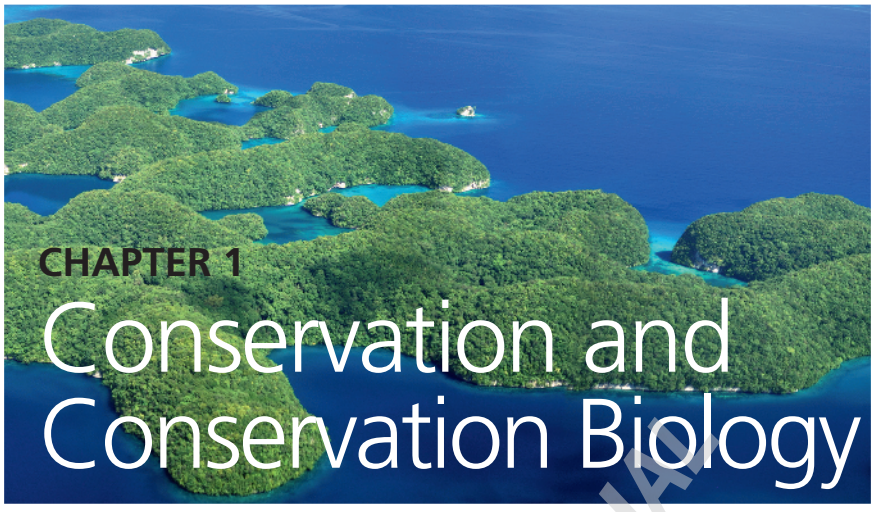

CHAPTER 1

Conservation and Conservation Biology

What Is Conservation?

Since the beginning of humanity people have been concerned about their environment and especially its ability to provide them with food, water, and other resources. As our numbers have grown and our technology has developed, so has the impact we are having on our environment, and thus we are becoming increasingly concerned. Media everywhere proclaim the current issues:

- "Conservationists call for tighter fishing regulations."
- "Ecologists describe consequences of warmer climates."
- "Environmentalists criticized by chemical industry."
- "Preservationists seek more wilderness."

These headlines also reveal an ambiguous terminology. Are we talking about conservation or preservation? Are the issues ecological or environmental? Students deciding which university to attend and which major to select are faced with a bewildering array of choices – soil and water conservation, environmental studies, natural resource management, conservation biology, wildlife ecology, human ecology, and more – that intertwine with one another. In this chapter we will try to resolve these ambiguities by examining how they are rooted in human history and ethics. To start on common ground we explore the key differences and similarities among conservationists, preservationists, environmentalists, and ecologists. In the second part of the chapter we will see where conservation biology fits into this picture.

A *conservationist* is someone who advocates or practices the sustainable and careful use of natural resources. Foresters who prudently manage forests, hunters and fishers who harvest wild animal populations sustainably, and farmers who practice the wise use of soil and water are all conservationists.

Fundamentals of Conservation Biology, Fourth Edition. Malcolm L. Hunter, Jr., James P. Gibbs and Viorel D. Popescu.

Companion website: www.wiley.com/Conservation-Biology4e

Citizens who are concerned about the use of natural resources are also conservationists and sometimes they assert that the activities of foresters, fishers, farmers, and other natural resource users are not prudent, sustainable, or wise. In theory, arguments over who is, or is not, a conservationist should turn on the issue of what is sustainable. In practice, most foresters, farmers, ranchers, and others – many of whom are careful stewards of the lands and waters they control – have ceded the title "conservationist" to their critics.

A *preservationist* advocates allowing some places and some creatures to exist without significant human interference. Most people accept the idea that conservation encompasses setting aside certain areas as parks and protecting certain species without harvesting them. The divisive issues are: how many and which areas, and which species. Many resource users believe that enough areas have already been closed to economic use, and they use "preservationist" as a negative term for people they consider to be extremists. Ironically, in the case of some set asides, like marine reserves, their preservation boosts fish harvests in surrounding areas. Nevertheless, because of this pejorative use, relatively few people call themselves preservationists. People who find themselves labeled preservationists by others usually prefer to think of preservation as just one plank in their platform as conservationists.

An *environmentalist* is someone who is concerned about the impact of people on environmental quality in general. Air and water pollution are often the proximate concerns; human overpopulation and wasteful use of resources are the ultimate issues. There is enormous overlap between environmentalists and conservationists. Many environmentalists would say that environmentalism encompasses conservation, while many conservationists would say the reverse. The difference is a matter of emphasis. By focusing on air and water pollution and their root causes, environmentalists often emphasize urban, suburban, and agricultural situations where human-induced problems and human well-being are paramount. Because conservationists focus on natural resource use, they tend to emphasize the rural areas and wildlands where natural resources are most abundant, as well as associated ecosystems and organisms, including people who might live there.

Traditionally, an *ecologist* is a scientist who studies the relationships between organisms and their environments. However, in the 1970s when concern for the environment first bloomed widely around the planet, the term developed a second meaning when the public failed to distinguish between environmentalists (activists) and the scientists (ecologists) who provided the scientific basis for the environmental movement. Now "ecologist" is often used in the popular press as a synonym for "environmentalist." Given this, a broader definition of an ecologist is a person who is concerned about the relationships between organisms (including people) and their environments.

Recently, these distinctions have become controversial and fuzzy, following a call for a "new conservation" that focuses on the benefits that nature provides for people (Kareiva and Marvier 2012) and the ways that people and nature depend on one another. This "conservation for people" movement is controversial because other people believe that conservation should also recognize the intrinsic value of nature (see next section). It is fuzzy because

people on both sides of the argument have lost sight of the fact that the origins of conservation (also see next section) were largely centered on human welfare (Hunter et al. 2014).

In summary, ever-evolving attitudes and perceptions are at the root of the confusion over who are conservationists, preservationists, environmentalists, and ecologists; each term persists because it has some utility in describing the diverse ways people interact with their environment.

A Brief History of Conservation

The roots of conservation are lost in prehistory (Fig. 1.1). No doubt there was a time when human reason, growing ever more sophisticated through the millennia, began to extend the idea of deferred gratification ("save this fruit to eat tomorrow rather than now") over much longer periods. Keep in mind that for 99% of our history as a species we were living in small, self-regulating groups of humans entirely dependent on wild species. Thus conservation has long been intrinsic to our welfare as expressed in the form of edicts and practices such as "Leave these tubers so there will be more next year when we pass this place." Or "Do not kill the pregnant females in this herd of peccaries so next year we will have even more to eat." Or "Nobody shall hunt in that sacred area near our home grounds." Certainly, such practices were simple, almost analogous to the food caching exhibited by many animals, but they were widespread and effective in governing human activity and represent conservation nevertheless. They remain relevant to this day, most notably in

Figure 1.1 The roots of conservation can probably be found among the earliest *Homo sapiens* such as the people who painted this mural in the Lascaux cave in France. (Thipjang/Shutterstock)

the practices of indigenous people who still live subsistence lifestyles in self-regulating societies using wild species (Berkes and Turner 2006).

Leaping forward, history records many examples of conservation throughout the ages and across cultures. For example, the biblical story of Noah's ark remains a popular metaphor for conservation, and the Bible also codifies the first-known game conservation law:

> If you come on a bird's nest, in any tree or on the ground, with fledglings or eggs, with the mother sitting on the fledglings or on the eggs, you shall not take the mother with the young. Let the mother go, taking only the young for yourself, in order that it may go well with you and you may live long. (Deuteronomy 22:6–7)

(In other words: don't kill mother birds.)

A far broader law was promulgated by Asoka, emperor of India 274–232 BCE:

> Twenty-six years after my coronation I declared that the following animals were not to be killed: parrots, mynahs, … wild geese, … cranes, bats, queen ants, terrapins, … tortoises, and porcupines, squirrels, twelve-antler deer, … rhinoceroses, … and quadrupeds which are not useful or edible…. Forests must not be burned.

Many laws focused on regulating rather than prohibiting the exploitation of species. For example, Middle Eastern pharaohs issued waterfowl hunting licenses, and night hunting was banned in the city-states of ancient Greece (Alison 1981). Early regulations emphasized trees and birds, mammals, and fish caught for food, but all species and whole ecosystems benefitted from the popularity of declaring preserves. Starting at least 3000 years ago with Ikhnaton, king of Egypt, and continuing with the royalty of Assyria, China, India, and Europe, as well as with the Greeks, Romans, Mongols, Aztecs, and Incas, history has recorded many decrees setting aside land to protect its flora and fauna (Alison 1981).

Conservation was an issue during the period when European states were colonizing the rest of the world because colonization often led to disruption of traditional systems of natural resource use and rapid overexploitation. Freedom from European game laws was a significant stimulus to colonization, and hunting was a major preoccupation of the colonizing class. Imagine how attractive the promise of abundant, freely available game would seem to people who feared for their lives whenever their appetite for meat led them to poach one of the king's deer. This phenomenon was particularly true on some small, tropical islands such as Mauritius and Tobago, and continental Africa (Grove 1992, 1995; Prendergast and Adams 2003).

Of course game species did not fare well under the onslaught of hungry colonists and soon regulations had to be enacted. For example, as early as 1639

it was illegal to kill deer between May 1 and November 1 in parts of Rhode Island (Trefethen 1964) and the Cape Colony in southern Africa had game laws by 1822 (MacKenzie 1988). This basic pattern – human populations growing, developing new technology for using natural resources, leaving crowded places and colonizing new lands, disrupting and displacing native peoples and their long-standing practices in these colonized areas, and then responding to overexploitation and expanding population with an array of ever more restrictive regulations – has been repeated across the globe and continues to this day.

With increasing human impacts, the abuse of resources other than trees and large animals also began to be recognized, albeit slowly, for species that lack obvious economic value such as most invertebrates, small plants, amphibians, and reptiles. Aldo Leopold (1949) called for saving every species with his well-known admonition, "To keep every cog and wheel is the first precaution of intelligent tinkering," but it was not until the 1960s and 1970s that the idea of "endangered species" (so imperiled that they were about to disappear from the face of the Earth forever) became a major issue for conservationists. During this period many nations passed laws (e.g. the United States Endangered Species Act) to form an umbrella under which all animal and plant species threatened with extinction could, in theory, benefit from conservation intervention. In practice, however, plants and smaller animals still are not given equal treatment, and other components of biodiversity such as microorganisms, genes, and ecosystems are usually not explicitly under the umbrella at all.

This brings us to the point of departure for conservation biology and this book, but first let us briefly return to preservation, environmentalism, and ecology to see how they mesh with the larger history of conservation.

Preservation

The roots of preservation are probably almost as ancient as the origins of spirituality. When religious leaders began to set rules for society, some species were protected as totems and some places like certain mountains were recognized as sacred and thus decreed off-limits or visited only on religious occasions (Fig. 1.2). Moving ahead many millennia, the establishment in 1872 of Yellowstone National Park, the world's first national park, is often identified as the beginning of governmental policy codifying the value of preservation. Here were nearly 10,000 square kilometers of evidence that society valued the landscape's sacredness; that its aesthetic qualities (particularly striking geological features like geysers and hot springs) justified removing some natural resources from the path of economic development. The national park movement has developed throughout the world and has been modified in many ways. Some preserves are off-limits even to visitors, such as the many zapovedniks (strictly protected areas) of Russia, while some parks, especially in Europe and India, maintain traditional cultural practices such as historic livestock grazing regimes. Nevertheless, the underlying value system remains largely intact. This same preservationist value system has also curtailed the exploitation of some species, such as various kinds of

Figure 1.2 Mount Fuji [*top*] has been a sacred mountain for the Buddhists and Shintoists of Japan for many centuries. (Tofoli.douglas/Flickr/Public domain) For the indigenous people of the Pacific Northwest, totem poles [*bottom*] often depict species that represent family identity and history, and have a sacred role in their culture. (Bernard Spragg/Flickr/CC0)

whales and songbirds, in many places. Obviously, species that are on the brink of extinction are slated for preservation, but others are simply species for which preservation has been deemed preferable to utilization. Many countries, for example, have banned the harvesting of all songbirds even though some species could be harvested in a sustainable manner.

Environmentalism

The first environmentalists were probably citizens of our earliest cities, more than 2000 years ago, who demanded sewers and chimneys to mitigate the impact of water and air pollution, respectively. For example, the Cloaca Maxima (which literally means "greatest sewer") was built in Rome around 600 BCE. The industrial revolution accelerated urbanization and brought its own problems such as coal burning and factory discharges into water bodies. Environmental issues became much more high profile after publication of Rachel Carson's 1962 treatise on pesticides, *Silent Spring*, and a global environmental movement finally coalesced at the first United Nations Conference on the Human Environment, in Stockholm in 1972. This event marked the beginning of an era of considerable effort toward environmental protection at the global, national, and local levels with many organizations created, laws passed, and treaties ratified.

Ecology

The elements of modern ecology can be traced to Hippocrates, Aristotle, and other Greek philosophers, but it was probably Alexander von Humboldt (1769–1859) who first articulated truly sophisticated ecological ideas, for example linking air pollution and deforestation to climate change (Wulf 2015). Nevertheless, the word "ecology" was not coined until 1869. Scientific societies of ecology and ecology journals followed in the early 1900s, and ecology soon proved useful in developing a scientific basis for forestry and other areas of natural resource management. However, ecology did not move into the public eye until the advent of environmentalism. As the environmental movement spawned new government agencies, advocacy groups, and consulting firms, universities educated large numbers of young ecologists to fill these organizations. Schools at all levels began informing students about the relationships between organisms and their environment. Consequently, there are now many professional ecologists and other experts who focus on the science of solving environmental problems, and many more people who are activists and call themselves ecologists out of concern for these issues.

An Overview of Conservation Ethics

It is easy to describe the history of conservation in terms of political benchmarks such as the passage of laws, but these are only a manifestation of a more fundamental process: the evolution of human value systems or ethics with respect to the environment. We will encounter conservation ethics in many chapters and will focus on the topic in Chapter 15, "Social Factors," but a brief preview here will complement our history of conservation and will provide a foundation for later chapters. To do so, we place conservation ethics into an historical context using three people – John Muir, Gifford Pinchot, and Aldo Leopold – as the vehicles to describe three fundamental ethics that

underpin conservation today: the Romantic-Transcendental Preservation Ethic, the Resource Conservation Ethic, and the Evolutionary-Ecological Land Ethic, respectively (Fig. 1.3) (Callicott 1990).

The *Romantic-Transcendental Preservation Ethic* became the basis for political action, most notably in the hands of John Muir (1838–1914), the writer and naturalist who founded the Sierra Club. Muir believed that communion with nature brings people closer to God (thereby providing a "transcendent" experience) and that visiting ancient forests and alpine meadows for this purpose is morally superior to using them to cut timber or graze livestock. In other words, nature is a temple that is sullied when people exploit it. Obviously, such an ethic puts a high premium on establishing parks to preserve nature.

At about the same time that Muir was calling for extensive preservation, Gifford Pinchot (1865–1946) was formulating a very different value system, the *Resource Conservation Ethic*. Pinchot was a forester and politician and founder of the US Forest Service. To Pinchot, nature consisted solely of natural resources that should be used to provide the greatest good for the greatest number of people for the longest time. This was not a call to plunder the land but rather to use it in a way that distributes benefits fairly and efficiently among many people, rather than among a few lumber barons and cattle kings, as was largely the case in his day. It also advocated wise, judicious use of natural resources so that future generations would not be shortchanged. By recognizing aesthetics as a resource, the Resource Conservation Ethic even found room for a modest amount of preservation to accommodate

Figure 1.3 Put yourself in the shoes of John Muir, Gifford Pinchot, and Aldo Leopold to view this landscape. How does this influence your perspective? (James P. Gibbs, author)

Transcendental philosophers and Romantic poets. Given these precepts and a history of overexploitation, Pinchot believed that natural resources should be owned or regulated by government.

Although there was a profound gap between Muir's and Pinchot's ethics, they both espoused an anthropocentric (people-centered) view of nature. They both wrote of nature's utility — its *instrumental value* in the terminology of philosophers. One promoted nature as a source of spiritual enlightenment, the other as a source of commodities, but neither claimed that nature had *intrinsic value,* value independent of its usefulness.

With the emergence of the science of ecology and the writings of Aldo Leopold (1886–1948) – known as the founder of wildlife conservation as a professional discipline and, ironically, a man who began his career eradicating predators but ended it as a strong advocate of wilderness – one finds a utilitarian perspective of species being questioned:

> Ecology is a new fusion point for all the sciences. The emergence of ecology has placed the economic biologist in a peculiar dilemma: with one hand he points out the accumulated findings of his search for utility or lack of utility in this or that species; with the other he lifts the veil from a biota so complex, so conditioned by interwoven cooperations and competitions, that no man can say where utility begins or ends. (Leopold 1939)

Leopold was explaining that because nature is an integrated system with transcendent properties and functions beyond a mere collection of the species that comprise it, each species is important as a component of the whole and thus has instrumental value because of its role in an ecosystem. This was the key idea that spawned the *Evolutionary-Ecological Land Ethic*. It took Leopold's ethical vision beyond the choice of either preserving nature as inviolate or efficiently developing it. Muir wrote of the equality of species in religious terms; Leopold expressed equality in ecological terms. Pinchot (1947) stressed the dichotomy between people and nature ("there are just two things on this material earth – people and natural resources"); Leopold thought of people as citizen-members of the biotic system. Leopold's ideas gave people the right to use and manage nature *and* the responsibility of doing so in a manner that recognized the intrinsic value of other species and whole ecosystems. Indeed, he contended that the very tools that had been so frequently used to destroy the environment (namely the axe and the plow) could also be creatively applied to heal it, especially if guided by science.

All three of these ethics are still prevalent. The Resource Conservation Ethic resonates with the natural resource–based industries and the associated government agencies that regulate them (although some would argue a profit

motive is more dominant than a conservation ethic). Some environmental organizations are wedded to the Romantic-Transcendental Preservation Ethic, reflecting a membership that uses nature primarily for spiritual rejuvenation. Consider the Wilderness Society, for example, and its frequent allusions to the spiritual reasons for "saving" nature. The Evolutionary-Ecological Land Ethic characterizes various groups that try to find a practical balance between the needs of people and nature, such as the World Wide Fund for Nature or The Nature Conservancy.

In the conclusion to his essay, Callicott (1990) asks some provocative questions. If people are valid members of the biotic community as Leopold asserts, why do we turn to landscapes without people (at least without industrial era people) to set benchmarks for what is natural? If beavers and reef-building corals can shape landscapes in positive ways, why can't people? Can people improve natural ecosystems? Can they promote and generate biological diversity? These are not simple issues, and we will return to them frequently in this book because this dynamic, often difficult, interface between people and nature is the crux of conservation and conservation biology.

What Is Conservation Biology?

So where does conservation biology fit among these larger issues? Conservation biology is the applied science of maintaining the Earth's biological diversity. A simpler, more obvious definition – biology as applied to conservation issues – would be misleading because conservation biology is both less and more than this. It is narrower than this definition because there are many biological aspects of conservation, such as biological research on how to grow timber faster, improve water quality, or graze more livestock, that are only tangentially related to conservation biology. On the other hand, it reaches far beyond biology into disciplines such as philosophy, economics, and sociology that are concerned with the social environment in which we practice conservation, the reasons we are motivated to maintain biodiversity, and disciplines such as law and education that shape the ways we implement conservation (Jacobson 1990; Soulé 1985). Fifty years ago, maintaining biological diversity simply meant saving endangered species from extinction and was considered a small component of conservation, completely overshadowed by forestry, soil and water conservation, fish and game management, and related disciplines. Now we know that we need a healthy and diverse biota for our own well-being. And with so many species at risk of extinction and the idea of biological diversity extending to genes, ecosystems, and other biological entities, conservation biology has moved into the spotlight as the crisis discipline focused on saving life on Earth, perhaps the major issue of our time (Wilson 1992).

Conservation biology is best conceptualized as an amalgamation of disciplines as depicted in Fig. 1.4 (Jacobson 1990). It sits between basic

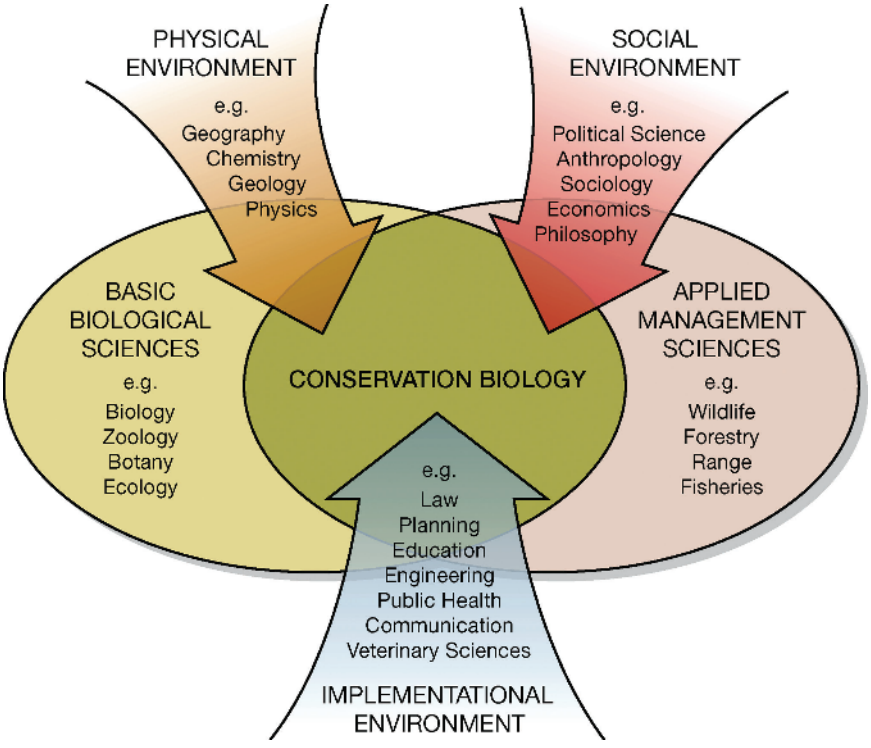

Figure 1.4 A schematic view of the relationship between conservation biology and other disciplines. (Jacobson 1990/ John Wiley & Sons)

biological sciences and natural resource sciences because it originated largely with biologists who have created a new natural resource science. It is different from traditional natural resource sciences because it places relatively greater emphasis on all forms of life and their intrinsic value, compared with traditional other natural resource sciences that usually focus on a few economically valuable species (Soulé 1985). Like natural resource sciences, conservation biology is influenced by the earth sciences because it addresses issues with strong environmental linkages. Finally, conservation biology depends heavily on social sciences, law, education, and other disciplines because it operates in the world of human socio-economic–political institutions and seeks to change those institutions to allow people to coexist with the rest of the world's species.

This model also illustrates how any student wishing to become a conservation biologist needs to focus on courses in the basic biological sciences and the applied sciences of natural resource management while acquiring a substantial understanding of the subjects that shape the legal, policy, social and cultural arena within which conservation operates. This has also led to a growing role and critical role for students with a primary background in law, economics, communication, education and so on, and a secondary foundation in biology. In fact, the term "conservation science" is

increasingly favored rather than "conservation biology" because the field is about so much more than biology.

A Brief History of Conservation Biology

The deepest, longest roots of conservation biology are widespread but its emergence as a discipline is usually attributed to the First International Conference on Conservation Biology held in San Diego, California, in 1978, and to the book that followed, *Conservation Biology* (Soulé and Wilcox 1980). Eight years after this small beginning the Society for Conservation Biology was formed, and it launched a new journal, *Conservation Biology*, in 1987 (Fig. 1.5). The society and its journal flourished, and universities, foundations, private conservation groups, and government agencies nurtured this growth with an array of conservation biology programs (Jacobson 1990; Meine et al. 2006).

The founders of conservation biology had many more links to institutions of basic biological sciences (e.g. genetics, zoology, botany) than to natural resource management institutions and they wove some novel and diverse intellectual threads into the discipline's tapestry. Ideas from evolutionary biology, population dynamics, landscape ecology, and biogeography provided a new understanding of the diversity of life, its origins and maintenance, how it is distributed around the globe, and what threatens it.

By forming a new professional society dedicated to the maintenance of biological diversity, conservation biologists partly overlapped the domain of some older professional societies. This was especially true of The Wildlife Society, which, on the very first page of *The Journal of Wildlife Management,* described wildlife management as "part of the greater movement for conservation of our entire native flora and fauna" (Bennitt et al. 1937). Today wildlife managers place an ever-growing emphasis on endangered and nongame species, including reptiles, amphibians, and sometimes even invertebrates and plants. However, much of their attention, arguably most, is still focused on "game" species, in large part because most of the funding for wildlife management agencies comes from the fees hunters and anglers are required to pay. Perhaps, if more wildlife managers had reached out to embrace all forms of life that are wild, not just the vertebrates, and to work with a constituency of all people who care about nature, not just hunters and anglers, then conservation biology might never have arisen as a separate discipline. This is especially apparent if one defines "wildlife" as "all forms of life that are wild," a definition that overlaps substantially with biodiversity. Notably, the first institution to apply science to conservation was the "Roosevelt Wild Life Station," established in 1919 to integrate science, natural history, and natural resources management for training a new generation of students to

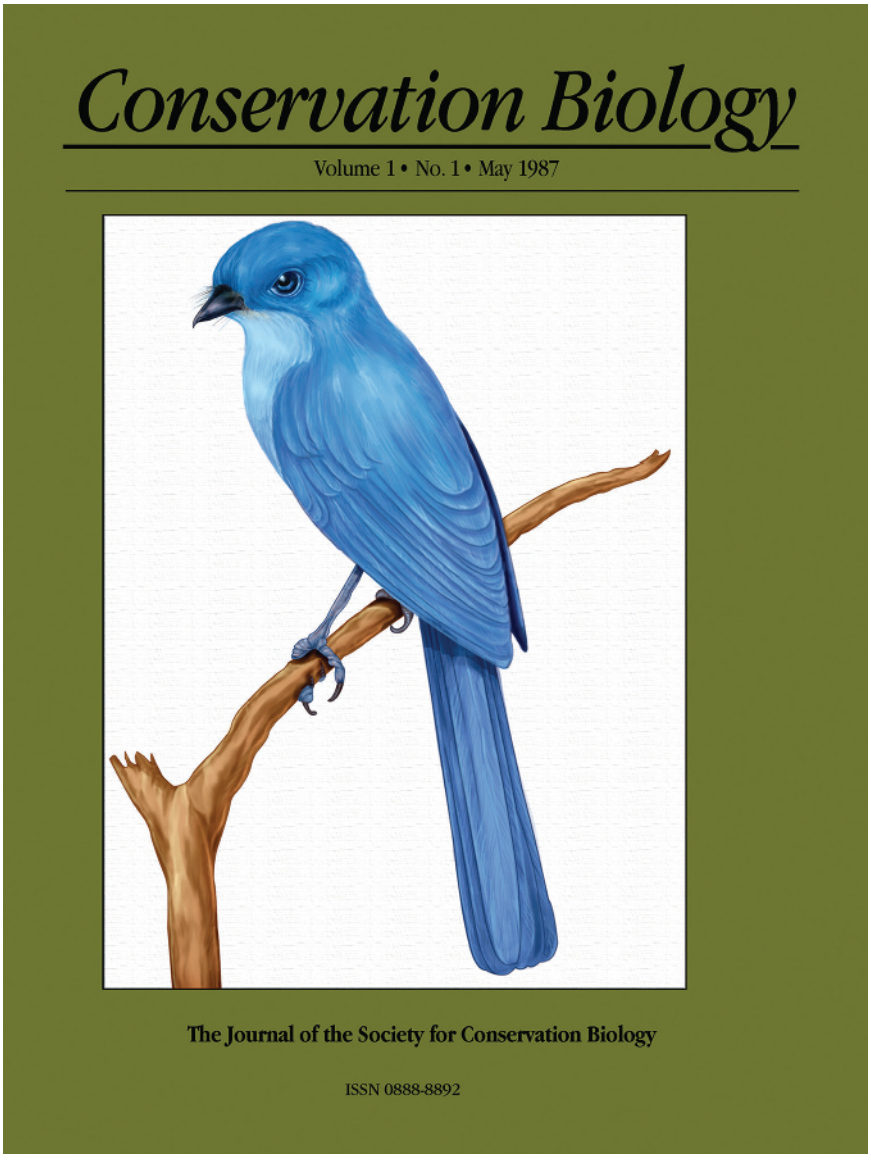

Figure 1.5 The Society for Conservation Biology began publishing *Conservation Biology* in May 1987 and held its first conference that June.

implement this new idea of "conservation" of "wild life." To be clear that this book uses a broad definition, we retain the original, two-word spelling, "wild life." As you can see, these terms "wildlife," "wild life," "biological diversity," and "biodiversity" have a long and inter-related history and still remain in use in different contexts.

CASE STUDY 1.1

Return of the Tortoises to Española Island[1]

The year is 1960. On the island of Española, a low dry expanse of eroding lava far to the southeast in the Galápagos Archipelago, a giant tortoise rests under a bush and gazes out to sea. The edges of her shell flare out dramatically – a distinctive characteristic of her lineage – but lichens cover it, a sign that she has not met with and bred with another tortoise in decades. Moreover, her head lies weakly on her outstretched forelimbs, her body withering within her shell. Beyond the small bush sheltering her from the blazing sun, hooves of goats thud against rock and dust swirls. Kids bleat hungrily after their mothers. The island is devastated, and even the goats are starving, driven to eat seaweed and drink seawater. The magnificent stands of arboreal cactus that once crowned the island are gone, torn down and stripped of their pads. Gone also is the carpet of fragile herbs and grasses that once covered the island, species that the large tortoises with their soft elephant-like feet and simple "beak" could only graze, but the toothed and hooved goats could destroy. Even the finches and mockingbirds that flitted about noisily in search of seeds and insects on the leaves of shrubs have mostly disappeared. Little remains but patches of prickly mesquite and expanses of exposed, powdery earth, from which lava blocks protrude polished brightly by the shells and claws of thousands of generations of giant tortoises. But they too are now all gone. Seemingly only the old female tortoise remains.

By the 1950s the Española Island tortoise had been given up as extinct. The island was low and accessible and the first stop for many whaling ships visiting the Galápagos in the 1800s. These sailing ships disgorged hungry sailors, who wobbled on their unstable "sea legs" deep into the trackless island, smoking clay pipes and clutching precious water supplies in fragile, hand-blown glass bottles. After much searching these sailors would haul tortoises down to the shore, likely thousands of them. Back on their ships the sailors stored the tortoises below decks where they survived for up to a year, without food or water, waiting to be slaughtered one by one to provide occasional fresh meat for the often scurvy-ridden crew. After decades of such depredations even the whaling ships stopped visiting Española once word got around that there were "no more" tortoises. Introduction of goats to the island (presumably to supply another source of meat for future visits) made matters even worse. By the 1950s boats passing the island reported the enormous goat population and wasted landscape, apparently confirming the demise of the Española Island tortoise.

One person, however, held out hope. In 1959 Miguel Castro was appointed as the first tortoise warden for the newly formed Galápagos National Park, which brought the first protections to these largely abandoned islands. He had a tough task ahead of him: starting the first program to protect these magnificent reptiles, which had been subject to plunder for two centuries and remained mere sources of bush meat for most local people, themselves scratching a living out of this austere landscape. Castro sailed a small boat to Española and made a brief reconnaissance trip in August 1963. Perhaps some tortoises might still exist. After much wandering around he found a single tortoise eating a torn-down cactus in the company of 15 goats. If there was one, perhaps there might be more? His curiosity piqued, Castro made a second trip in November 1963. Again he saw mostly goats, thousands of them, busily stripping bark from cactus tree roots, causing the cacti to fall over. Remarkably he also found the same tortoise he had found in August. He then found another tortoise, in a different part of the island, living in isolation. The signs were positive that perhaps a small nucleus of tortoises might survive.

Further trips to Española located more individuals. Some 14 were eventually relocated and brought into captivity near Park headquarters on another island. Once together in captivity, mating quickly ensued among the tortoises, who were now enjoying abundant food compared to life on their goat-devastated island, perhaps the first breeding to occur in a half century!

But producing young tortoises was not easy. Nobody had successfully bred giant tortoises in large numbers before. Even the best zoos of Europe and the United States had tried and failed. Conventional wisdom was that it was not possible. Through trial and error, another park guard, Fausto Llerana, along with many helpers and advisors, gradually developed tortoise husbandry.

One lingering problem was that the small nucleus of remaining adults had a very skewed sex ratio: 12 females and just two males. So the international search for more Española tortoises began. Old records were unclear but suggested that a group of tortoises had been removed from Española and shipped to San Diego, California, around 1935. Perhaps some yet survived 35 years later in distant California? Further investigation revealed that there was indeed a male still alive from that shipment. So-called "Diego" was large and still extremely vigorous. He was boxed up and after several false starts trying to find an aircraft suitable to transport him, he was finally flown to Ecuador and then sailed back to Galápagos in August, 1977. The captive population became strikingly more productive shortly after Diego's arrival. Diego is to this day a prolific breeder.

The captive Española tortoises also had a major, unanticipated and ancillary benefit – educational and public relations value. Local people, especially school children, and tourists visited (and still do) the rearing center with its breeding enclosures and incubators. Visitors can still see the hatchlings clustered around their water baths. The breeding program came to serve as a prime example of what could be done to reclaim some of what had been lost in Galápagos. It remains a major attraction to visitors.

Once numbers in captivity had built up and the Española tortoises were out of danger of outright extinction, the Galápagos National Park Service turned its attentions to remedying the problems on the tortoises' home turf back on Española. During the 1970s, about 3000 goats were eliminated from Española through an intense hunting campaign by park guards. Groups of guards with rifles, stout boots, and jugs of water would go to the field for weeks and even months and hunt down the goats. The terrain was difficult and the comforts few. They lived largely off what they hunted. Huge numbers of goats were culled early in the process but the very last goats took many months to eliminate. The last goats were of course the wiliest ones of all; the hunters knew each by their coat colors. The guards eventually succeeded, through sheer dedication and skill. Now just a few skulls of goats and dessicated goat droppings can be found on the island, weathering to bright white in the blazing sun

After the goats were removed the repatriations of the first hatchling tortoises began in 1975. Areas of the island with the last remaining patches of cactus were chosen as special release sites because the cactus provides critical food, moisture, and shade for young tortoises. Boxes of 5-year-old hatchlings were transported first by sea and then up the rocky slopes of the islands in backpacks and released one by one.

The captive population generated over 2000 offspring repatriated to Española. Of the repatriated tortoises, perhaps half died of natural causes but half survived and grew well (Gibbs et al. 2014). Most significantly, after nearly 30 years of reintroductions, some of the first repatriates have grown to adulthood. These repatriated tortoises are now reproducing on Española (Fig. 1.6). Nests can be found and occasionally, a soft-shelled, tiny tortoise newly emerged from its nest.

The population is again secure and sustaining itself. But not all is well. The vegetation has recuperated rapidly now that the goats are gone, but perhaps too rapidly as it has become impenetrable in many areas, even blocking movements by the newly arrived tortoises. The slow-growing cacti remain scattered and rare but they are showing signs of recovery, now that the tortoises are back to disperse their seeds.

Coda

The Española tortoises, once abandoned and quietly relegated to extinction, have returned to their native ground. All 15 surviving tortoises found 60 years ago are still alive in June 2020 and all were retired back to their original home on Española to be with their hundreds of offspring and "grand-offspring." They are

now essentially taking care of themselves. Humans can step back out of the picture, after being a destructive force and then a healing one, and let the tortoises and their ecosystem resume interacting as they did for thousands of years previously. Conservation has succeeded. It was accomplished by a cadre of dedicated individuals, mostly Ecuadorian park managers and scientists with some foreign support, working with scarce funds. Because of the program's success, Española tortoises are now being liberated on another island – nearby Santa Fe Island that lost its tortoises 200 years ago – to restore the ecological role of tortoises there and develop an "insurance" colony for Española tortoises. It is an example of the awesome power of humans to control the fate of wild life. It is also an example of how we can be both agents of destruction and benevolent stewards of restoration. This book seeks to explore these issues with you in much greater detail and to provide guidance on achieving positive outcomes for the many creatures around the world that, like the Española tortoises, are still struggling to survive.

Figure 1.6 This Española tortoise was among the very first repatriated to the island as a small hatchling some 25–30 years ago once goats had been removed and the island's habitat restored. It is likely one of the tortoises now responsible for the new hatchlings appearing again on the island, representing the first reproduction in this population in many decades. At right is Mr Fausto Llerena, a park guard and tortoise keeper of over 40 years, who largely is responsible for figuring out how to breed Galapagos tortoises in large numbers in captivity. (James P. Gibbs, author)

1 Primary sources for this section were: Marquez et al. (1991), Milinkovitch et al. (2004), Gibbs et al. (2014), and personal observations.

Summary

People who care about nature and the natural resources we obtain from nature, such as clean air and clean water, come with many labels: conservationists and preservationists, environmentalists and ecologists. Although these people share many goals, their priorities can differ. For example, conservationists advocate the careful use of natural resources, whereas environmentalists often emphasize maintaining an uncontaminated

environment. The history of conservation has a recurring theme: people being forced to limit their use of natural resources more and more as human populations grow and technological sophistication increases. Conservation history is marked by practices and laws regulating our use of natural resources, but more fundamental is the evolution of our ethical attitudes toward nature and its intrinsic and instrumental values. Three ethical positions underpin our motivation and practices to conserve biodiversity: (1) the Romantic-Transcendental Preservation Ethic (briefly, nature is best used for spiritual purposes); (2) the Resource Conservation Ethic (nature is natural resources to be carefully developed for human purposes); and (3) the Evolutionary-Ecological Land Ethic (people are part of nature and have both the right to change it and a responsibility for respecting the intrinsic value of other species and ecosystems in general). Conservation biology is the applied science of maintaining the Earth's biological diversity. It differs from basic biologic sciences because it reaches out to economics, law, education, politics, philosophy, and other subjects that shape the human world within which conservation must operate. It differs from traditional natural resource sciences because it places relatively greater emphasis on all forms of life and their intrinsic value, compared with other natural resource sciences, which typically focus on relatively few species with high instrumental (usually economic) value.

FURTHER READING

A comprehensive world history of conservation would be voluminous but some succinct overviews are available (Hughes 2009; Simmons 2008). If you want more depth there are whole encyclopedias (Krech et al. 2004), even one covering just the United States (Brosnan 2011). Many books cover certain times, phenomena, and places; for example, the sixteenth to eighteenth centuries (Richards 2003), the twentieth century (McNeill 2000), European colonization (Grove 1995), collapse of civilizations (Diamond 2005), Canada (MacDowell 2012), Latin America (Miller 2007), the Mediterranean (Hughes 2005), and the United States (Merchant 2007). Also see the journal *Environmental History*. Articles by Soulé (1985), Callicott (1990), and Jacobson (1990) form a foundation for the latter parts of the chapter and merit further reading. For relevant websites, check out the Society for Conservation Biology's website at conbio.org and some of the major international conservation groups at www.iucn.org, wwf.org, www.nature.org, www.conservation.org, and www.worldwildlife.org.

TOPICS FOR DISCUSSION

1. Do you think of yourself primarily as a conservationist, environmentalist, ecologist, or preservationist, or none of these? Why?
2. Which of the three ethics discussed do you think will be predominant 50 years from now? Why? Would you feel comfortable promoting one of these ethics among your friends and family?
3. Name some organizations that exemplify each of the three ethics today. Have any of these organizations changed their philosophy?
4. Can you identify examples of how each of the disciplines in Fig. 1.4 has contributed to conservation of a specific species in danger of extinction?