Endangered species

As human populations have increased dramatically over the last few hundred years, mirrored by similarly expanding pressures on the natural world, a strong movement concerned with the well-being of nature has grown in response. At its core, this environmental movement seeks to promote the sustainable harvest of natural resources, to preserve natural landscapes, and to protect biological diversity. Integral to these central principles is the preservation of species, for species provide humanity with renewable natural resources, shape and animate natural landscapes, and bind together complex natural systems. This entry critically reviews the early twenty-first-century status of the endangered species concept, with particular emphasis on the role and realized contribution of the U.S. Endangered Species Act to the management of endangered species. It further provides a brief review of international legislation dealing with endangered species and summarizes the current global status of species.

What is an endangered species?

An endangered species is defined as any species of organism that faces a high risk of extinction within a portion or the entirety of its geographic range. The endangered species concept, however, is a human construct subject to debate and interpretation. Many organizations use varying criteria to determine what merits listing a species as endangered. The most widely recognized of these organizations are the International Union for Conservation of Nature (IUCN) and the U.S. Fish and Wildlife Service (USFWS).

The IUCN Red List of Threatened Species (IUCN 2013b) strives to provide status reports for all species of organisms worldwide, categorizing them into the following nine groups: extinct, extinct in the wild, critically endangered, endangered, vulnerable, near threatened, least concern, data deficient, and not evaluated. Whereas the categories of extinct, extinct in the wild, data deficient, and not evaluated are self-explanatory, the other five categories are more nuanced. A species is listed as critically endangered when it is deemed to face an "extremely high risk of extinction in the wild," endangered when it is "facing a very high risk of extinction in the wild," vulnerable when it is "facing a high risk of extinction in the wild," near threatened when it is "likely to qualify for a threatened category in the near future," and least concern when the species' status does not qualify it for any of the other categories (IUCN 2001 p. 14–15).

In contrast, the USFWS classifies species into only two categories: endangered and threatened. A species is defined as endangered when it is "in danger of extinction within the foreseeable future throughout all or a significant portion of its range" and threatened when it is "likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (USFWS 2013a).

While these definitions sound rather simple, there are complications in applying them to real-life scenarios. In all of these definitions there is room for the interpretation of phrases such as "high risk," "foreseeable future," and "significant portion." Further, most species worldwide have not been the subjects of much scientific investigation, making it difficult to assess their status on the basis of evidence. There has been much debate as to whether researchers should assume the worst- or best-case scenario when scientific data are limited: Conservationists often argue the former, but existing policies tend to favor the latter. Even for well-studied species it has proven exceedingly difficult for biologists to predict extinction risk as there are countless factors that can contribute to the decline of a species. In the attempt to calculate the risk of extinction experienced by different species, biologists have established a new subdiscipline of ecology focused on determining minimum viable populations and conducting population viability analysis (Akçakaya and Sjögren-Gulve 2000). Biologists who work in this field attempt to determine the number of minimum populations necessary for a species' survival and use complex mathematical modeling to estimate the likelihood that these populations will survive over a given period of time under different scenarios. These studies have greatly increased scientists' understanding of certain organisms and processes, but much work remains in order to decipher the complexity of ecological systems and understand the factors contributing to the decline of species.

Although listing procedures are supposed to be based solely on the best available science, other human interests and biases also influence the listing process. The IUCN and the USFWS are subject to political pressures, and their decisions to list a species may be swayed by social and economic considerations. The existence of other governmental

regulations also factor into the listing process: The USFWS is likely to conclude that species that are provided oversight by other legislation (e.g., marine fish species whose harvest is regulated under the Magnuson–Stevens Fishery Conservation and Management Act) do not necessitate listing under the Endangered Species Act. In addition, listings are subject to aesthetic judgments made by people: Large, charismatic, highly visible, and terrestrial species have typically been more prone to being listed. As the protection, conservation, and rehabilitation of species requires significant time, interest, and resources, it is perhaps inevitable that listing procedures incorporate human interests. Although the definition of what constitutes an endangered species may seem simple, the application of this definition to real-life scenarios has proven exceedingly complex and will likely continue to be so in the foreseeable future.

The importance of maintaining biodiversity

While the decline of species worldwide is indisputable, debates exist about the importance of maintaining biodiversity. Should environmental conservation get in the way of human interests such as economic development, recreation, and comfort? Are extinctions, including mass extinction events, not a natural process? Are human interests and environmental conservation at odds with one another?

Extinctions

Although extinctions have occurred throughout history, there is alarming concern among biologists that the current rate of extinctions is on par with the fastest declines of biodiversity the planet has ever seen. The exact rate of current extinctions is difficult to quantify, however, there is consensus that the rate has been accelerating rapidly as the direct result of human alterations to the global environment. In a contribution to the 1988 book *Biodiversity*, Edward O. Wilson argues that "the current reduction of diversity seems destined to approach that of the great natural catastrophes at the end of the Paleozoic and Mesozoic eras—in other words, the most extreme in the past 65 million years" (11–12).

In an article published in 2000, Stephen Jay Gould addressed the argument that extinctions comprise a natural process and therefore are not of concern. He yielded the points sometimes argued by those who seek to devalue extinctions—that extinctions are unavoidable and that Earth has shown the ability to rebound in terms of biological diversity after mass extinction events. Gould argued, however, that the time scale is important to consider here: Recovery from mass extinctions—that is, the reestablishment of a balance of similar biological diversity—takes millions of years. According to Gould, *Homo sapiens* as a species is thought to be only 200,000 years old, and so:

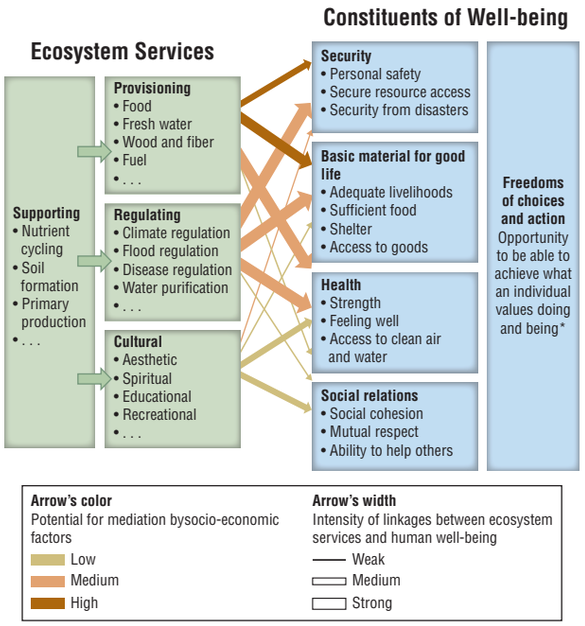
> Of what conceivable significance to us is the prospect of recovery from mass extinction 10 million years down the road if our entire species, not to mention our personal lineage, has so little prospect of surviving that long? Capacity for recovery at geologic scales has no bearing whatever upon the meaning of extinction today. . . . We are trying to preserve populations and environments because the comfort and decency of our present lives, and those of fellow species that share our planet, depend upon such stability. (232)

He concludes that to say that humanity should let a species go extinct "because all species eventually die makes about as much sense as arguing that we shouldn't treat an easily curable childhood infection because all humans are ultimately and inevitably mortal" (232).

Ecosystem services

In the attempt to quantify the value of nature to humanity, biologists and environmental scientists have begun to calculate the economic value of natural services (Sekercioglu 2010; Wenny et al. 2011). The study of ecosystem services has grown in popularity over the last several decades and has begun to alter how people think about national and global economies. In a 2000 contribution, Janet N. Abramovitz argued that

> nature's "free" services form the invisible foundation that supports our societies and economies. We rely on the oceans to provide abundant fish, on forests for wood and new medicines, on insects to pollinate our crops, on birds and frogs to keep pests in check, and on rivers to supply clean water. We expect that when we need timber we can harvest it, that when we need new crops we can find them in nature, that when we drill a well we will find water, that the waste we generate will disappear, that clean air will blow in to refresh our cities, and that the climate will be stable and predictable. Nature's services have always been there free for the taking, and our expectations—and economies—are based on the premise that they always will be. (331–332)



The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and public and private policy. Reproduced by permission of Gale, a part of Cengage Learning.

Nature has long been viewed as a boundless resource, and humanity's economies are largely based on this notion. However, current human populations and levels of resource consumption have proven this assumption wrong. Humanity's mechanisms for monitoring the economic success of a nation, such as the US gross domestic product (GDP), deem positive for the economy the blanket consumption of natural resources and do not incorporate the services provided by nature. Abramovitz argued that this encouragement of consumption has led to a "biodiversity deficit," which she defined as the destruction of species and ecosystems faster than nature can create new ones.

> Nature's living library—the genes, species, populations, communities, and ecosystems in existence today—represent a wealth of options for future generations and for change in the biosphere. . . . By reducing the number of species and the size and integrity of ecosystems, we are also reducing nature's capacity to evolve and create new life. In just a few centuries we have gone from living off nature's interest to spending down the capital that has accumulated over millions of years of evolution, as well as diminishing the capacity of nature to create new capital. (333)

Whereas Abramovitz focused on the maintenance of current ecosystem services, many other scientists have argued that there are tremendous resources in the natural world that remain to be developed and that could greatly benefit future human civilizations. Wilson stated that "we have come to depend on less than 1% of living species for our existence, the remainder remaining untested and fallow" (1988, 15). There are numerous potential plant sources for food, pharmaceuticals, fibers, and energy sources. Insects may serve as superior crop pollinators and control agents for weeds and pests. Bacteria, yeasts, and other microorganisms have potential as medicines and food, as well as in soil restoration and toxic waste remediation. In summary, nature has the potential of providing a diverse array of solutions to human problems. Humanity has only begun to explore and tap into these resources, while simultaneously destroying them at a rapid rate.

Ethics

Although it is important to consider human self-interests as a species in regard to the natural environment, including the analysis of ecosystem services provided to humans by nature, some argue that humanity has a moral and even religious commitment to maintaining biodiversity and ecosystem integrity. In a 2004 contribution, Holmes Rolston III stated that "the motivation to save endangered species can and ought to be pragmatic, economic, political, and scientific; deeper down it is moral, philosophical, and religious" (233).

In what is regarded as one of the classic essays in conservation literature, "The Land Ethic" (originally published in 1949), Aldo Leopold wrote the following: "A system of conservation based solely on economic self-interest is hopelessly lopsided. It tends to ignore, and thus to eventually eliminate, many elements in the land community that lack commercial value, but that are (as far as we know) essential for its healthy functioning. It assumes, falsely, I think, that the economic parts of the biotic clock will function without the uneconomic parts" (2004, 378).

Leopold argued that people have a duty to attempt to conserve all of the parts of the "clock," his metaphor for the natural world, as every component is important when united, even though they may not be valuable independent of the other pieces. He went on to state that "health is the capacity for self-renewal. Conservation is our effort to understand and preserve this capacity" (381). Leopold summarized his land ethic in this now-famous statement: "A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise" (382). Modern ecological thought provided support for Leopold's ethic, with findings that small, overlooked, and even seemingly bothersome species play important roles in the maintenance of ecosystems. For example, in a 2003 contribution, Svata M. Louda and Tatyana A. Rand argued that

> there are practical as well as aesthetic and ethical reasons for working to maintain minor, even seemingly obnoxious, species and their interactions. In particular, this case suggests that we are not yet in a position to predict the cost associated with the decline and loss of a specific species, since its ecological function and economic value may not be obvious. (6)

While Leopold's land ethic argues for conservation for the inherent good of nature, other authors have argued that there is a more spiritual and/or religious basis for the need for conservation. In a 2002 contribution, Stephen R. Kellert contended that the conservation of nature should be based not on pity for the weak, but on our own self-interest. He argues that nature enhances humanity's capacity for experiencing beauty and fulfillment in our lives and for feeling connected to something greater than ourselves: "a broad anthropocentric ethic of duty and responsibility for the natural world reaffirms our complicated and unyielding ties with creation. We draw ethical nourishment and moral guidance from recognizing and celebrating this commonality. Conversely, degrading our relation with nature engenders more than material harm. It leads, far more profoundly, to a loss of identity, meaning, and purpose" (64). In a more overtly religious argument, Rolston highlights the story of Noah's Ark as an example of how "God wills for each species on Earth to continue, despite the disruptions introduced by humans" (233).

The rise of human culpability

Human populations have likely been responsible for the extinction of species for millennia. The extinction of megafauna in Asia, Europe, Oceania, and the Americas parallels the arrival of ancestral humans to these continents in their emigration from Africa thousands of years ago, and although there is little direct evidence of human involvement in these extinctions, there are well-argued theories suggesting this to be the case (Martin 2005; Presscot et al. 2012). The development of tools, including the use of fire and hurling rocks and the crafting of spears and bows, allowed for the easy capture of unsuspecting animals. Human intelligence allowed for human populations to grow, as prey species declined and

became extinct around the globe. Undoubtedly some early cultures became aware of their impacts and perhaps sought a balance with prey species in order to preserve these resources. Many early civilizations found some degree of balance with their natural surroundings.

As human global mobility increased drastically in the second millennium AD with the development of oceangoing craft able to navigate oceans and as peoples from one continent began harvesting resources from another, the human–nature balance was disturbed. In particular, islands, as relatively small and vulnerable tracts of land, were drastically affected by the new arrivals of humans, whether the islands were previously inhabited or not. From the fifteenth to nineteenth centuries, islands experienced a new and devastating wave of extinctions. These extinctions occurred rapidly and, for the first time, were documented extensively (Pimm et al. 2006). The pattern of extinctions was most obvious among birds, as they were more easily observed than other taxa. A 2012 paper by researchers at BirdLife International and Charles Darwin University summarized the bird extinctions from 1500 until the early 2000s, citing the extinction of 279 species and subspecies of birds (Szabo et al. 2012). According to this research, the majority of these extinctions have taken place on oceanic islands, with 78.7 percent of species extinctions and 63 percent of subspecies extinctions. For example, Hawaii lost 36 species and subspecies, the tiny archipelago of the Mascarene Islands in the Indian Ocean lost 27, New Zealand lost 22, and French Polynesia 19. Alarmingly, this study finds that the rate of bird species extinctions is now accelerating on continents.

One particularly important and noteworthy case of extinction was that of the dodo (*Raphus cucullatus*) on the island of Mauritius in the Indian Ocean. European explorers first discovered the island in 1507. Starting in 1598, the island became a frequent stopover for Dutch traders crossing the Indian Ocean. The first record of people eating dodos comes from 1601. Though not regarded as particularly tasty, the large, flightless and naive birds were hunted easily and fed many people. Records from early sailors show that the dodos were harvested by the dozen. Further, exotic pigs, monkeys, goats, chickens, cattle, deer, cats, and dogs were all introduced to the island by the early visitors; pigs and monkeys became direct predators of dodos, and other introduced species competed with them indirectly. With all of these pressures, the species declined rapidly. The last sighting of the dodo was made on the island of Mauritius in 1662 (Quammen 1996).

The decline of the dodo was so precipitous and undeniably caused by human influences on the island that it became a famous example of the impacts of early explorers on island ecology. Environmental historians often characterize this episode as being instrumental in the awakening of human awareness of how people can affect ecosystems. People began to realize that resources could be exhausted and that humans could completely eradicate a species from Earth in a relatively short amount of time. It could be argued that the endangered species concept has its roots in this episode in the mid-seventeenth century.

Although the seed of responsibility may have been planted in the human psyche in the seventeenth century, it took a few more centuries and many other extinction events for the concept to mature. Some noteworthy extinctions in this era are that of the Steller's sea cow in the mid-1700s, the African bluebuck around 1800, the Mauritius blue pigeon in the early 1800s, the great auk in the mid-1800s, and the Atlas bear, which was hunted out of the Atlas Mountains of Morocco in the late 1800s. Two particularly drastic and important cases of extinction and near extinction, both of which occurred in the United States in the 1800s, are revealing as to the scale of humanity's potential for impacting the environment. The passenger pigeon (*Ectopistes migratorius*) and the American bison (*Bison bison*) were two of the most abundant animals on the North American continent until widespread hunting caused their populations to decline rapidly during the Industrial Revolution. These two case studies proved instrumental in the establishment of a more concrete moral and legislative foundation for conservation, as the implications for these species' collapses could not be clearer: If unrestrained, humans have the potential to devastate even the most abundant of species in mere decades.

Illustration of the extinct Steller's sea cow (*Hydrodamalis gigas*), a sirenian that lived in the Bering Sea and was hunted to extinction in the 1700s. The Steller's sea cow is related to the manatee and the dugong. Richard Ellis/Science Source

The passenger pigeon

Ranging throughout eastern North America, the passenger pigeon was one of the most numerous bird species on Earth just two centuries ago. In the 1800s, the passenger pigeon was commercialized as a food source, and hunting was practiced on a massive scale; pigeons were hunted throughout the Midwest and shipped by railroad to eastern cities. The population declined slowly but steadily from about 1800 to 1870, before experiencing a catastrophic collapse between 1870 and 1890.

There were some attempts at curbing the rate of hunting before the bird was driven to extinction, but none of them was successful. In 1857 a bill was brought before the Ohio state legislature seeking protection for the passenger pigeon, but a committee of senators filed a report stating that "the passenger pigeon needs no protection. Wonderfully prolific,

Shooting passenger pigeons, which are now extinct, for sport in Louisiana c. 1870s. © North Wind Picture Archives/Alamy.

having the vast forests of the North as its breeding grounds, traveling hundreds of miles in search of food, it is here today and elsewhere tomorrow, and no ordinary destruction can lessen them, or be missed from the myriads that are yearly produced" (Hornaday 1913, 1). Other measures in Michigan and Pennsylvania sought to stop hunting and prohibit netting pigeons near nesting areas, but these were weakly enforced and proved too little, too late. The species was highly gregarious and apparently needed large flocks to court and breed. As their numbers diminished, their biology further inhibited their reproduction. The species entered an extinction vortex from which it could not return. Attempts at captive breeding failed, and the last known individual died in the Cincinnati Zoo in 1914.

The precipitous decline of the passenger pigeon, culminating in its extinction, was not in total vain, however, in that it proved to be one of the foremost examples that aroused public awareness of the potential impacts of human activities on species and raised interest in the need for conservation legislation. One other contemporary case equals the potency of this episode in terms of influence on the modern conservation movement—that of the American bison.

The American bison

The American bison, currently the largest native land mammal on the North American continent, once roamed the grasslands from northern Mexico to northern Canada in enormous herds. In the nineteenth century, hunting of the bison was rampant and actively endorsed by the US federal government for a variety of reasons, including reducing pasture competition for domestic livestock and weakening the populations of Native Americans that depended on bison for food and clothing. The railroad industry also worked to cull bison herds that threatened the safety of their new railways. The main cause of decline, however, was commercial hunting; bison hide was used for clothes, rugs, and industrial machine belts. By the mid-1880s the bison was dangerously close to extinction, with just a few hundred individuals left.

As the bison came perilously close to extinction and plans to save the species were discussed, the US government declined to play any significant role in the protection or recovery of the species. In 1874 President Ulysses S. Grant vetoed a bill that would have protected the remaining bison.

Bison in snow at side of Yellowstone River © REBimages/Alamy.

In 1875 General Philip Sheridan of the US Army pleaded with the US Congress to allow the slaughter of the remaining bison to aid in the control of Native Americans (Bergman 2004).

The recovery of the bison was in fact a private endeavor, with ranchers purchasing bison to protect and breed, likely with some foresight into the potential to profit from the species. These small, private measures eventually led to the recovery of the bison, albeit in a limited fashion. As of 2012 there were an estimated 500,000 bison in captive commercial populations, but only about 30,000 individuals in wild herds, and only about 15,000 of these are deemed free roaming and truly wild. The only continuously wild herd of bison in the United States resides within Yellowstone National Park and numbers between 3,000 and 3,500 individuals (Bergman 2004).

Both the drastic decline of a once superabundant and emblematic large mammal species and the inability and disinterest of the US government in protecting the species brought alarm to various groups of Americans. Along with that of the passenger pigeon, the story of the American bison played a key role in instigating the natural resource management initiatives of the Progressive Era.

Early conservation legislation in the United States

Early American environmental philosophy tended toward a so-called myth of abundance. Experience soon showed, however, that wildlife in North America, while abundant, was not infinite. For example, the Massachusetts Bay Colony adopted a closed season on deer by 1693, and several other colonies soon followed suit (Goble 2006). During the Industrial Revolution, human capacity for development and consumption of resources increased greatly. These times were characterized by the idea that nature was a resource to be harvested in order to convert natural capital into private wealth.

In the 1890s the Progressive Era in US politics took shape, with the ideals of reducing corruption, promoting women's suffrage, and increasing efficiency in all sectors of the government, economy, and society. Progressives strongly supported the use of the scientific method in many areas. While not primarily a conservation movement, many of the ideals of the Progressive movement were applied to the environmental issues of the time. Considering the examples of the passenger pigeon and American bison, progressives believed that proper management of natural resources could allow for a more sustainable yield and therefore a more

efficient and sustainable economy. Theodore Roosevelt, who served as president of the United States from 1901 to 1909, was one of the key proponents of this mode of thought, along with Gifford Pinchot, Roosevelt's appointee to head the newly established U.S. Forest Service. In describing the role of this new agency, which was formed in 1905, Pinchot summarized the mindset of the movement this way: "In the administration of the forest reserves . . . all land is to be devoted to its most productive use for the permanent good of the whole people, and not for the temporary benefit of individuals or companies" (Goble 2006, 9). Progressivism was an important step in the modern conservation movement, having established an ideology of utilitarian conservation in the United States that lasted until the 1960s. Many early attempts of the federal government to protect natural resources occurred in this era and are worth considering in some detail.

The Lacey Act of 1900, passed under the presidency of William McKinley (when Roosevelt was vice president), is regarded as the first federal law in the United States directed at the preservation of wildlife. In an attempt to address the overhunting of game animals, the law prohibited the transportation of illegally harvested game across state lines and also addressed the introduction of nonnative species to ecosystems. The act's primary focus was to preserve the populations of game animals through the regulation of interstate commerce, although it proved largely ineffective because it did not regulate hunting that occurred within states. In the early twenty-first century, the law is still used to discourage the importation and spread of invasive species.

As the Lacey Act proved largely ineffective at preventing the continued decline of migratory game birds, conservationists continued to lobby for more effective legislation. The Weeks–McLean Act, passed in 1913, asserted that the federal government had the authority to regulate the hunting of migratory birds directly (rather than simply in relation to interstate commerce). Nonetheless, the act was immediately challenged, and the Supreme Court ruled it was unconstitutional, as the regulation of hunting was deemed to be the role of the states. In response to this ruling on the Weeks–McLean Act, Congress shifted tactics and pursued an international treaty for the protection of migratory birds with Great Britain—the Convention between the United States and Great Britain (for Canada) for the Protection of Migratory Birds of 1916. In order to implement this convention within the United States, Congress passed legislation providing authority to the federal government through the Migratory Bird Treaty Act of 1918. This act was also challenged in courts, much like the Weeks–Mclean Act, but the climate of the US Supreme Court had changed, and this time the court ruled that "it is not sufficient to rely upon the States. The reliance is vain" (Goble 2006, 10). This important ruling opened the door for federal oversight and management of species.

A juvenile whooping crane in migration. Courtesy of operationmigration.org.

Well after the dramatic declines of the passenger pigeon and American bison in the 1800s, the whooping crane (*Grus americana*) rekindled the urgency for conservation measures in conservation-minded Americans in the 1930s. The case of the whooping crane rose to notoriety when the population dropped below twenty individuals in the 1930s as a result of habitat destruction and overhunting. As a charismatic and elegant species, it became an important symbol of the conservation movement. In 1937 the Bureau of Biological Survey (a forerunner of the Fish and Wildlife Service) acquired the property for and established the Aransas National Wildlife Refuge in Texas to protect the wintering grounds of the whooping crane. As of 2012, the whooping crane survived as a result of an intense conservation program, with a total population of just a few hundred. Although the species continued to struggle for survival, it remained an important symbol of the conservation movement in the United States and of the difficulties in restoring a critically endangered species.

In 1940 Congress passed the Bald Eagle Protection Act, which sought to save a national icon of the United States from impending extinction. This law increased the federal government's powers to regulate harm to or killing of bald eagles anywhere in the nation and advanced the notion of the federal government's role in protecting endangered species. Also in 1940, the United States signed the first international convention on conservation since the 1916 treaty with Great Britain. The Convention on Nature Protection and Wild Life Preservation in the Western Hemisphere committed the United States, in bold language, to "protect and reserve in their natural habitat representatives of all species and genera . . . in sufficient numbers and over areas extensive enough to assure them from becoming extinct through any agency within man's control" (OAS 2012, 1).

Although the developments of the Progressive Era made significant improvements in the preservation of migratory birds and the protection of the bald eagle, these developments made for little improvement in the protection of most other biodiversity. While conservation philosophy greatly developed during this time, the actual legislation lacked significant tools to effectively preserve species. The 1960s brought about a new era in endangered species conservation that started with a burst of pro-conservation legislation.

The early modern era

The first attempt at a comprehensive federal endangered species act was the Endangered Species Preservation Act of 1966 (ESPA), which focused on the preservation of wildlife habitat in order to conserve native fish and wildlife threatened with extinction. Although the wording of the ESPA called for dramatic efforts to conserve species, the act had relatively few legislative tools and little funding, making it weak in its application. The ESPA did call for a formal listing of endangered species, and seventy-eight species were listed in 1968—likely the crowning achievement of the act.

In 1969 Congress attempted to remedy some of the weaknesses of the ESPA by placing more emphasis on the direct *take* of species and recognizing the international component of endangered species conservation. The modified act, renamed the Endangered Species Conservation Act (ESCA), sought to regulate interstate and international trade in endangered species and was backed by stiff civil and criminal penalties for noncompliance. The ESCA also called for the secretaries of the interior and state to convene an international conference on endangered species. The conference was eventually held in Washington, DC, in 1973 and succeeded in passing the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), a treaty that established an international system for the regulation of imports and exports of endangered species. As of 2012, CITES remained one of the most important international tools for the regulation of trade and the conservation of endangered species.

The ESPA and ESCA set an ideological framework for endangered species conservation legislation in the United States, but they lacked tools and a comprehensive plan for how to achieve the goals they outlined. The conservation movement was in full swing in the United States in the early 1970s, and the time was ripe for more comprehensive legislation. In 1973, the same year that the important CITES convention was established, the US Congress passed what has been regarded as the most important and comprehensive biodiversity conservation legislation the nation or world had seen to that date: the Endangered Species Act.

The Endangered Species Act of 1973

President Richard Nixon signed the Endangered Species Act (ESA) into law on December 28, 1973. It was one of the least controversial bills of 1973 to go through Congress, with versions being passed by the Senate by a vote of 92–0 and the House of Representatives by a vote of 355–4. At the time there was widespread popular concern for the decline of species and broad political consensus that the federal government needed better legislative tools to protect the nation's biological heritage. In reflection of this consensus, the ESA was shaped into what was widely regarded as the most authoritative, stringent, and comprehensive legislation dealing with endangered species conservation the world had ever seen.

The justification for the enactment of the law is based on three main findings:

1. Various species of fish, wildlife, and plants in the United States have been rendered extinct as a consequence of economic growth and development not tempered by adequate concern and conservation.
2. Other species of fish, wildlife, and plants have become so depleted in numbers that they are in danger of, or threatened with, extinction.
3. These species of fish, wildlife, and plants are of aesthetic, ecological, educational, historical, recreational, and scientific value to the nation and its people (Kubasek and Silverman 2005).

An important component of the act was the simple defining of the terms *endangered*, *threatened*, and *take*. In Section 3 of the ESA, these terms are defined as follows:

- "The term 'endangered species' means any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man."
- "The term 'threatened species' means any species that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range."
- "The term 'take' means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (NOAA 2012).

In its original phrasing, the ESA was clear about the importance of preserving biodiversity and specific about how to address the issue. It authorized the listing of "threatened" and "endangered" species, required federal agencies to ensure that their actions did not jeopardize a listed species, prohibited the unauthorized "take" of endangered species by any person, provided the federal government with the authority to acquire land for the conservation of listed species, and imposed civil and criminal penalties for infractions of the act (Scott et al. 2005a). The ESA states that a number of factors can contribute to a species' threatened or endangered status, including the "present or threatened destruction, modification or curtailment of its habitat or range; overutilization for commercial, recreation, scientific, or educational purposes; disease or predation; the inadequacy of existing statutory mechanisms; or other natural or manmade factors affecting its continued existence" (Kubasek and Silverman 2005, 389).

The philosophy behind how the act would work is as follows: if a species is deemed endangered or threatened, it would be listed and critical habitat for the species would be determined. The USFWS, for terrestrial organisms, or the National Oceanic and Atmospheric Administration (NOAA), for marine and anadromous (species that use both marine and river systems) organisms, are then responsible for constructing a recovery plan for the species based on the best available science and determining how best to remove or mitigate the threats to the species in order for its populations to recover.

During the recovery process, the species would receive full protection from harm from any agency or person, with civil and criminal penalties at the disposal of the USFWS or NOAA for enforcement (Scott et al. 2005a).

The act was rigid in its original design. The definition of *take*—the key term used in the act to define harming an endangered species—was comprehensive and allowed for little misunderstanding or loopholes. In one of the important early US Supreme Court cases testing the rigidity of the ESA, *Tennessee Valley Authority v. Hill* (1978), the Court decided that the law would "admit to no exception" for harm caused to an endangered species, in this case the snail darter, a small fish (Scott et al. 2005a). But in response to this Supreme Court decision, and as a result of changing political pressures, Congress began a long process of modifications to the original act, in order to reduce its rigidity and to seek a balance between endangered species conservation and human economic and private property interests.

Amendments and adjustments to the ESA

Below are summarized the most important amendments to the ESA.

1978

In 1978, in response to *Tennessee Valley Authority v. Hill*, Congress made significant amendments to the ESA. These amendments focused on the procedures necessary for listing a species as threatened or endangered, making the process significantly more complicated. In the listing process, the USFWS was now required to hold local hearings and include a designation of critical habitat before deciding whether to list a species. While the process became much more complicated, Congress also placed a two-year time limit on the process: Those listing decisions that were not completed within two years were to be withdrawn from consideration. The effects of these seemingly subtle changes in the listing process were profound: Fewer than 5 percent of the more than 2,000 species that were proposed for listing in 1978 were finalized, and on December 10, 1979, the USFWS withdrew listing proposals for 1,876 species (Scott et al. 2005a). By modifying the listing procedures, Congress changed what was originally simple and straightforward legislation into a significantly more complex and loophole-prone law.

1982

The next round of significant modifications to the ESA came in 1982, when Congress responded to an executive order by President Ronald Reagan that mandated the listings be economically justified. Congress rebuked this executive order by specifying that listing determinations were to be based on the best scientific data and not based on economic considerations. In this same round of amendments, however, Congress weakened the strict take guidelines outlined in the original version of the act, allowing for incidental takes of endangered species. Incidental take permits were established, which greatly reduced the stringency of the original legislation, permitting both federal agencies and individuals to take an endangered species so long as it would not "appreciably reduce the likelihood of survival and recovery of the species in the wild" (Scott et al. 2005a, 10). This amendment proved particularly important in the mid-1990s, when the execution of the ESA was significantly modified under the administration of President Bill Clinton to reduce conflicts with private property holders and in an attempt to increase the effectiveness of habitat conservation on private land.

1988

Amendments in 1988 focused on three themes: monitoring of recovered species, increasing the accountability of the government during the recovery process, and enhancing the protection of plant species. Specifically, the amendments required that a recovered species be monitored for five years and allowed it to be fast-tracked to relisting if the species is deemed threatened or endangered again during this period. In addition, species recovery plans were required to undergo a public notice and comment period, and federal agencies were required to consider these comments; biennial reports to Congress were required on the development and implementation of recovery plans and on the status of all species with recovery plans; federal and state governments were required to report all expenditures associated with endangered species recovery; and the protection of endangered plants was increased by including a prohibition on the malicious destruction of federal lands.

Executive branch actions in the 1990s

Arguably the most important modifications to the ESA came in the mid-1990s. Since its inception, a major point of contention under the ESA was the definition of *harm*. In the 1990s Bruce Babbitt, the US secretary of the interior, interpreted harm to mean "an act which actually kills or injures wildlife. Such [an] act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavior patterns, including breeding, feeding, or sheltering" (Kubasek and Silverman 2005, 390). This broad definition of harm was challenged in court in the early 1990s, and after mixed rulings in lower courts, the definition was finally upheld by the US Supreme Court in 1995. The upholding of this broad definition significantly restricted the actions of landholders with endangered species or their habitat on the landholders' private property. Although this decision was deemed an important victory for environmentalists, it was a contentious decision that, some believed, motivated property rights advocates against the ESA and brought a significant backlash to the legislation.

In response to the public backlash to this Supreme Court decision, Babbitt attempted to make administrative reforms to the act that would reduce the conflict between private property holders and endangered species conservation. He advocated strategies that were incentive based rather than penalty based in regard to endangered species conservation, and he helped expand the use of incidental take permits. Such permits had been authorized by the 1982 amendments to the act and included habitat conservation plans, candidate conservation agreements, and safe harbor agreements. A habitat modification plan is a mitigation plan for activities

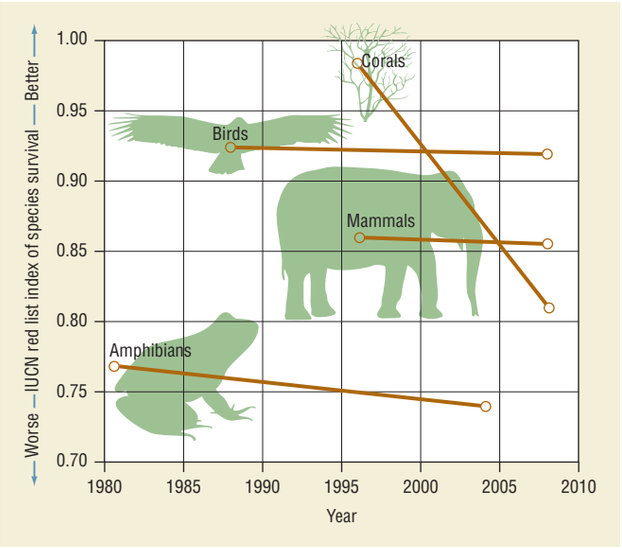


Figure 1. Red List Indexes (RLI) for reef-forming corals, birds, mammals, and amphibians. Coral species are moving towards increased extinction risk most rapidly, while amphibians are, on average, the most threatened group. An RLI value of 1.0 equates to all species qualifying as Least Concern (i.e., not expected to become Extinct in the near future). An RLI value of 0 equates to all species having gone Extinct. A constant RLI value over time indicates that the overall extinction risk for the group is constant. If the rate of biodiversity loss were reducing, the RLI would show an upward trend. Reproduced by permission of Gale, a part of Cengage Learning.

that involve the "take" of a listed species. When such a plan is authorized, the take of the species is authorized with agreed-on mitigation requirements to redress the harm caused. A candidate conservation agreement is a voluntary agreement between a landowner and the USFWS in which the landowner agrees to specified actions to conserve a species that is a candidate for listing under the ESA, with assurances that the federal government will not impose stricter guidelines on the landowner than those agreed on at the time. A safe harbor agreement can be issued by the USFWS when it is deemed that an action by a landowner "will provide a net conservation benefit to the affected listed species" (Scott et al. 2005b, 28). This is a method by which the USFWS can assure landowners doing a good deed on behalf of a listed species that they will not be penalized.

In general, these permits allowed for individuals and organizations to voluntarily agree to certain guidelines, and in return the federal government would assure them that no new restrictions would be placed on the use of their private land. The response to these modifications was mixed and quite heated at times. Some argued that these agreements were friendly toward the interests of private property rights advocates and developers and that they reduced the stringency and effectiveness of the ESA. Others argued that Babbitt's incentive-based approach proved more effective at mitigating habitat destruction and reduced the contention between conservationists and private property rights advocates, helping establish a results-driven middle ground.

Post-2000

There were some relatively minor amendments to the ESA between 2000 and 2012, but these were generally considered to pose only minor changes to the effectiveness or implementation of the law. The most important of these amendments came in 2004, when the US Department of Defense was exempted from critical habitat designations under the ESA under certain criteria.

Critical review of the ESA

Decades after its being signed into law, the ESA continued to be a cornerstone of US biodiversity policy and was among the nation's most important environmental laws. As of 2012, however, there was vigorous debate regarding the efficacy of this legislation in protecting and restoring populations of endangered species. This section provides a review of the successes and criticisms of the act prior to 2013.

The numbers

When the Endangered Species Act was enacted in 1973, there were 392 species listed as endangered and threatened, composed of only vertebrate animal species (Scott et al. 2005b). As of January 2013, there were 1,434 domestic species on the list, including 621 animals and 816 plants, and an additional 615 foreign species (USFWS 2013b). The diversity of listed species has increased greatly over time, with the list beginning with a focus on vertebrate animals and then expanding to include a diverse array of wildlife, including plants and invertebrates. There are still biases evident in what is listed, however, including a notable underrepresentation of marine species (Armsworth et al. 2005).

As of February 2012, 36 US and foreign species or distinct populations of species had been removed from the USFWS endangered species list as a result of causes other than "original data error" since the inception of the law. Of these, 26 had been deemed "recovered," and the remaining 10 species had gone extinct (Congressional Research Service 2012).

Criticisms of the ESA

There is a tremendous amount of scientific literature analyzing the effectiveness of the ESA, with a broad range of interpretations of its successes and downfalls. The primary criticisms of the act include the following:

1. it is underfunded;
2. it is reactionary rather than preventative;
3. it focuses on individual species rather than ecosystem health;
4. it is ineffective and controversial when addressing conservation on private property; and
5. it is impotent to address the magnitude of the conservation challenges of today.

In regard to funding, Joe Kerkvliet and Christian Langpap, in a 2007 study, found that increased spending on a species

reduces the probability that the species will be declining or go extinct. Further, these researchers found that ESA-related spending is more effective in preventing declines than in promoting recovery: "Even though funds spent on threatened and endangered species may in general not lead to full recovery (and delisting), they seem to prevent further decline and eventual extinction" (508). One possible reading of this research is that attention (and funding) should be focused on declining species sooner, so as to invest in prevention and avoid the difficulties that endangered and threatened species face to recovery. Other researchers (e.g., Male and Bean 2005) have similarly found that spending is correlated with improved status.

When a species is imminently close to extinction, and therefore qualifies for listing under the ESA, it faces a number of biological challenges that inhibit recovery. In a 2005 study, Martin F. J. Taylor and colleagues found that species listed as threatened are more prone to have an improving status than species listed as endangered. They argued that the prompt listing of species, before their numbers are critically low or their habitat is extensively impaired, could significantly enhance the efficacy of the ESA. Nonetheless, current trends in listing tend to favor waiting until a species qualifies for endangered status. This was evident from the numbers for January 2013, when 1,109 domestic species were listed as endangered and 319 domestic species were listed as threatened (USFWS 2013b). Furthermore, Daniel J. McGarvey, in a 2007 article, argued that the current listing of endangered species incorporates an important error in thinking—one of being overly cautious in determining how and when to list species. When dealing with the listing of endangered species, he argued, it is much more harmful not to list a species that is indeed endangered than it would be to list a species that is not: "uncertainty should not constrain efforts to protect imperiled species ... particularly when the threat of irreversible damage exists" (69).

The focus of the ESA on individual species rather than overall ecosystem health has also been a source of criticism. Some have argued that, in focusing on individual species, the act is inherently nearsighted and that a much more effective and efficient means of promoting conservation would be to focus on ecosystem health and habitat conservation. In a 2005 contribution, J. Michael Scott and colleagues stated that "the ESA is an at-risk *species* act—it is not a comprehensive *biodiversity preservation* act" (2005a, 4). For a 2001 study, Amy Whritenour Ando conducted economic analyses on the efficacy of endangered species programs, and she concluded that "there are sizable beneficial spillovers from the protection of one species in a county to the welfare of its neighbors. This suggests that a move toward an ecosystem or at least regional approach to species protection may make sense" (331).

The most contentious aspect of the ESA has been the regulation of privately owned endangered species habitat. Private property rights activists have argued that the ESA places an unjust burden on landowners to conserve endangered species. The majority of endangered species rely, at least in part, on private property for habitat. Langpap, in a 2006 article, pointed out that "more than half of the listed endangered species have at least 80% of their habitat on private land" (558–559). In order to reduce the conflict between conservationists and landholders, the USFWS promoted the use of habitat conservation plans (HCPs), which allow for some loss of endangered species habitat in exchange for long-term plans to minimize and mitigate the loss. These plans have been strongly criticized by some environmentalists who have argued that they undermine ESA take standards and contribute to the deterioration of endangered species habitat. Others have argued that compromises and assurances between the USFWS and private landholders have helped decrease preemptive endangered species habitat destruction and have fostered increased preservation of habitat.

As part of a 2007 study, Paul J. Ferraro and colleagues found evidence that there are surprising negative incentives for landowners to preemptively destroy habitat on their private property that may qualify as endangered species habitat. They found that, on average, the placement of a species on the endangered species list is actually detrimental to the status of a species if it is not combined with substantial government funds. "Shoot, shovel, and shut up," a tendency for landowners to preemptively harm species and habitat on their private property to avoid future regulation of their land uses, has been widely documented. Furthermore, in a 2012 study, Langpap and Kerkvliet found that, on average, HCPs have had a positive effect on species recovery, citing evidence that, from 1990 to 2004, species with HCPs are more likely to show improvement in recovery status and less likely to be declining than species without an HCP. While HCPs may not be a perfect solution to the conservation of endangered species on private property, they may reduce conflict and thus have a net positive effect on the efficiency and effectiveness of the act.

The magnitude of the conservation challenge in the twenty-first century is truly awesome and will test the act over the coming decades (Scott et al. 2005a). As of 2012, more comprehensive legislation was needed to address such complex issues as increased habitat fragmentation, the spread of invasive species, human population growth, and global warming, among other factors, in order to successfully prevent extinctions and promote species recovery. In their 2005 contribution, Scott and his colleagues contended that

> the ESA is a tool of last resort that can slow but not prevent the accelerating loss of biodiversity from the American landscape. Simply put, it comes into play too late. To prevent species from becoming endangered and thereby conserve our nation's biological infrastructure, we must look beyond the ESA and craft ways to accommodate more native species in areas where we live, work, and recreate. (15)

Successes of the ESA

The ESA came under fire for not succeeding in recovering many species. In response, many argued that endangered species conservation is fighting against great odds and that recovery might not be the best metric for success, citing that the amount of time that the act has been in operation is relatively short (decades) compared to the time that species have been declining (centuries); that the recovery of some

species may be near impossible as they are too close to the brink of extinction and are inhibited by demographic, genetic, and habitat limitations; and that the conservation and restoration of species is increasingly difficult in a world with a growing human population, increasing habitat destruction and spread of invasive species, and accelerating climate change. Despite these overwhelming difficulties, the ESA does have some positive results to show.

Writing in 2001, Gregory D. Hayward and colleagues argued that the "mismatch between the temporal scales of the extinction process and the implementation of the ESA" limits analysts' ability to judge the ESA's success given that, at the time their contribution was published, less than three decades had elapsed since the act's passage (9). One alternative measure of the effectiveness of the ESA may be the capacity of the act to prevent the extinction of declining species—a criterion by which the act can be judged to have largely been successful. In a 1999 study, Mark W. Schwartz roughly calculated that ESA protection had prevented as many as 187 extinctions, by regulating takes, preserving habitat, and developing recovery plans.

In their 2005 study, Taylor and his colleagues argued that the ESA is effective legislation, based on their findings that (1) the longer a species is listed, the more likely it is to be improving; (2) species with critical habitat designation for two or more years are more likely to be improving; and (3) species with dedicated recovery plans for two or more years are more likely to be improving. They argued that the benefits of listing include recovery plans, protection from unauthorized takes, protection of critical habitat, increased scientific research, captive breeding, public education, and habitat restoration and acquisition. These findings suggest that these conservation measures are effective and that they act cumulatively over time. In order to improve the efficacy of the act, Taylor and his colleagues advocated the early listing of species, as they found threatened species to be more prone to recovery than endangered species, and also argued for the protection of critical habitat and the creation of dedicated recovery plans.

Prospects for the future

As of 2013 there was wide agreement that the Endangered Species Act could be made more efficient and effective. A few of the most common and compelling suggestions were to increase oversight and regulation of takes, increase data collection on species, modify the listing process, and increase incentives for conservation on private property. All of these calls for improvements, however, require increased funding—the key to improving the act's effectiveness.

In a 2006 article, Fidel Hernández and colleagues argued that many recovery plans are limited in their effectiveness because they suffer from a lack of scientific data. These researchers argued that the data that do exist need to be used more effectively in order to create better recovery plans and that the development of academic–agency partnerships could help improve the use of existing data and foster further research in areas in which significant data are lacking. Partnerships between regulatory agencies and academics could increase the effectiveness of conservation expenditures by focusing research on areas of concern.

The most hotly debated aspect of the ESA is the conservation of endangered species on private property. Robert Bonnie, in a 1999 article, argued that mitigation banking of endangered species habitat may be an important improvement to the act. This concept would allow for landowners to destroy habitat legally if they were to buy mitigation credits. This money would be used to incentivize the protection and restoration of habitat in other areas and could allow specialists to plan where best to protect and restore habitat to benefit the species in question. Bonnie contended that mitigation banking could also significantly reduce conflicts between endangered species and private property advocates. Stephen Polasky and Holly Doremus, writing in 1998, argued that the current design of the act, by placing a huge burden on the government to identify and conserve habitat, while providing compensation to landowners only in extreme cases, provides little incentive for cooperation and the preservation of habitat. They also stated that, in order to address this problem, increased compensation, in the form of tax credits, land swaps, or other noncash measures, could be provided to landowners who forego development and provide habitat for listed species. Similarly, Polasky and Doremus argued that conservation policy should *reward* landowners who discover that they have endangered species on their land, rather than punishing them with regulations and penalties. These authors contended that endangered species preservation needs to do a better job of preserving species and habitat on private property to be successful, and they argued that society as a whole should bear the costs of endangered species conservation, rather than individual property owners. In his 2006 study, Langpap also found that incentives, particularly compensation and assurances, can be effective at improving the conservation of endangered species on private property and also provided evidence that the traditional regulatory approach to conservation on private property has generated perverse incentives for landowners to discourage the presence of endangered species on their property.

The ESA has served to protect hundreds of species from extinction and has directly and indirectly contributed to the preservation of millions of acres of habitat for wildlife conservation. Simultaneously, the ESA has affected human activities, such as ranching, logging, recreation, and development. Despite many successes, the US federal government is not meeting its self-stated goals as outlined in the ESA to recover endangered species. Increased funding and, arguably, significant modifications to the legislation may be necessary for this to occur.

International conservation strategies

Treaties are the primary international governmental mechanisms for promoting biological conservation. A treaty is a voluntarily signed agreement by member parties that are dedicated to championing a certain cause. Once signed, a treaty may be legally binding. Arguably the two most important international treaties pertaining to biological conservation are the Convention on International Trade in

Endangered Species of Wild Fauna and Flora (CITES) and the United Nations Convention on Biodiversity. In addition, it is worth considering the important role of the International Union for Conservation of Nature (IUCN) in bringing together governmental and nongovernmental organizations to develop conservation strategies, as well as its Red List of Threatened Species, which is the international standard for the status assessment of species.

CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has been called "perhaps the most successful of all international treaties concerned with the conservation of wildlife" (Kubasek and Silverman 2005, 435). Annually, the international trade in wildlife is estimated to be worth billions of dollars and to include hundreds of millions of plants and animals. The value of some species and their by-products on the international market is extremely high, and the demand for them places an enormous incentive for their harvest and trade. Such harvesting can have dire consequences on wildlife populations and has caused many species to decline to the point at which they are approaching extinction. Other traded species continue to be common, but the regulation of their trade is necessary to prevent overharvesting and a resulting decline. The goal of CITES is to regulate this trade in order to protect threatened and endangered species, as well as to prevent the declines of more common species. In the early 2000s, CITES provides varying degrees of oversight and protection for over 30,000 species.

CITES has its origins in the Convention Relative to the Preservation of Fauna and Flora in Their Natural State, signed in London in 1933. This agreement was sought primarily for the protection of African game species that were being heavily hunted and exported at the time. There were several other regional attempts at controlling the trafficking of wildlife in the mid-twentieth century, but none was sufficiently comprehensive at regulating the global trade, until CITES was signed into law by twenty-one countries in March 1973 (CITES Secretariat 2012). The treaty was planned and drafted as the result of a resolution by the International Union for Conservation of Nature (IUCN) in a 1963 meeting. The final text was agreed on in a convention in Washington, D.C., attended by eighty countries in March 1973. On July 1, 1975, CITES became law after being ratified by ten member countries. Since its founding, CITES has been one of the international conservation agreements with the largest memberships—by 2013, 177 countries had become members (CITES Secretariat 2013).

All import and export of species on the CITES species list is to be authorized through a licensing system. Each country is responsible for creating a management authority, in charge of administering the licenses, and a scientific authority, to advise on the effects of trade on the status of species. Species fall into three categories of regulation: Appendixes I, II, and III. Appendix I species are endangered, and trade in these species will be authorized in only the most extraordinary of circumstances. Appendix II species are considered to be vulnerable to extinction if freely traded, and thus trade is highly restricted. Appendix III species are protected within a country that has ratified CITES and that is seeking the cooperation of other nations in protecting the species. Enforcement of the treaty is left to signatory countries. In the United States, it is implemented through and augmented by the Endangered Species Act (CITES Secretariat 2013).

In 2000 the IUCN completed a comprehensive review of CITES and drew the following conclusions:

- Through its monitoring requirements, CITES has developed the most comprehensive database on international trade in species.
- CITES has been very effective at reducing the trade in some species. The IUCN cited wild cats, nonhuman primates, bears, marine turtles, reptiles (skins), and plants as examples of successes.
- CITES has failed to effectively manage the trade of other species. The IUCN cited the rhinoceros as an example of this.
- There has been little study of the status or trade of most of the species on the CITES species list, so it is difficult to conduct a thorough analysis of the effectiveness of the legislation.
- The treaty has continued to evolve with the times, proving flexible. Several "innovative measures" have been ratified in subsequent conventions since 1973. This flexibility seems to be one of the best traits of the legislation (IUCN 2000).

The IUCN further highlighted the limitations of CITES, pointing out that while the goal is to conserve wildlife, and that while some of the species listed under CITES have been declining, these declines in many cases fall outside the jurisdiction of the treaty, which is responsible solely for regulating international trade in species. There are, of course, many other factors that can contribute to the decline of species. In its review, the IUCN stated that the limited scope of CITES also makes it difficult to evaluate the effectiveness of the convention, as a number of factors that are not overseen by CITES may contribute to the decline of listed species.

In a 2009 article, Max Abensperg-Traun argued that CITES could be improved by promoting incentive-driven conservation, rather than its current regulation scheme. He noted that the use of and trade in wildlife in developing countries is often an imperative rather than a choice and argued that incentive structures that are developed on local levels are likely to be more effective measures of preserving species. Abensperg-Traun called for the promotion of trade in alternate species, while regulating others, in order to offset the economic hardships in developing countries. Other key issues with CITES include a lack of scientific research on most CITES-listed species and a lack of enforcement. Member countries are responsible for enforcement but often lack the resources and training to adequately identify, much less regulate, the trade of the 30,000-plus listed species.

The Convention on Biological Diversity

In recognition of the value of biodiversity and the pressing threats to its wellbeing, the United Nations Environment

Programme in 1988 called for a convention on biodiversity to address related issues. At a 1992 conference held in Nairobi, Kenya, the text of the Convention on Biological Diversity (CBD) was agreed on, and it was opened for signing later that year at the United Nations Conference on Environment and Development held in Rio de Janeiro, Brazil (also known as the Earth Summit). The CBD was implemented in December 1993 after being signed by 168 parties. It established three main goals: the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of the benefits from the use of genetic resources (Secretariat of the Convention on Biological Diversity 2000).

The goals of the CBD are comprehensive and forward thinking, arguing for a new global consciousness and plan for the protection of biodiversity and the fair and equitable use of natural resources. Signatories to the convention agree to "conserve and sustainably use biodiversity" and are required to develop national biodiversity strategies and action plans in relation to sectors of the economy, including forestry, agriculture, fisheries, energy, transportation, and urban planning. By signing the convention, nations also commit to identify and monitor biodiversity in need of conservation, establish protected areas, restore degraded ecosystems, promote traditional and indigenous knowledge of the sustainable use of biodiversity, manage invasive species, control organisms modified by biotechnology, promote public participation and awareness, and report on their progress in these areas (Secretariat of the Convention on Biological Diversity 2000). The convention's authority comes from the Conference of the Parties (COP), which consists of all ratifying governments. The COP reviews progress, identifies priorities, and establishes work plans.

The CBD has provided an important framework under which nations can establish goals, oversee progress, highlight directions for future research, and distribute funding to developing nations. This convention, however, lacks any enforcement mechanisms to certify that biodiversity will be protected. In some ways it parallels the conservation legislation in the United States leading up to the Endangered Species Act, particularly the Endangered Species Preservation Act of 1966, which had lofty rhetoric espousing the conservation of species but few legislative mechanisms to enforce these goals. Likewise, the CBD has established a framework and ethic for international biodiversity conservation that may set the stage for more formidable and binding legislation in the future.

IUCN

The International Union for Conservation of Nature (IUCN) is the world's oldest and largest international network promoting environmental conservation. It has a democratic structure for determining policies and has a membership that includes more than 1,000 governmental and nongovernmental organizations worldwide, with a mission to "influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable" (IUCN 2013a). In practice, the IUCN supports scientific research, manages field projects, and brings governmental and nongovernmental organizations together to develop and implement conservation policy. Importantly, the IUCN publishes the Red List of Threatened Species, the world's most comprehensive conservation status list for species. The stated goal of the Red List is to "provide information and analyses on the status, trends and threats to species in order to inform and catalyse action for biodiversity conservation" (IUCN 2013c). In 2012 the Red List included nearly 66,000 species assessments, almost four times as many as were included in 2000. Further, the list has expanded from the original focus on mammals and birds to include most other taxa (Godfrey et al. 2008).

The current global status of species

According to the most recent analysis of the Red List, conducted by Jean-Christophe Vie, Craig Hilton-Taylor, and Simon N. Stuart and colleagues, an estimated 1.8 million species have been described by science (Vié et al. 2009). Estimates of the actual number of species in existence vary widely—from 2 million to 100 million—but tend to converge around 8 million to 9 million species (Mora et al. 2011). However, a recent review estimates the number of species in the world as 5 ± 3 million (Costello et al., 2013). As of 2012, only 3.8 percent of the world's described species have had their status assessed by the IUCN's Red List. There are strong biases regarding which species have been assessed, favoring terrestrial vertebrates and plants in well-studied regions of the globe. Nevertheless, these assessments still provide an important window into the trends in species worldwide. In general, species that are restricted in their geography and dispersal ability are more vulnerable to extinction than the converse. For example, as a group, amphibians are more threatened than birds, while the range-restricted cycads are more threatened than the more cosmopolitan conifers.

In addition, this same report highlighted the general scientific consensus that climate change will play an increasingly important role in driving species extinctions (e.g., Sekercioglu

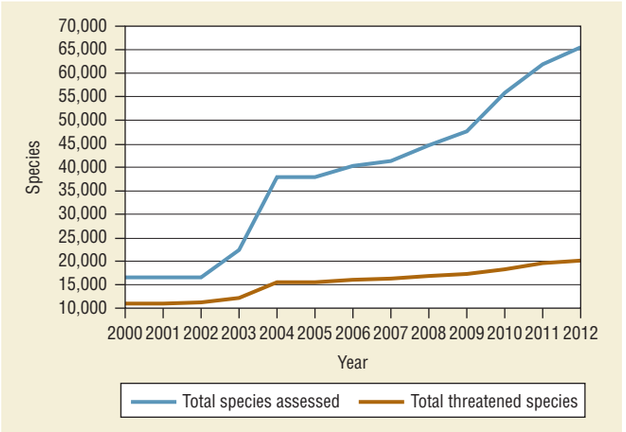


Figure 2. Assessed species versus threatened species. Reproduced by permission of Gale, a part of Cengage Learning.

et al. 2012; Wormworth and Sekercioglu 2011). Particularly vulnerable are species that have specialized habitats, have narrow environmental tolerances, depend on interspecies interactions, or have limited dispersal ability. The report conducted more specific assessments of the susceptibility to climate change of three groups and found that 35 percent of birds are particularly susceptible, 52 percent of amphibians, and 71 percent of warm-water reef-building coral species.

As of 2008, there were 869 recorded extinctions, with an additional 290 species that were listed as "possibly extinct." In addition, 3,246 species were listed as critically endangered; 4,770 as endangered; 8,912 as vulnerable; and 3,796 as near threatened. Also at that time, 5,570 species were listed as data deficient, while 17,675 species were determined to be of least concern. Of all the assessed species worldwide, 38 percent were threatened with extinction (listed as critically endangered, endangered, or vulnerable; Vie et al, 2008). These numbers are indicative of a world out of balance. Urgent and comprehensive conservation strategies are necessary to slow or reverse these disturbing trends.

The future is ours to write

The endangered species concept has a long history with origins dating back centuries, but it has developed greatly over the last several decades into a topic of utmost interest and concern in modern society. Different philosophies for why endangered species are important to conserve have been developed and expanded on, with arguments citing the ecosystem services provided by biodiversity, as well as the ethical and even religious responsibilities that humans may have to nature.

In 1973 the United States enacted the Endangered Species Act, which is regarded as the most comprehensive and stringent endangered species legislation the world has ever seen. While the act has succeeded in some instances, it has been criticized as being ineffective at fulfilling its goal of preventing extinctions and restoring populations of threatened and endangered species. The most important legislation internationally, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, has sought to regulate trade in threatened and endangered species, while the United Nations Convention on Biodiversity has encouraged biological conservation through the establishment of biological reserves, the promotion of cooperation and education, and the facilitation of the funding of projects in developing countries. International legislation has also had some important successes but is limited and nonbinding, relying on countries to join voluntarily and to self-enforce. With funding for regulation and conservation lacking, species have continued to decline both in the United States and internationally since the inception of these laws, proving that the existing strategies have been largely insufficient at protecting and restoring species worldwide.

In the early 2000s, endangered species conservation is likely more pressing and difficult than it has ever been. Species are increasingly threatened by the continued growth of human populations, the ongoing destruction of habitat, and the ominous threats posed by global warming. As mentioned above, 38 percent of all evaluated species have been deemed threatened with extinction. Yet, there is hope. The existing body of national and international legislation, scientists' rapidly expanding knowledge of natural systems, and the growing concern for the environment among younger generations provide a framework from which to springboard into the next era of biological conservation—an era that humanity should feel compelled to define anew. While endangered species conservation is up against great odds, the ethical and economic importance of maintaining biodiversity merits great measures.

Resources

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