conduct, and guidelines and recommendations of international organizations (Boyle, 1999).

With establishment of the United Nations (UN) in 1945 after World War II, international governance advanced greatly. The UN Charter authorized it to achieve harmony of actions among nations and to resolve common problems through diplomacy and international mechanisms. Initially constrained

#### Box 3.4 Some definitions in international law

**Agreement**: a compact entered into by two or more nations or heads of nations; in the wide sense, any act of coming into conformity; in the narrow sense, an accord between states, but less formal than a treaty; may or may not be obligatory; includes convention, treaty, protocol, accord, act, declaration, pact, provision, etc.

**Convention**: agreement concluded among states on matters of vital importance; often used *in lieu* of treaty, but usually restricted to agreements sponsored by an international organization; intended to be legally binding, but requires ratification.

**Declaration**: a document whose signatories express their agreement with a set of objectives and principles; may not be legally binding, but carries moral weight.

**International law**: the body of legal rules and norms that regulates activities carried out by agreement among nations; intended to be legally binding, but requires ratification.

**Protocol**: agreement that completes, supplements, amends, elucidates, or qualifies a treaty or convention; has the same legal force as the initial document.

**Ratification**: final confirmation of a treaty, convention, or other document by a nation's competent body (legislature or head of state), thereby becoming legally binding and securing that country's commitment to it; there is no prescribed length of time for ratification.

**Regime**: arrangements that contain agreed-upon strategies, principles, norms, rules, decision-making procedures, and programs that govern interactions of participants in specific areas, such as fishing, navigation, trade, and scientific research.

**Resolution**: text adopted by a deliberative body or an international organization; may or may not be binding.

**Treaty** (from Latin *tractere*, to "treat"): an agreement entered into by two or more nations or heads of nations; intended to be legally binding; requires ratification.

*Sources*: Fox (1992); Gamboa (1973); Gleick (2000); University of Virginia School of Law (online)

**Table 3.4** UN environmental agencies with international marine programs.

| UN agency (year formed) | Mandate | Examples of commissions or relevant programs |
|---|---|---|
| **FAO** Food and Agriculture Organization, an autonomous agency within UN system (1945) | To improve nutrition, food production and distribution; alleviate hunger-malnutrition; food standards; long-term strategy for conservation and management of natural resources. | Intergovernmental Oceanographic Commission (IOC); Fisheries Department involved in Convention on Biological Diversity and UNCLOS; programs on environmental quality. |
| **UNESCO** UN Educational, Scientific, and Cultural Organization (l946) | To advance universal respect for justice, rule of law, human rights, fundamental freedoms of all peoples; emphasizes interdisciplinary approach; promotes understanding; encourages scientific research and training. | Man & Biosphere Program (MAB); World Heritage sites; Coastal Regions and Small Islands Initiative; promotes international ocean science: works closely with International Council of Scientific Unions (ICSU) and Scientific Committee on Ocean Research (SCOR). |
| **IMCO** International Maritime Organization (IMO l958); preceded by Inter-Governmental Maritime Consultative Organization1947) | To develop policies for international shipping; to facilitate technical cooperation; concern for marine environment, maritime safety, efficiency of navigation; prevention and control of marine pollution from ships. | Administers London Convention, and subsequent conventions, e.g., MARPOL and protocols for pollution; develops guidelines for ballast-water control of exotic species introductions; measures to prevent accidents; maritime legislation and its implementation. |
| **UNEP** UN Environmental Program (l972) | To coordinate environmental agreements and activities within United Nations system; to aid nations develop and adopt environmental policies, strategies, and actions. | Helps with formation of environmental treaties and agreements; funds and guides environmental strategies and action plans; coordinates regional seas programs and shared environmental problems of multinational, multi-cultural nations that border those seas; aids environmental negotiations, conventions (e.g., for biodiversity, climate change). |

by national sovereignty, the UN was increasingly called upon to address growing transnational issues in international development, pollution, resource exploitation, and others, and to achieve preeminence through its specialized, problem-resolving agencies (Table 3.4) as mandated by their constitutions to undertake global, environment-related policy-making. Each agency has a policy-making body representing the views of member states, and expertise in research and management to which issues may be referred. The policy-making architecture and related capacity of these specialized UN agencies provide a global approach for addressing complex maritime/marine issues (Hinds, 2003). In particular, routine discharge of ballast water and sewage is regulated under international pollution standards for the high seas (Table 3.5). The UN, however, unlike national authority, has no counterpart to a national legislature, lacks regulatory power, and requires its agencies to seek consensus among nations.

Environmental activity expanded exponentially after World War II (Fig. 3.3). As numerous environmental organizations became established, discussions among them lead to international treaties and intergovernmental organizations collectively called the "world environmental regime," broadly defined as "a partially integrated collection of world-level organizations, understandings, and assumptions that specify the relationship of human society to nature" (Meyer *et al.*, 1997). International regimes are usually directed toward specific topics such as fishing, scientific research, navigation, trade, biodiversity, and their consequences; e.g., the *Convention on Biological Diversity*, *Agenda 21,* and various protocols. Most rest on one or more constitutive documents that are not necessarily legally binding. Regimes are particularly necessary for resolving transboundary environmental issues that arise when activities within the jurisdiction of one nation have consequences affecting other nations. When a fish population migrates between national jurisdictions, fishing in one area can affect fishing in another area, resulting in disputes over the level of take, even when precise species distributions may not be known. A general trend is to reallocate jurisdiction under voluntary agreements, from national to transnational to supranational authorities, usually lacking power as a "soft-law" mechanism. The final version of a compromised protocol is often a diluted solution that lacks civil-society commitment (Brown, 2011).

International ocean policy is especially complex. It combines individual interests of sovereign nations within an ocean commons matrix of traditional practices, where freedom of the seas brings economic benefits in sea trade, international preeminence in sea power, national security, and global stability (Kraska, 2008). Throughout history, all nations held legitimate right to the high seas, with freedom to navigate, to use resources, and to fish as a common use right. Through the 15th century's maritime mobility, small nations gained vast

**Table 3.5** Major international conventions on vessel pollution. Many follow protocols on specific aspects. Dates indicate signing of agreements; ratification takes almost a decade.

| Date | Instrument | Intent |
|---|---|---|
| 1963 | *Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water* | To prevent nuclear pollution, globally. |
| 1969 | *International Convention Relating to Intervention on the High Seas in Cases of Oil Pollution Casualties* | To prevent or mitigate oil pollution by accidents involving ships outside territorial waters. A protocol extending to other hazardous substances (chemicals) entered into force in 1983. |
| 1969 | *International Convention on Civil Liability for Oil Pollution Damage* | To ensure adequate compensation from damage of oil pollution. Placed liability compensation on ship owners releasing or discharging oil. |
| 1971 | *International Convention for the Establishment of an International Fund for Compensation for Oil Pollution Damage* | To provide further compensation to oil pollution victims. Placed the burden of compensation on ship owner, with time limits on amount payable. Funded by oil importer contributions. |
| 1972 | *London Convention. Protocol bans radioactive wastes and incineration at sea* | Control all sources of pollution to marine environment by dumping of wastes. |
| 1973/1978 | *International Convention for the Prevention of Pollution from Ships (MARPOL) and its 1978 Protocol (MSARPOL) supercede the International Convention for the Prevention of Pollution of the Sea by Oil (1974)* | Addressed pollution by oil, noxious liquid substances, harmful substances carried in packaged forms, sewage, and garbage. Widely regarded as the most important instrument of its type. Almost all other agreements since this time have depended on the principles therein. Areas identified as "special areas" receive higher protection. |
| 1974 | *Paris Convention for prevention of marine pollution from land-based sources* | Further restrictions on dumping of wastes at sea. |
| 2001 | *International Convention on the Control of Harmful Anti-fouling Systems on Ships* | Prohibits use of harmful organotins in anti-fouling paints used on ships; establishes a mechanism to prevent potential future use of other harmful substances in anti-fouling systems. |

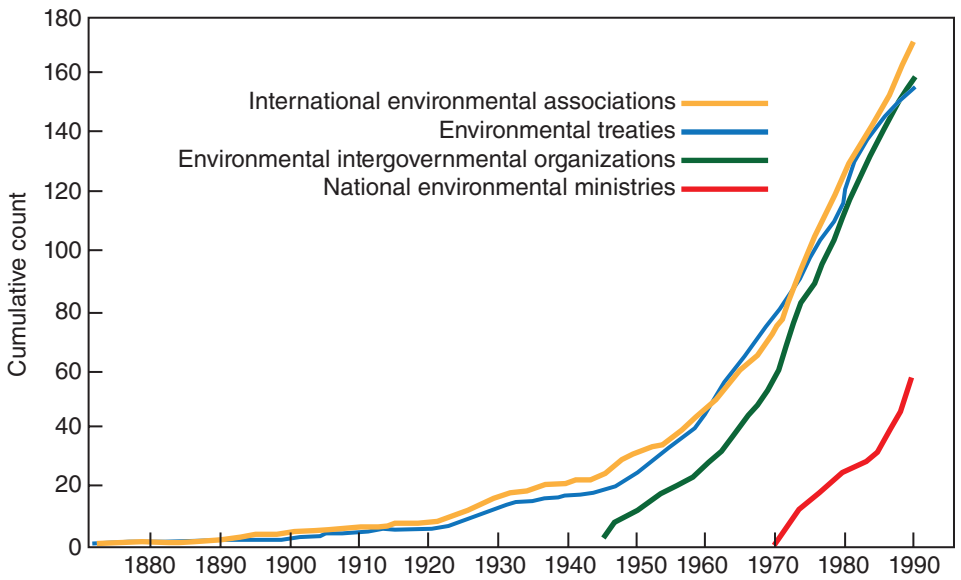


**Fig. 3.3** International environmental activities accumulated with greater intensity after World War II, with an extraordinary expansion of international non-governmental and governmental organizations, and treaties. From Meyer *et al.* (1997), with permission.

empires and power, and relied upon such freedoms for safety and prosperity and for conducting international trade. As freedom of the seas waxed and waned, tensions between governments grew in the exercise of government authority over the sea (Kraska, 2011). In the late 1600s, nations endorsed piracy as a profession, pitting one ruler against another on the open seas, and privateers were rewarded for capturing goods of other countries. With increasing activity and recognition of the ocean's importance, particularly after World War II, development, management, and protection increased and

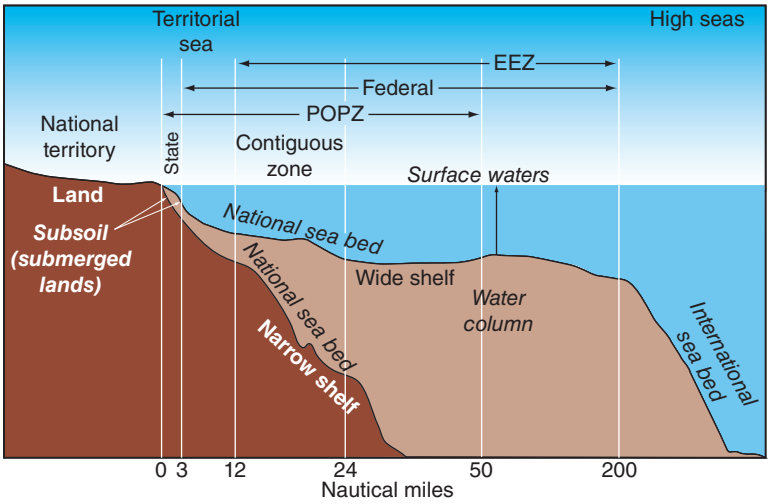


**Fig. 3.4** Coastal and marine jurisdictional boundaries recognized under international law subdivide ocean space horizontally and vertically, with different regulations for surface water, the water column, seabed, and subsoils (i.e., submerged coastal lands, usually under state or provincial control). Ocean space allocated to national sovereignty includes a contiguous zone that extends another 12 nmi and where coastal nations can exercise control over customs, immigration, and fiscal or sanitary (pollution) matters. Nations exert control over living and non-living resources within the Exclusive Economic Zone (EEZ), beyond which are the high seas (open ocean; commons, international) under UNCLOS, but where certain restrictions may apply. A Prohibited Oil Pollution Zone (POPZ) is declared by some nations under the *International Convention for the Prevention of Pollution from Ships* (MARPOL). Compare with ecological subdivisions, Fig. 4.7.

jurisdictional boundaries became established over coastal areas and marine resource uses (Fig. 3.4). Fisheries, marine-mammal conservation, shipping, oil and gas, and mining issues required legal distinctions and established authority over use of designated areas and resources. Furthermore, new uses of the oceans for international trade, national security, oil, gas, energy development, and transport made oceans and coastal seas contested arenas.

### 3.5.2.1 International frameworks for conservation

The UN Conference on the Human Environment in 1972 was a major world event for environmental issues. It brought global recognition to human-environment interactions in a framework for environmental action, recognizing that "Man has the fundamental right to freedom, equality and adequate conditions of life, in an environment of a quality that permits a life of dignity and well-being." It provided Principles and Recommendations for nations to act, with communications about environmental issues (e.g., air pollution), training, and working relationships among agencies on such issues as clean water and population growth. It also recognized that when resources and environment are involved, a sovereign nation should not engage in activities that negatively affect the sovereignty of others.

In 1984, the UN General Assembly followed up by establishing the World Commission on Environment and Development (WCED)—the *Brundtland Commission*. Its 1987 report, *Our Common Future* (WCED, 1987), proposed *sustainable development*, a controversial term that divided nations: developed nations of the global *north*, many with already depleted resources, promoted resource sustainability, while the lesser-developed global *south* sought economic development of natural resources to benefit rising human populations.

In 1992 the UN convened the largest group of world leaders ever held at the United Nations Conference on Environment and Development (UNCED)—the "*Rio Earth Summit*"—in Rio de Janeiro to meet on environmental concerns. One hundred seventeen heads of state, concerned scientists, conservation organizations, and thousands of delegates and participants representing 178 nations placed humans at the *center of concerns for sustainable development* (Principle 1 of the *Rio Declaration*). This summit focused on developing international cooperation for shared environmental concerns, including conservation of large ecosystems that require large-scale transboundary management, as for example regional water resources. The Rio Conference initiated two important, legally binding conventions: The *Framework Convention on Climate Change* (the *Climate Change Convention*) that led to the adoption of the Kyoto Protocol in 1997, and the *Convention on Biological Diversity* (CBD) that urged nations to develop national strategies for the conservation and sustainable use of biological diversity. A comprehensive plan for action, *Agenda 21*, outlined strategies that set forth rights and obligations of nations to be carried out at all levels of organization; Chapter 17 addressed ocean protection (Table 3.6). Among its major themes, "Marine and Coastal Biodiversity" was specifically addressed in the *Jakarta Mandate on the Conservation and Sustainable Use of Marine and Coastal Biological Diversity* adopted in 1995 (Table 3.7).

The 2002 World Summit on Sustainable Development held in Johannesburg (South Africa) strongly reaffirmed UNCED and *Agenda 21*. Political leaders agreed to strive for *a significant reduction in the current rate of loss of biodiversity by 2010*, challenging the ecological and conservation community to detail the rates of biodiversity change (Dobson, 2005). Currently, available evidence indicates that biodiversity loss has not slowed, but rather is increasing (Secretariat of the CBD, 2013). In 2000, the United Nations Secretary-General, Kofi Annan, in his report to the UN General Assembly, called for an assessment of the consequences of ecosystem change for human well-being and for the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being. Consequently, the *Millennium Ecosystem Assessment*, based on government requests and synthesis by 1360 experts, found that the most important drivers of change relate to habitat and climate, invasive alien species, pollution, human population, over-exploitation, technology, and lifestyle, with fishing being most

**Table 3.6** Agenda 21 of the *Rio Declaration on Environment and Development* provided 27 principles to guide nations through goals and objectives, including a *Program of Action for Sustainable Development*. Section 2, Chapter 17, is on ocean protection; other chapters are identified by title only. Data from UNEP (2013a) Agenda 21. www.unep.org/.

*Rio Declaration on Environment and Development*
Principle 1: "Human beings are at the center of concerns for sustainable development."

*Agenda 21: Program of Action for Sustainable Development*
Sec. I. Social & Economic Dimensions: cooperation to accelerate sustainable development; combating poverty; changing consumption patterns; demographic dynamics and sustainability; protecting and promoting human health; promoting sustainable human settlement development; and integrating environment and development into decision-making.
Sec. 2 Conservation & Management of Resources for Development: atmosphere; land resources; deforestation; desertification and drought; mountains; agriculture and rural development biological diversity; biotechnology; freshwater; toxic chemicals; hazardous wastes; solid wastes and sewage; and radioactive wastes.
Chapter 17: Protection of oceans and all kinds of seas, including enclosed and semi-enclosed seas, and coastal areas and the protection, rational use and development of their living resources.
(A) Integrated management and sustainable development of coastal area, including exclusive economic zones
(B) Marine environmental protection
(C) Sustainable use and conservation of marine living resources of the high seas
(D) Sustainable use and conservation of marine living resources under national jurisdiction
(E) Addressing critical uncertainties for the management of the marine environment and climate change
(F) Strengthening international, including regional, cooperation and coordination
(G) Sustainable development of small islands
Sec. 3 Strengthening the Role of Major Groups: women; children and youth; indigenous people; non-governmental organizations; local authorities; workers and trade unions; business and industry; scientific and technological community; and farmers.
Sec. 4 Means of Implementation: financial resources; transfer of environmentally sound technology; science for sustainable development; education, public awareness, and training; capacity-building in developing countries; institutional arrangements; legal instruments and mechanisms; and information for decision-making.

**Table 3.7** The *Jakarta Mandate on the Conservation and Sustainable Use of Marine and Coastal Biological Diversity* (1995) is a global consensus on the importance of marine and coastal biological diversity and is part of the Ministerial Statement at the Convention on Biological Diversity to implement conservation and sustainable use of marine and coastal biological diversity. Six key thematic issues were identified, being addressed through a multiyear program of work and advocating the ecosystem approach. Data from the Secretariat of the Convention on Biological Diversity (2013). Jakarta Mandate. UNEP (2013a), Agenda 21 online http://www.unep.org/.

| Thematic issues | Operational objectives |
|---|---|
| 1. Integrated marine and coastal area management (IMCAM) | • Review existing instruments<br>• Promote development and implementation at the local, national, and regional levels<br>• Develop guidelines and indicators for ecosystem evaluation and assessment |
| 2. Marine and coastal living resources | • Promote ecosystem approaches to sustainable use of marine and coastal living resources<br>• Make available to parties information on marine and coastal genetic resources |
| 3. Marine and coastal protected areas | • Facilitate research and monitoring activities on value and effects of marine and coastal protected areas, or similarly restricted areas, on sustainable use of marine and coastal living resources<br>• Develop criteria for establishment, management of marine and coastal protected areas |
| 4. Mariculture | • Assess consequences of mariculture for marine and coastal biological diversity and promote techniques to minimize adverse impacts |
| 5. Alien species and genotypes | • Achieve better understanding of the causes and the impacts of introductions of alien species and genotypes<br>• Identify gaps in existing or proposed legal instruments, guidelines, and procedures and collect information on national and international actions<br>• Establish an "incident list" of introductions |
| 6. Ecosystem approach | • Precautionary; science-based; experts; involve local and indigenous communities; three levels ofimplementation (national, regional, global) |

important in marine ecosystems (Millennium Ecosystem Assessment, 2005). These factors also cause loss in ecosystem function and services.

### 3.5.2.2 International maritime law

The *United Nations Convention on the Law of the Sea* (UNCLOS) exemplifies the most advanced and binding international law-making. Its framework was initiated with conferences held in 1930, 1958, and 1960 (UNCLOS, 2012). In 1965, 32 nations claimed 12 nmi territorial seas, increasing to 67 by late 1970s. In 1973, a negotiated framework, signed by 159 nations in 1982 under UNCLOS III and ratified in 1994, illustrated the increasing importance of oceans and the slow process of negotiation. Several industrialized countries objected to provisions for seabed mining (and others) and did not sign the treaty, most notably the United States, Great Britain, and Germany. UNCLOS III represents the most ambitious, most historic, and most far-reaching of international agreements to that time, providing the legal framework for all activities in the oceans and seas with a set of rules for use (UN General Assembly, 2009). Nevertheless, the U.S. claimed 200 nmi marine EEZs by Presidential Proclamation in 1983, followed by 27 countries claiming territories greater than 12 nmi by the beginning of the 21st century; 14 extended claims to 200 nmi, a phenomenon described as "creeping national jurisdiction." The greatest transfer of resources in recorded history thus occurred when UNCLOS III gave nations sovereign rights over all resources, living and non-living through extension of their EEZs seaward to 200 nmi. Sovereignty now divides most ocean space into segments that force nations to agree inter alia on management regimes for shared resources (Fig. 3.4). EEZs for island nations provide jurisdictional extensions that are often many times the size of the nation's land area. UNCLOS III governs the high seas beyond areas of national jurisdiction through consensus and agreement among nations, with the intent that conservation and sustainable use of marine biodiversity should be consistent with the legal framework of UNCLOS.

As a "constitution of the oceans" (MARIBUS, 2012), UNCLOS is among the most notable of maritime agreements (Table 3.8).

**Table 3.8** Major events that influenced international maritime law and facilitated "creeping" offshore jurisdictions. Compiled from Archer *et al.* (1994); Wilder (1998); *Encyclopædia Britannica* (1999–2000) online.

| Date | Event | International Agreement |
|---|---|---|
| 450 AD | Codification of Roman Law. Evolved from law of ancient Rome (735 BC–5th century AD) | Legal system forming western law. Established Law of Procedure and absolute ownership, unlike Germanic systems and English law |
| 529–535 | Freedom of the Seas | First legal document of the sea |
| 1493 | *Mar clausum* by Papal bull *Inter Cetaera* | Gave Spain exclusive rights to land and sea west of Azore Islands |
| 1588 | England defeats *Spanish Armada* | Saved England from invasion and Dutch Republic from extinction. Delivered heavy blow to Spain |
| 1625 | *Mare Liberum* by Hugo Grotius | Freedom of the Seas; seas are international territory; defense for Holland's Dutch East India Company |
| 1702 | *De Dominio Maris*. Von Bynkershoek's cannon-shot rule | Codified coastal states rights to adjoining sea within range of shore-based artillery, about 3 nmi |
| 1793 | President Jefferson claims 3 nmi territorial sea for U.S. | Ripened into globally accepted standard over which a nation could assert ownership of the seas. |
| 1938 | U.S. exploration of Gulf of Mexico outside territorial sea | Oceans beyond 3 nmi fall under international law as common property of all nations. Drilling technology and discovery of oil in Gulf of Mexico spurred U.S. to extend its jurisdiction |
| 1945 | Truman Proclamations: U.S. establishes offshore control | Other nations assert claims. Constricts freedom of navigation |
| 1958 | First UN Conference on Law of the Sea (UNCLOS I); not ratified | Produced four separate conventions: Territorial Seas; Fisheries; Continental Shelf; High Seas. Failed ratification over Rights of Innocent Passage |
| 1960 | UNCLOS II: not ratified. | Nations claim 12 nmi territorial sea |
| 1976 | US Fisheries Conservation and Management Act | Expanded American fisheries jurisdiction from12 to 200 miles, eroding political power of distant-water fishing fleets and increasing coastal fishing |
| 1982 | UNCLOS III: not ratified | High seas resources become *mare nostrum* (our seas). 200 nmi EEZ established |
| 1983 | Reagan Presidential Proclamation 5030 | Declared 200 mile EEZ for U.S., in line with central provisions of UNCLOS III |
| 1994 | UNCLOS III: ratified | All coastal nations claim 200 nmi EEZs |
| 1999 | Clinton Presidential Proclamation | Extends U.S. contiguous zone from 12 to 24 nmi offshore, for enforcement of environmental, customs, and immigration laws |

It gave nations opportunities to evolve their own management strategies without compelling them to do so. It established overarching rules governing all uses of the world's oceans and seas and their resources, containing provisions for enforcing international pollution standards, fisheries soft laws, and binding dispute-settlement procedures. Conflict resolution is placed under the aegis of the signatories themselves, making UNCLOS a unique instrument in international law, with far-reaching implications.

UNLOS III in 1982 established the Commission on the Limits of the Continental Shelf (UNCLOS, 2012) to facilitate implementation of LOS to the outer limits of all nations' territorial sea and continental shelf beyond 200 nmi, constituting a last major redrawing of the world map. With a deadline of May 2009 established for submitting claims, the Commission received 48 national claims for vast extensions of maritime territories that began an undersea land-grab that made boundary demarcation a contentious diplomatic issue. Following the deadline, Russia placed its flag under the North Pole to claim the Arctic, which other Arctic states opposed, e.g., Canada, the United States, Norway, and Denmark. And in the South China Sea, a dispute among nations over the Spratly Archipelago that has plagued the region for decades, even when the Islands lacked economic importance prior to 1982, reflects a unique history of geopolitics when oil was discovered. Under UNCLOS III, islands that can sustain humans or an economic life are entitled to a 200 nmi limit, and title to the contested Spratlys could determine ownership of significant oil and gas resources. As this dispute is unresolved, the eventual outcome rests with the nations involved. To help resolve issues of energy extraction, the autonomous International Seabed Authority established by UNCLOS has developed rules, regulations, and procedures relating to deep seabed mining ("Mining Code").

#### 3.5.2.3 International fisheries

UNCLOS addresses conservation and sustainable use of fishes and marine biodiversity beyond areas of national jurisdiction. Of particular relevance to fisheries is Part V for the EEZ and Part VII for the High Seas. UNCLOS takes a precautionary, ecosystem approach to management due to uncertainty of ocean ecosystems beyond areas of national jurisdiction (i.e., deep-sea ecosystems) and the vulnerability, resilience, and functioning of associated biota. The UN FAO is the only intergovernmental organization worldwide formally mandated by its constitution to undertake fisheries and aquaculture data collection, compilation, analysis, and diffusion of information.

The United Nations General Assembly supports sustainable fisheries on the high seas (A/RES/66/68). Nations and Regional Fishery Management Organizations (RFMOs) manage fisheries to prevent significant adverse impacts on areas identified as vulnerable marine ecosystems (VMEs), a concept described in FAO's *International Guidelines for the Management of Deep-sea Fisheries in the High Seas* (March 2007; Auster *et al.*, 2011). "Vulnerability" is the likelihood that a population, community, habitat, and ecosystem characteristics will experience substantial alteration due to short-term or chronic disturbance (FAO, 2009). Regional implementation, however, is problematic because of a lack of specificity and ecological uncertainties (Auster *et al.*, 2011).

The international, national, and local dimensions of fisheries include legally binding rules that become injected into national policies, legislation, and international treaties. Fisheries governance involves both hard law, such as national laws and international treaties, and soft law that lacks legally binding obligations, such as the FAO Code of Conduct for Responsible Fisheries and FAO International Plans of Action (Lugten, 2006). Since the 1990s, there has been a shift from hard to soft law in fisheries management (Allison, 2001). Soft-law international instruments are carefully negotiated and drafted with a basic understanding of good-faith commitment and a desire to influence the development of state practices. But while such soft-law instruments have substantially increased in number since the 1990s, fisheries have continued to decline, as too many boats seek too few fish.

Strong economic incentives are driving illegal and unreported fishing. Current worldwide illegal and unreported fishing losses total $10 to $23.5 billion annually and remove 11 to 26 million tons of fish (Fig. 2.8), which contributes to over-exploitation of stocks and hinders the recovery of populations (MRAG, 2005; Agnew *et al.*, 2009). At most risk are developing countries whose generally poor fisheries management and lack of control cause loss of major economic benefits, along with high costs of environmental degradation.

Fisheries governance is also hindered by the very uneven distribution of fish, which has been compensated by trade since time immemorial. Trade plays an important role in fishermen's livelihoods, even at the level of "subsistence" fisheries. In recent decades, international fish trade has increased rapidly, facilitated by widespread use of refrigeration, improved transportation, and communications. However, voluntary guideline obligations to curb overfishing are vague (Hewitt *et al.*, 2009) and nations often lack the capacity to undertake resource assessments, to develop management systems, and to effectively monitor user activities.

#### 3.5.2.4 Regional mechanisms

Regional programs have the advantage of matching the geographic scale of many marine resource and environmental issues to large-scale ecosystem boundary conditions, such as for regional seas. Regional initiatives offer comprehensive institutional frameworks for international cooperation and as links to national governance.

The UNEP Regional Seas Programme has played a catalytic role in developing and implementing regional-seas programs since the 1970s (Table 3.9). UNEP facilitates information exchange, response options, and national ocean-management strategies. Regional governments adopt conventions, protocols, and action plans to address transboundary resource problems, pollution, management, institution building, protected areas, and finance.

One of the first and most successful regional agreements was the *Antarctic Treaty* (Table 3.2), which grew out of a scientific program—the International Geophysical Year (1957). This Treaty ensures that Antarctica is used for peaceful purposes, with international cooperation in science. An important innovation was that it suspended national sovereignty. The Treaty's jurisdiction encompasses a natural oceanographic

**Table 3.9** UNEP Regional Seas conventions. Most have many aspects in common; protocols have been added to address priority concerns, of which samples are listed. Dates are for adoption of conventions; many are not yet in force. Several other regional seas programs exist, but many have not yet achieved conventions. Compiled from UNEP (2013) http://www.unep.org/regionalseas/programmes/default.asp.

| Regional Sea | Instrument/administrator | Some major objectives |
|---|---|---|
| Baltic Sea | *Convention on the Protection of the Marine Environment of the Baltic Sea Area* (Helsinki Convention, 1974) | Pollution; protection of biodiversity; alien species; monitoring program; protected areas; integrated watershed management. |
| Northeast Atlantic | *Convention for the Protection of the Marine Environment* (Oslo and Paris conventions, 1974; revised as OSPAR, 1992) | Formulated regional consensus for cooperative actions on resources management and biodiversity. |
| Mediterranean Sea | *Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean* (Barcelona Convention, 1976) | "Blue Plan" for long-term regional, coastal management, emphasizing pollution control and including a protected-area network. |
| Arabian Gulf | *Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution* (Kuwait Convention, 1978) | "Kuwait Action Plan" for combating pollution and for transboundary movements and disposal of hazardous waste. |
| Eastern Africa | *The Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern African Region* (Nairobi Convention, 1985) | Framework strategy for comprehensive approach to coastal area development; major concern for wild fauna and flora; pollution in cases of emergency. |
| West and Central Africa | *Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region* (Abidjan Convention, 1981) | Comprehensive strategy for conservation and development; pollution in cases of emergency. |
| Red Sea and Gulf of Aden | *Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment* (Jeddah Convention, 1982) | Comprehensive strategy for conservation; principal concern is for pollution by oil and other harmful substances. |
| Wider Caribbean | *Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region* (Cartagena Convention, 1983) | Action Plan for Caribbean Environment Program; specially protected areas for wildlife; oil spills; reduction and control of land-based sources of pollution. |
| South Pacific | *Convention for the Protection of Natural Resources and Environment of the South Pacific Region* (Noumea Convention, 1986). | Multilateral cooperation on protection of natural resources, dumping and pollution. |

boundary, the oceanic Antarctic convergence, which encompasses unique biodiversity and significant fishing interests—notably krill, *Euphausia superba*, a basic food for many whales, seals, and penguins. The jurisdiction of the *Antarctic Treaty* was extended in 1980 through the *Convention for the Conservation of Antarctic Marine Living Resources* (CCAMLR), which endorsed ecosystem management. This Treaty has become a model for international cooperation, especially in scientific research; its *Agreed Measures for the Conservation of Antarctic Fauna and Flora* was an important consequence.

The Wider Caribbean is bounded by over 30 island and continental nations speaking English, French, Spanish, and Dutch which have ratified the 1983 *Convention for Protection and Development of the Marine Environment of the Wider Caribbean Region* containing protocols for regional cooperation in pollution control and protected areas and wildlife. The UNESCO-sponsored program Caribbean Coastal Marine Productivity (CARICOMP-1), a cooperative research network of over 25 marine laboratories, synoptically monitored using standardized methods the trends in structure and functionality of coral reefs, seagrasses and mangroves for over 20 years. The data were freely available online through a data management center at the University of the West Indies in Jamaica. CARICOMP-1 is coming to an end in 2013 with the publication of summary papers. A new cooperative network of laboratories, CARICOMP-2, will provide regional scientific input to developing regional programs in ecosystem-based management and regional governance, particularly the Caribbean Large Marine Ecosystem Project (http://www.clmeproject.org/).

FAO has also inaugurated a series of regional commissions and councils. The Intergovernmental Oceanographic Commission (IOC) studies phenomena such as El Niño and its major effects on climate, marine diseases, wildlife, and fisheries. A contentious case concerns the Atlantic bluefin tuna (*Thunnus thynnus*), arguably the world's most valuable fish, managed by the International Council for Conservation of Atlantic Tuna (ICCAT). Between 1970 and 2000, the western-Atlantic population declined to approximately 20% of its spawning stock

biomass. ICCAT set quotas based on the assumption that eastern and western populations are distinct. Recent evidence (Block *et al.*, 2001) indicates that these populations intermix and that the species may not recover until and unless fishing is restricted throughout its entire range.

Despite many successes, decades of international programs have proven weak (Soares, 1998). This is due to gaps between approval of intergovernmental and international conventions, agreements, resolutions, and recommendations and their timely implementation (Hinds, 2003), as well as being hindered by the conflicting goals between resource exploitation and conservation.

## 3.6 MANAGEMENT CONCEPTS

Management is a goal-oriented mechanism for addressing specific policy objectives through strategic action plans under designated authorities (e.g., agencies). Management is a dynamic tool, responding adaptively to new information in a field that too often lacks sufficient information and resources and for which consensus among diverse constituencies must be reached. Marine management concepts are rapidly evolving from sector-based management towards ecosystem-based approaches for solutions to long-term resource issues.

### 3.6.1 Fisheries management

Key principles of traditional fisheries management are the regulation of exploitation and the management of fish stocks. The objective is to regulate fishing activities—when, where, and how to fish—so that fishing becomes sustainable and fish populations remain abundant and healthy. Science plays a key role in policy-directed management, evolving toward ecosystem-based fisheries management (Box 3.5).

The concept of Large Marine Ecosystems (LMEs) is an attempt to define fishery-based ecosystems for areas covering

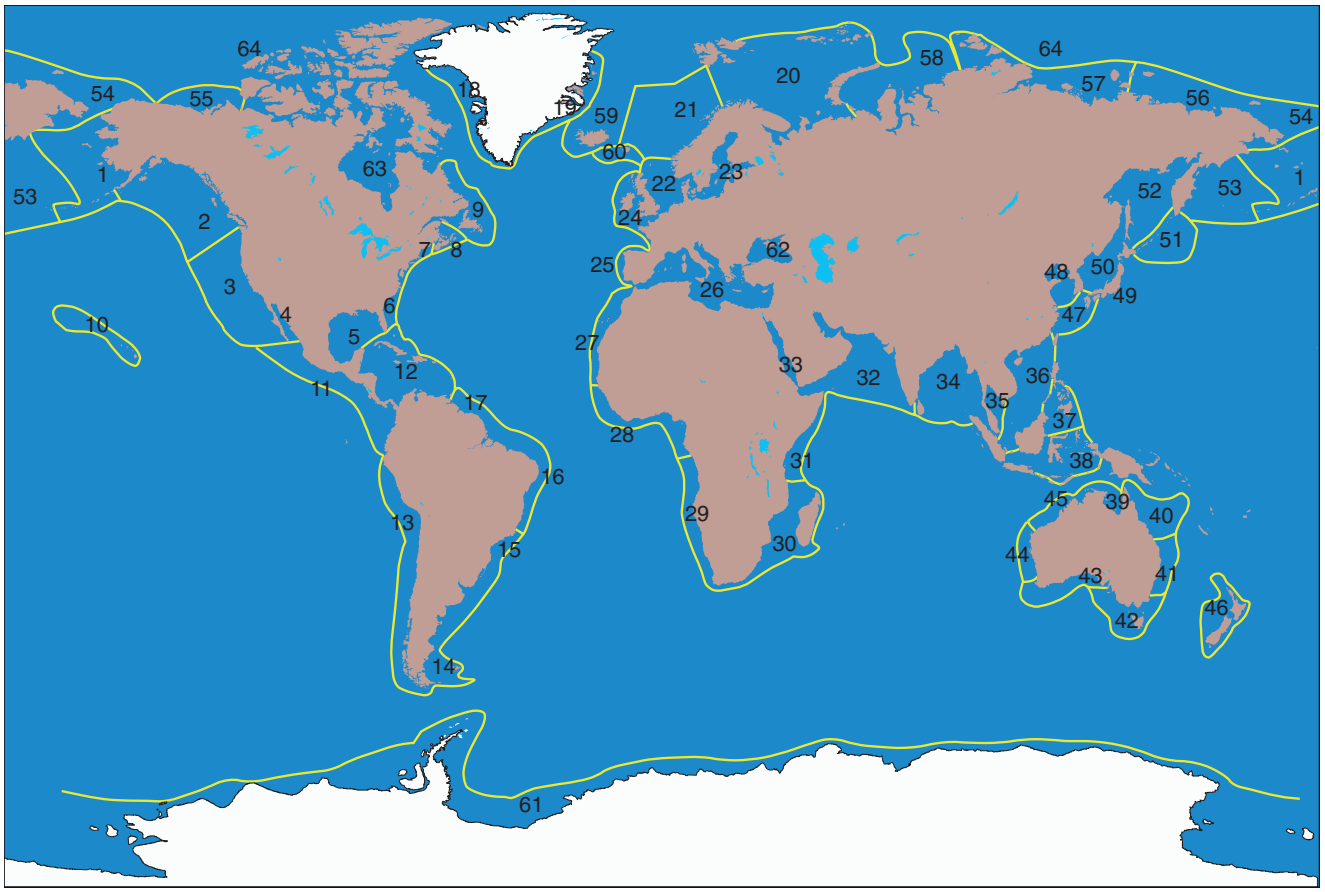


**Fig. 3.5** Large Marine Ecosystems, now 64 in number. This concept incorporates ecosystem-based management, including concern for productivity, fish and fisheries, pollution, ecosystem health, socioeconomics, and governance, and is through a smaller number of international projects. See text for further explanation. From Sherman K, Aquarone MC, Adams S (2007). *Global Applications of the Large Marine Ecosystem Concept 2007–2010*. NOAA Technical Memorandum NMFS-NE-208. NOAA National Marine Fisheries Service, Northeast Fisheries Science Center, Woods Hole, Massachusetts.

200,000 km$^2$ or more of ocean space and characterized by distinct hydrography, productivity, and trophic interactions (Fig. 3.5; Sherman *et al.*, 2009). The 64 designated LMEs contribute approximately $12 trillion annually in ecosystem services to the global economy. Thus, LMEs are as much economic as they are environmental assets. Within many LMEs, however, overfishing is most severe, marine pollution is concentrated, and eutrophication and anoxia are increasing. Since 1995, the Global Environment Facility (GEF, Section 3.7.2) has provided substantial funding to support country-driven projects that introduce ecosystem-based assessment and management practices for the recovery and sustainability of LME goods and services (NOAA, online).

### 3.6.2 Coastal management

Coastal management incorporates complex interactions of laws, programs, and efforts to evaluate trade-offs and make decisions about how to use, conserve, and value resources and opportunities within the coastal realm (Frontispiece, Ch. 4). Coastal areas are important economic zones and are valued for their ecosystem functions and services. Finding the right balance between conservation and use engages all levels of government, research institutions, private citizens, industry participants, and non-governmental organizations (considered as "stakeholders") for establishing priorities and zoning, resolving user conflicts, and gaining partnerships among multiple levels of government and the public.

The coastal management planning process is distinguished by consensus building, generally conceived as a set of public goals or policies, a framework of procedures for carrying out those policies, and a set of organizations or agencies to implement procedures. A significant challenge is adopting land-sea interactions within an ecological unit (Ch. 4) for management and resolving conflicts among users.

Integrated coastal zone management (ICZM) is a conceptual extension of CZM, strongly influenced by UNCED as set out in *Agenda 21, Chapter 17*. By shifting toward predominantly bottom-up approaches among stakeholders, and by increased emphasis on long-term intergenerational sustainability, ICZM attempts to overcome single-sector management, fragmented

## Box 3.5 Fisheries science: acquiring knowledge to support policy and management

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### What is fisheries science?

Fisheries science broadly seeks to understand processes that control the dynamics and well-being of exploited fish and invertebrate populations and to predict their responses to fishing mortality. As such, fisheries science is quantitative ecology that investigates issues related to life history, population dynamics, habitats, and trophodynamics. It is a mix of fundamental and applied science conducted in support of policies enacted to assure sustainable fisheries. Policies generally are the legislative or executive mandates requiring responsible stewardship of fisheries and other marine resources. Fisheries science also serves resource managers who use scientific knowledge of fish population biology, habitats, predators, and prey to devise appropriate regulations for meeting policy goals. Scientific knowledge and advice often are delivered to managers in the form of numerical models to guide designation of catch targets and thresholds that guard against overfishing. Managers usually sit on commissions or in agencies with regional jurisdiction. In the United States, this translates into eight regional Fisheries Management Councils that strive to conduct their business (rules and regulations) based on the "best science available," thus carrying out the sustainable fishery policy required by the *Magnuson-Stevens Fishery Conservation and Management Act*.

In the past 50 years, the scope of fisheries science has broadened from principally addressing questions on population dynamics and demographics to inclusion of broader ecological research on effects of the environment, consequences of heavy fishing on predator-prey interactions, climate change, and effects of contaminants, pollutants, and disease. As requirements for ecosystem-based fisheries management have evolved, this "new" fishery science is increasingly conducted by research teams with broad interdisciplinary expertise.

### Science to serve management

Two kinds of science, referenced here as Modes 1 and 2, serve fisheries management. Both are important for acquiring knowledge that managers use in addressing widespread overfishing in marine ecosystems. Mode 1 rests firmly on traditional science goals; it must be objective, legitimate, credible, and transparent. These classic criteria describe the science of discovery. Mode 1 fishery science is fundamental inquiry on the biology, ecology, and dynamics of fish populations or stocks (segments of a population) and usually is conducted in research laboratories and institutions by individuals or small research groups. Graduate student thesis research and other in-depth investigation into fish biology, ecology, and demographics fall into this mode. Mode 1 science can be slow and deliberate, must stand up to peer review and, by itself, usually is not sufficient to serve the impatient needs of fisheries management and policy. Consequently, fishery science has become increasingly reliant on Mode 2 science. Mode 2 science generally is sharply focused on answering management questions in a timely manner. It can consist of fundamental investigations or

modeling research, or be a synthesis of scientific knowledge. It is usually conducted by teams and depends on consensus building by collective expertise of technical committees or advisory groups. Mode 2 fishery science frequently is delivered as a product of "Stock Assessment Workshops" hosted by management agencies or commissions. It may be sponsored by government, industry, NGOs, and sometimes special interests, and is conducted at regional levels (for example, blue crab in Chesapeake Bay) or national-international levels (for example, bluefin tuna in the Atlantic Ocean). Mode 2 science under the best circumstances is objective and transparent; it may or may not be subjected to rigorous peer review. Expert groups conduct assessments and often synthesize vast amounts of information on fish biology, population dynamics, habitats, hydrography, interacting species, and socio-economics for management agencies, either directly or via prestigious sponsoring institutions (e.g., National Research Council). In broad context, Mode 2 fishery science is the approach by which global and regional issues are being addressed, for example, climate change and its effect on productivity of ecosystems, and interactions with fisheries.

A large share of conservation and fishery science now consists of research on degraded ecosystems, depleted fish populations, and on effects of fishing on ecosystems. As policies evolve and we adopt precautionary, ecosystem-based approaches in fisheries management, the need to conserve ecosystem services, as well as manage for high, sustainable fishery yields, is becoming increasingly prominent. Traditional management institutions may require diversification and restructuring to manage fisheries in the broader context of ecosystem-based management. These needs are highly evident in stressed coastal ecosystems and estuaries such as Chesapeake Bay. As such, a combination of fundamental, in-depth science on the ecology of organisms and habitats (Mode 1) and synthetic science to advise management (Mode 2) provide complementary pathways to: (i) rebuild fisheries—for example, blue crab; (ii) to maintain restored fisheries—for example, striped bass; and, hopefully, the knowledge to (iii) restore collapsed fisheries—for example, oysters and American shad. Historically, the emphasis of fisheries science was provision of knowledge and advice to support single-species management. Recently, the emphasis has shifted and needs for knowledge on multi-species interactions, essential fish habitat, effect of fishing on the ecosystem and on untargeted organisms (the bycatch), and conservation of ecosystem services have become dominant themes for modern fisheries science that supports ecosystem-based management.

jurisdictions, and hierarchical command-and-control procedures. Thus, ICZM aims to achieve sustainable resource use among various economic and environmental sectors, but is challenged by insufficient attention to integration of economic, social, and political forces within ecological boundaries. Nevertheless, ICZM remains highly attractive as a unifying concept, providing for collaboration, communication, coordination, and information exchange among multiple disciplines and various sectors.

### 3.6.3 Marine Protected Area management

MPAs are managed for environmental and biodiversity protection, and for scenic or socio-economic values. They encompass many different management types, from strict protection to multiple use, carried out by public and private organizations, and within distinct management regimes (UNEP, 2009). Many do not restrict fishing, and some do not restrict oil and gas extraction. The largest MPAs (Section 3.3) are managed under a range of different management concepts. Australia's Great Barrier Reef Marine Park (GBRMP), established in 1975 for coral-reef conservation and marine spatial zoning, permits human activities that include fisheries and tourism while seeking high-level protection in specific areas. Its management agency, the Marine Park Authority, was established through an Act of Australia's Parliament. The largely unspoiled U.S. Papahānaumokuākea Marine National Monument that protects coral reefs, atolls, shoals, and islands is managed as a permanent "no-take" marine reserve through Presidential Proclamation 8031. Britain's Indian Ocean Chagos Marine Reserve is managed as a Strict Nature Reserve, and in the Pacific Ocean Kiribati's Phoenix Islands Protected Area Trust restricts fishing, being managed through cooperative partnerships financed through an endowment. These large remote areas of the ocean invite tourism and ecotourism opportunities, enhancing economic opportunities for island people.

### 3.6.4 Biosphere reserves

Biosphere reserves are internationally recognized under UNESCO's Man and the Biosphere Programme. They intend to integrate conservation with human activities, being a first attempt to institute a concept of hierarchical spatial planning by means of recognizing core, buffer, and transition zones. Today, the global network includes 580 sites in 114 countries (UNESCO, 2011); only a few are coastal-marine (Ch. 11). Biosphere reserves include three interconnected functions: conservation, development, and logistics. Appropriate zoning schemes combine core protected areas with surrounding buffer and transitional zones and are thereby particularly suitable for marine application. Local stakeholders, often with highly innovative and participatory governance systems, foster sustainable development. Biosphere reserves also foster dialogue for conflict resolution over natural resources by integrating cultural and biological diversity and traditional knowledge in management. They also can demonstrate sound sustainable practices and policies based on research and monitoring and act as sites of excellence for education and training.

Biosphere reserves have no force in international law, but can become legally official through national authority. As such, they can build and promote a global network of places designed to mesh human activity with biological and scenic assets according to community mechanisms.

### 3.6.5 Restoration management

Restoration management is increasingly becoming a major conservation priority, borne from the recognition of pervasive species depletions and ecosystem degradation. The goal of restoration is not necessarily to restore ecosystems to a pristine condition, due to the shifting baseline phenomenon (Dayton *et al.*, 1998, Jackson *et al.*, 2011) whereby identification of original, pristine conditions cannot be known. Rather, the goal is to renew degraded, damaged, or destroyed ecosystems through active human intervention, to prevent further degradation, and to achieve sustainable ecosystem states. Restoration of an area's natural resources, habitats, and services to some sustainable, resilient state is viewed as essential.

An active and growing area of marine restoration ecology involves government-mandated restoration of natural resources injured by human-use incidents, such as oil and chemical spills, pollutant releases, or physical destruction of habitat (Peterson and Kneib, 2003). U.S. federal laws, notably the *Comprehensive Environmental Response, Cleanup, and Liability Act* (CERCLA) of 1980, and the *Oil Pollution Act* (OPA) of 1990, dictate that restoration actions be undertaken to provide equivalent compensation for losses or injuries to natural resources held in public trust and to the ecological services that those resources would have provided (Burlington, 1999). Biodiversity restoration requires many management tools, which include sustainable fisheries management, pollution control, maintenance of essential habitats, and the creation of marine reserves. In this way, society invests in the productivity and reliability of the ecological goods and services that coastal ecosystems and oceans provide to humanity (Worm *et al.*, 2006).

### 3.6.6 Ecosystem-based management

Ecosystem-based management (EBM) is being widely considered as an effort to conserve species, maintain biodiversity, and to place human uses in an environmental context (McLeod and Leslie, 2009; Ch.13). It strives for integration of all management concepts mentioned above by focusing on protection, restoration, and management of functioning ecosystems within a spatially designated area as conceived in marine spatial planning (MSP; Ch. 13). It adopts ecosystem and precautionary principles as means for addressing the ecological impact of fisheries, environmental degradation, and other human-caused effects, while maintaining ecological integrity and vital economic interests that benefits society, e.g., healthy seafood, clean beaches, ocean benefits, and reducing the consequences of expanding anoxic and hypoxic zones.

EBM is made explicit in the *Marine Mammal Protection Act*, the *Magnuson-Stevens Fishery Conservation and Management Reauthorization Act*, and CCAMLR. Scientists and managers see challenges as to how to maintain the resiliency of systems that provide critical ecosystem services while also overcoming undesirable phenomena (Levin and Lubchenco, 2008). EBM assumes that uncertainty requires precaution and that new information requires adaptive management, which strongly suggest that EBM is experimental, requiring a strong element of research and monitoring. Thus, achieving positive results involves collaboration among biological, environmental, social sciences, as well as public understanding for promoting government policy.

## 3.7 AGENTS FOR CONSERVATION

Social movements, scientific evidence, financial institutions, and conservation groups that spur action have the capacity to sustain conservation efforts by altering public opinion, mobilizing voters, and/or creating new, non-legal norms of behavior and changed values. These can change the direction of society and alter the abuse of resources.

### 3.7.1 Environmental non-government organizations (NGOs)

People power has achieved national and international importance through non-governmental organizations (NGOs). NGOs are exceedingly diverse in their interests and methods, but together form effective communication channels among policy, politics, science, and the public. Tens of thousands of NGOs exist worldwide, only about half of which in developing nations are older than a decade or two, but until recently coastal-marine programs were relatively neglected. Most NGOs are non-profit and depend on voluntary efforts and contributions, with their survival often depending on the courage and persistence of a few dedicated individuals. Only the largest and most powerful have scientific expertise; others may develop ties with universities and government research organizations. NGO interests are overwhelmingly directed towards crisis situations, such as charismatic endangered species, depleted fisheries, habitat protection, and environmental pollution, with programs often lacking comprehensive strategies. Notable exceptions concern strategies for "hot spots" of species richness and biodiversity protection via public or private protection. NGOs are constrained to raise most of their funds by marketing issues that are attractive to the public. Programs for coral reefs, wetlands, sea turtles, marine mammals, and most recently "no-take" fisheries reserves have gradually intensified since the 1990s through the efforts of NGOs.

The first NGO of global significance was the International Union for the Conservation of Nature and Natural Resources (IUCN, the World Conservation Union) in 1948. IUCN has since grown into a large organization with worldwide influence and strong connections with the UN and national governments. Other national and international NGOs emerged, especially from the 1960s onwards and mostly in the developed world. Many then tended towards emotional "animal welfare" issues, but since that time their scientific credibility has grown significantly. Each NGO employs a variety of tactics

to promote species protection and/or environmental conservation. Lawsuits represent a sample of NGO actions that are effectively used to promote environmental protection and to influence environmental policy-making and enforcement. Interest in the marine environment has also increased substantially, principally through using charismatic species—polar bears, whales, seals, tuna, sea turtles, corals etc.—as metaphors for climate change, over-exploitation, oil spills, and the like.

Many NGOs work closely with UN agencies to play important roles in numerous environmental conventions. Collaborative partnerships are continually formed to advance conservation in innovative ways. UNEP, FAO, and NGOs often work together on fisheries management to blend fisheries and conservation in MPAs. Throughout the world, community groups are organizing around coastal watersheds for regional spatial planning and management. Separately, or occasionally en masse, NGOs lobby governments, publicize information of strategic importance, and influence international conferences. They can be major actors in negotiation, as reflected at the Rio Conference in 1992, where more than 1400 NGOs were accredited to participate in discussions leading to conventions on biodiversity and climate change. Coalitions of NGOs continue to be represented at many international meetings, such as those of the *International Whaling Commission*, *London Dumping Convention*, and *Convention on International Trade in Endangered Species*. NGOs have also pressured international institutions to enlarge their environmental activities. Thus, NGOs have become a powerful force, influencing the direction of environmental and development policies through advocacy and "on-the-ground" action.

### 3.7.2 Development and financial assistance organizations

Conservation actions require considerable financial support. Funds come from development banks, national agencies, private foundations, and other sources (Table 3.10). The World Bank is a significant funding source, a partner in environmental programs, and a primary funder for projects to support the *Biodiversity Convention* and the *Stockholm Convention on Persistent Organic Pollutants* (POPs), among others. The International Monetary Fund (IMF), established in 1944 by the UN, enables countries (and their citizens) to act with one another to ensure the stability of the international monetary system, which is

**Table 3.10** International banks and funds. Examples. The World Bank and the UN have almost the same membership. International funding is competitively available through international, intergovernmental organizations, such as the Global Environmental Facility. Coastal-marine resources receive small portion of total funds available, proportional to public interest. From www.imf.org; web.worldbank.org; www.undp.org; www.iadb.org/.

| Name | Formation–goal | Functions |
|---|---|---|
| World Bank (WB, 1944) | Integrates nations into wider world economy; promotes long-term economic growth to reduce poverty in developing countries. Program on Global Sustainable Fisheries Management and Biodiversity Conservation in Areas Beyond National Jurisdiction | Largest single source of development lending; exerts policy leadership; trustee for Global Environment Facility (GEF) Trust Fund, an independent international financial entity created (1991) by UNEP, UN Development Program, and World Bank to help developing countries deal with environmental concerns |
| International Monetary Fund (IMF, 1944) | Monitors world currencies; helps maintain orderly system of payments between countries; lends money to members with serious imbalance of payments | Major influence on development policies of developing countries; monitors transactions in international trade and investment |
| UN Development Program (UNDP, 1965) | Provides developing nations with policy advice on a range of issues pertaining to poverty, institutional capacity, and globalization | Assists nations and territories; *Capacity 21* was launched at UNCED (1992) to assist nations implement *Agenda 21*; as of 2001, *Capacity 21* supported 21 efforts in 75 nations |
| Development Banks | Provide financial support and professional advice for economic and social development in developing countries | *Four Regional Development Banks*: African; Asian; European Bank for Reconstruction and Development; Inter-American Development Bank Group; The World Bank Group<br>*Multilateral Financial Institutions*: European Commission (EC) and European Investment Bank (EIB); International Fund for Agricultural Development (IFAD); Islamic Development Bank (IDB); The Nordic Development Fund (NDF) and The Nordic Investment Bank (NIB); OPEC Fund for International Development (OPEC Fund) |

essential for promoting sustainable economic growth, increasing living standards, and reducing poverty (IMF.org, online). Most public and private development and assistance organizations work closely with UN agencies (Table 3.4). Their main objectives are to assist developing nations in policy development, national strategies, infrastructure, and specific conservation projects. Private philanthropic organizations, particularly in the U.S., also fund environmental projects worldwide; e.g., the *Census of Marine Life* (Ch. 5).

Multinational development banks have often supported economic development projects with deleterious environmental consequences. But pressures from governments, NGOs, and the public have gradually influenced them to be more concerned with conservation. Hence, most multinational banks have adopted policies for sustainable development, with specific goals for biodiversity, fisheries, ocean law, shipping, pollution, global climate change, regional seas, freshwater, and related issues. The GEF is a cooperative effort of UNEP, the United Nations Development Programme (UNDP), and the World Bank, and is influential in supporting biodiversity conservation in developing nations. The GEF, participating countries, and other donors have provided significant support for LME projects. Unlike development banks, the World Trade Organization deals with global rules of trade among nations. Its main function is to ensure that trade flows as smoothly, predictably, and freely as possible.

A variety of assistance organizations are also promoting economic instruments that increasingly are being accepted as means to change human behavior. Economic incentives are being applied to protect forests and fisheries and to establish and manage protected areas. Many economic incentives address the "externality" costs of resource depletion and pollution such that producers, transporters, and consumers face full social and environmental costs of pollution and resource extraction. For example, the "polluter pays principle" reflects a shift in the burden of proof. Assistance organizations do not generally support scientific research per se, but may support assessment and monitoring programs that influence management. The PEW Charitable Trust, for example, is an independent nonprofit that serves the public interest by providing information, advancing policy solutions, and supporting civic action, and has been especially effective by focusing on problems of climate change and large-scale protection of the global marine environment. Its *Global Ocean Legacy* program has supported creation of Large Ocean Reserves. The Sloan Foundation was the main supporter of the *Census of Marine Life* (Box 5.1).

## 3.8 CONCLUSION

Coastal and marine environmental change is forcing society to confront a paradox: conserve and restore diminishing marine assets as demands for ocean use intensify. Addressing this paradox requires a better understanding of marine science (Chs. 4, 5) and the challenges that each case study presents (Chs. 6–12). The need is to connect conservation mechanisms to issues at appropriate scales, with an understanding of ecosystem performance and resiliency, social justice, and equity. Challenges to national sovereignty, good governance, and ocean protection are emerging in the 21st century from the formation of gigantic economic trading blocs and megacorporations, from rapid communications along the information highway, and from privatization. Solutions require innovative thinking in order to achieve sustainable use, to diminish or halt the loss of biodiversity, and to promote environmental sustainability.

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