CHAPTER EIGHT

Biodiversity

Biodiversity is the sum of all the biological differences among living things, whether at the species level, genetic level, or ecosystem/community level. As expressed by The Keystone Center in a 1991 report, biodiversity is "the variety of life, and its processes; including the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur." Implicit in this definition are the interacting, interdependent structures and functions among the genetic, species, and ecosystem levels of biota and their physical, chemical, and biological environment.

From an ecological-economic standpoint, biodiversity is important for the "goods and services" provided to living systems, including human systems. Some of those services are the capture of solar energy (plants); conversion of that energy into food, fiber, fuel, and pharmaceuticals (plants); pollination of fruit-providing plants (bees, butterflies, and hummingbirds); dispersal of seeds (animals); decomposition of waste (microbes); filtration of water (plants); and purification of air (plants). Conversely, biota require goods and services provided by their habitats, and the condition of habitat-specific biota reflects the condition of that environment. As the integrity of a habitat is destroyed through degradation, fragmentation, or contamination, the species living there are affected.

The United Nations Environment Programme cites 13.6 million as a reasonable estimate of the total number of species on Earth. Of this total, nearly 60 percent are insects; another 21 percent are bacteria, fungi, or viruses. Fewer than one eighth of all species have been scientifically described.

Species richness generally increases moving from colder polar regions to hotter tropical regions. This distribution is exemplified by the tally of species abundance in North American countries (Table 8.1).

RECENT TRENDS

The Nature Conservancy and state agency-based Natural Heritage Network maintain databases with information on more than 28,000 U.S. species and an additional 11,000 subspecies and varieties. In 1996, The Nature Conservancy reported on the conservation status of 20,481 native U.S. species, representing 13 major groups of plants and animals that have been classified and studied in sufficient

Table 8.1 Abundance of Species in North American Countries

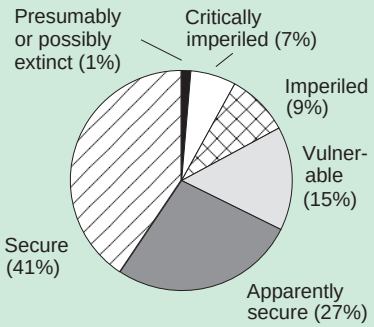
	Mammals	Birds	Reptiles	Plants
Canada	197	462	42	3,220
United States	466	1,090	368	20,000
Mexico	439	961	717	20,000

Source: World Resources Institute, *World Resources 1992-93* (Oxford University Press, New York, 1992).

detail to allow status assessment for each of their species.

The Nature Conservancy analysis revealed that, based on their global rarity, almost one third (32 percent) of the species surveyed were in some danger (Figure 8.1). About 1.3 percent were presumed or possibly extinct, 6.5 percent were classified as critically imperiled, another 8.9 percent were imperiled, and 15 percent were classified as vulnerable. States in the Southwest and Southeast harbor the greatest number of imperiled species (Figure 8.2). Hawaii and California both have more than 600 imperiled species and subspecies.

Figure 8.1 Status of U.S. Plant and Animal Species, 1995



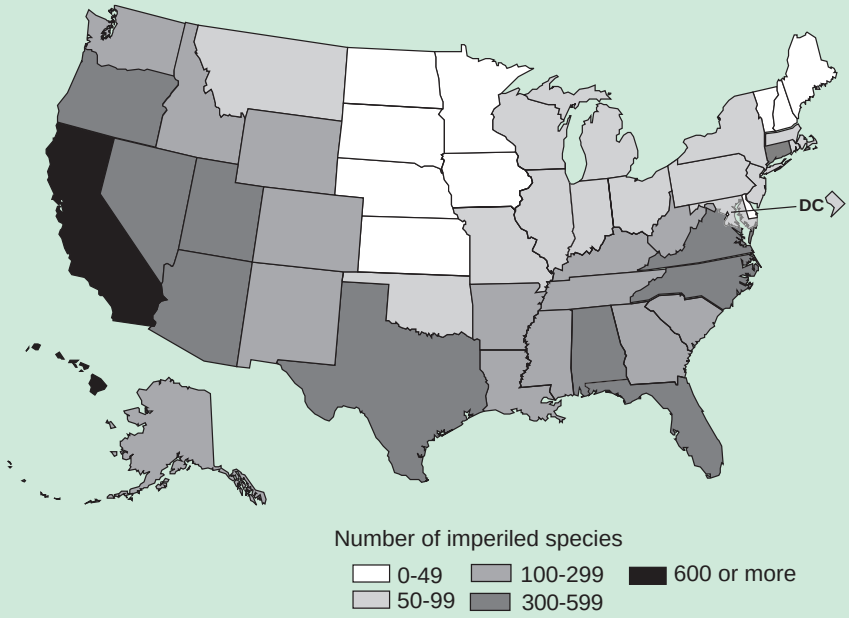
Source: The Nature Conservancy, *Priorities for Conservation: 1996 Annual Report Card for U.S. Plant and Animal Species* (TNC, Arlington, VA, 1996).
Note: Total=20,481 species; does not include 346 species not yet ranked.

The work done by.The Nature Conservancy and Heritage Network complements that done by the Defenders of Wildlife, which identified the 21 most-endangered ecosystems of the United States (see also Chapter 7, "Ecosystems," Figure 7.1). These reports corroborate studies done by federal and state agencies and by academia identifying correlations between ecosystem degradation, fragmentation, or contamination and species found at risk. A compilation of many of those studies—especially those addressing species status and trends—was prepared by the Department of the Interior's National Biological Service as *Our Living Resources*; this publication is the basis for much of the following discussion.

Species Dependent on Aquatic Systems

Records of species at risk indicate that those dependent on aquatic systems for all or part of their life cycle are in the most dire condition. The four groups

Figure 8.2 Biodiversity Hotspots by State, 1995

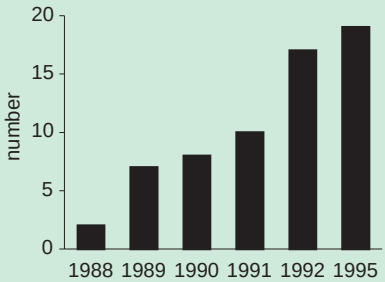


Source: B.A. Stein, "Putting Nature on the Map," *Nature Conservancy* (TNC, Arlington, VA, January/February 1996).

most at risk—freshwater mussels, freshwater fishes, crayfish, and amphibians—all depend on rivers, streams, or lakes; they generally spend their life cycle confined to a single watershed or reach of the waterway.

Mussels. In many national waterways, mussel populations have suffered badly from habitat loss as a result of dam construction, channelization, dredging operations, and water pollution. Dam construction alone has wiped out 30 to 60 percent of native mussel populations in some rivers. Competition from nonnative mollusks, notably the Asian clam and the recently introduced zebra mussel, also contributes to the decline. During the next 10 to 20 years, zebra mussels will most likely spread throughout most of the United States and southern Canada (Fig-

Figure 8.3 U.S. States Affected by Zebra Mussels, 1988-1995



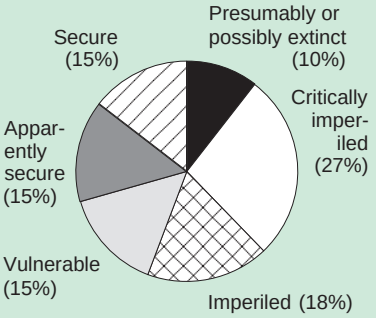
Source: A.J. Benson and C.P. Boydstun, "Invasion of the Zebra Mussel in the United States," In: *Our Living Resources,* LaRoe et al, eds., U.S. Department of the Interior, National Biological Service (GPO, Washington, DC, 1995).

ure 8.3). This exotic species attaches to the surface of native mussels in such high numbers that the native species are unable to breathe or eat.

Both the National Biological Service and The Nature Conservancy report that about two thirds of all native mussel species are in danger (Figure 8.4). According to Interior Department figures, only 70 of 297 native mussel species appear to have stable populations, and many of these species have declined in abundance and distribution since the late 1800s (Figure 8.5).

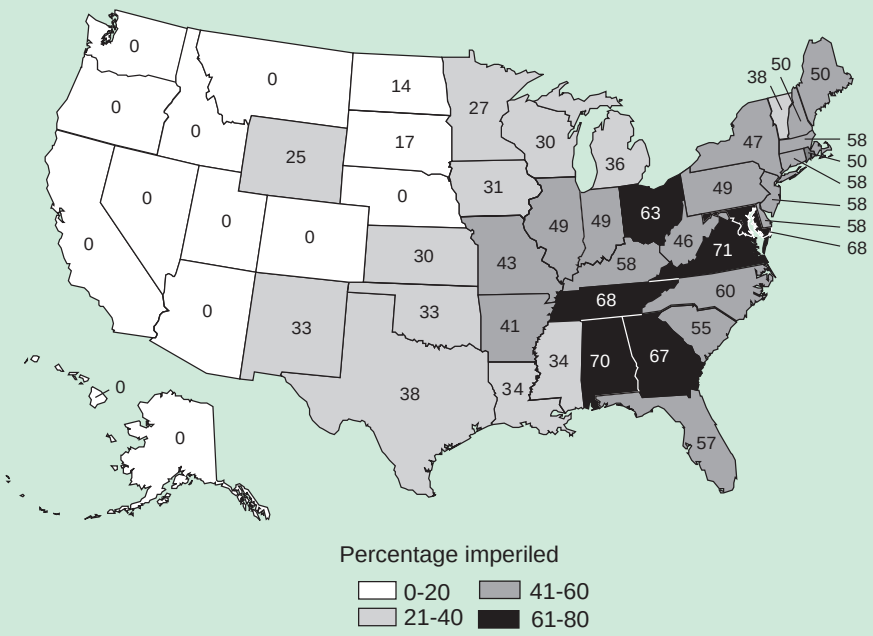
Freshwater Fishes. Freshwater fishes also are experiencing relatively rapid changes in their habitats, often causing

Figure 8.4 Status of U.S. Freshwater Mussel Species, 1995



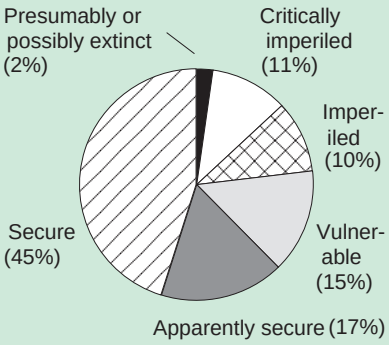
Source: The Nature Conservancy, *Priorities for Conservation: 1996 Annual Report Card for U.S. Plant and Animal Species* (TNC, Arlington, VA, 1996).
Note: Total=311 species; does not include 15 species not yet ranked.

Figure 8.5 Imperiled Freshwater Mussels by State, 1993



Source: J.D. Williams and R.J. Neves, "Freshwater Mussels: A Neglected and Declining Aquatic Resource," In: *Our Living Resources,* E.T. LaRoe, G.S Farris, C.E. Puckett, P.D. Doran and M.J. Mac, eds., U.S. Department of the Interior, National Biological Service (GPO, Washington, DC, 1995), p. 178.

Figure 8.6 Status of U.S. Freshwater Fish Species, 1995



Source: The Nature Conservancy, *Priorities for Conservation: 1996 Annual Report Card for U.S. Plant and Animal Species* (TNC, Arlington, VA, 1996).
Note: Total=815 species; does not include 10 species not yet ranked.

risks to their survival. Fish species have adapted to a variety of conditions in the United States. Some of the species found in the country are old, primitive forms such as the sturgeon, gar, paddlefish, and bowfin; as well as younger and more genetically advanced species such as sunfishes, minnows, and darters.

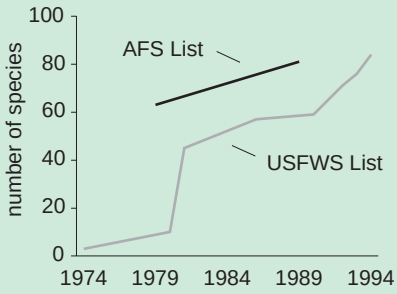
Of the roughly 800 native freshwater fish species in the United States, The Nature Conservancy estimates that about 35 percent are imperiled or vulnerable (Figure 8.6). The American Fisheries Society (AFS) in 1979 developed a list of 198 native fish species judged in danger of disappearing; in 1989, the AFS list had grown by 25 percent to 254 species.

The vast majority of imperiled species are threatened by the deteriorating quality of their aquatic habitats, either through habitat destruction or contamination. Factors such as overharvesting, introduction of nonnative fish and other species, and disease seem to be less significant threats to fish populations.

Many imperiled species have local distributions—some are restricted to particular reaches of a single watershed; others, such as the Devils Hole pupfish, are limited to a single spring. These species could be lost by a single, isolated, debilitating event. Other species, such as paddlefish and sturgeons, depend on large rivers. Their imperiled status indicates widespread threats to these extensive habitats.

According to the AFS list, the Southwest and Southeast have the highest average number of fish species listed per state (Figure 8.7). In the Southeast, a relatively high proportion of minnows, darters, and madtom catfishes are imperiled. In many cases, sedimentation and siltation resulting from poor land-use practices are

Figure 8.7 Imperiled Fishes in the U.S. Southeast, 1974-1994



Source: Walsh et al., "Southeastern Freshwater Fishes," In: *Our Living Resources,* LaRoe et al, eds., U.S. Department of the Interior, National Biological Service (GPO, Washington, DC, 1995).
Note: USFWS=U.S. Fish and Wildlife Service. AFS= American Fisheries Society.

White sturgeon, the largest freshwater fish in North America, has been negatively affected by overexploitation, poaching, and habitat alteration due to hydropower dams.

Photo Credit:
Courtesy of Oregon Historical Society

eliminating habitat for these bottom-dwelling species.

The cumulative effect of habitat degradation also has caused widespread fragmentation (that is, more populations living in smaller, unconnected habitats) of many species, which adds to the challenge of trying to reverse and restore any diminished genetic reserves of fish populations. Introduction programs can also cause the loss of genetic diversity; for example, the introduction of the Florida largemouth bass has compromised the genetic integrity of all populations of northern largemouth bass into which the species has been introduced in the Southeast.

In the Pacific Northwest, stocks of salmon and steelhead in the Columbia River basin are down by more than 80 percent from historic levels. Similarly, in California, salmon stocks are down 65 percent, and winter-run chinook salmon in the Sacramento River have been reduced by more than 97 percent in the last 20 years.

White sturgeon—the largest freshwater fish in North America, found in the Sacramento-San Joaquin, Columbia, Snake, and Fraser Rivers—has been negatively affected by overexploitation, poaching, and habitat alteration due to hydropower dams. Of the 11 fish communities isolated upstream between dams on the Columbia River, white stur-

geon are known to be relatively abundant in only three. In the lower reaches of the Columbia, the recent adoption of more restrictive harvest regulations may have allowed populations to stabilize.

Reptiles and Amphibians. Because reptiles and amphibians are critical to the natural functioning of many ecological processes, the species in these groups are key components of important ecosystems. Furthermore, the benefits to human medical practices in understanding basic biological processes from study of amphibian metamorphosis and development are significant.

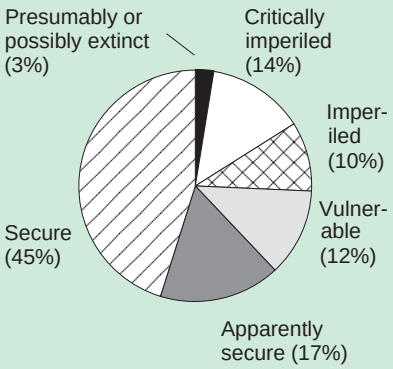
The native herptofauna of the continental United States comprise about 230 species of amphibians (about 62 percent of which are salamanders and 38 percent frogs) and about 277 species of reptiles (about 19 percent turtles, 35 percent lizards, 45 percent snakes, and fewer than 1 percent crocodilians). Another 2 species of turtles, 17 lizards, 2 snakes, and 1 crocodilian have been introduced.

The Nature Conservancy provides information on the status of amphibians (Figure 8.8). For example, the coastal plain of the southeastern United States, which is identified as an endangered ecosystem (see also Chapter 7, "Ecosystems"), contains a rich diversity of reptiles and amphibians. Of the 290 species native to the Southeast, 170 (74 amphibians, 96 reptiles) are found within the range of the remnant longleaf pine ecosystem. Many of these species are not found elsewhere, particularly those amphibians that require temporary ponds for reproduction. Many coastal plain species are listed federally or by states as endangered or threatened or are candidates for listing. Examples include the flatwoods salamander, striped newt, Carolina and dusky gopher frogs, eastern indigo snake, gopher tortoise, eastern diamondback rattlesnake, and Florida pine snake.

Habitat degradation and loss seem to be the most important factors adversely affecting amphibian and reptile populations. The drainage and loss of small aquatic habitats and their associated wetlands have had a major adverse affect on many amphibian species and some reptiles.

Many other factors have been involved in the decline of amphibian and reptile populations; most—perhaps all—of these are human-caused. For example, nonnative species of gamefish introduced for sport are thought to be one reason for the declines of frog populations in mountainous areas of some western states.

Figure 8.8 Status of U.S. Amphibian Species, 1995

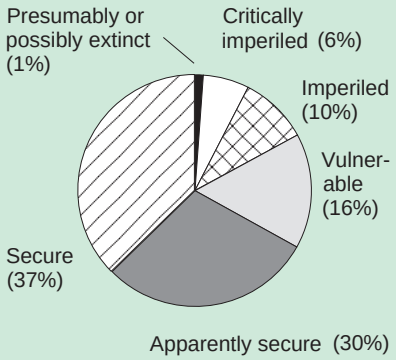


Source: The Nature Conservancy, *Priorities for Conservation: 1996 Annual Report Card for U.S. Plant and Animal Species* (TNC, Arlington, VA, 1996).
Note: Total=237 species.

Plants and Fungi

This section describes trends in two of the major groups of life on earth: green plants and fungi, including mushrooms, lichens, and molds. Members of the plant and fungal groups have both economic and ecological importance. Plants transform solar energy into usable economic products essential to society and provide the basis for most life on earth by generating oxygen as a product of photosynthesis. Fungi not only mediate critical biological and ecological processes, including the breakdown of organic matter and recycling of nutrients, but also play important roles in symbiotic association with plants and animals. Some fungi also produce commercially valuable substances including antibiotics and ethanol; others are pathogenic and cause damage to crops and forest trees.

Figure 8.9 Status of U.S. Vascular Plant Species, 1995



Source: The Nature Conservancy, *Priorities for Conservation: 1996 Annual Report Card for U.S. Plant and Animal Species* (TNC, Arlington, VA, 1996).
Note: Total=18,156 species; does not include 262 species not yet ranked.

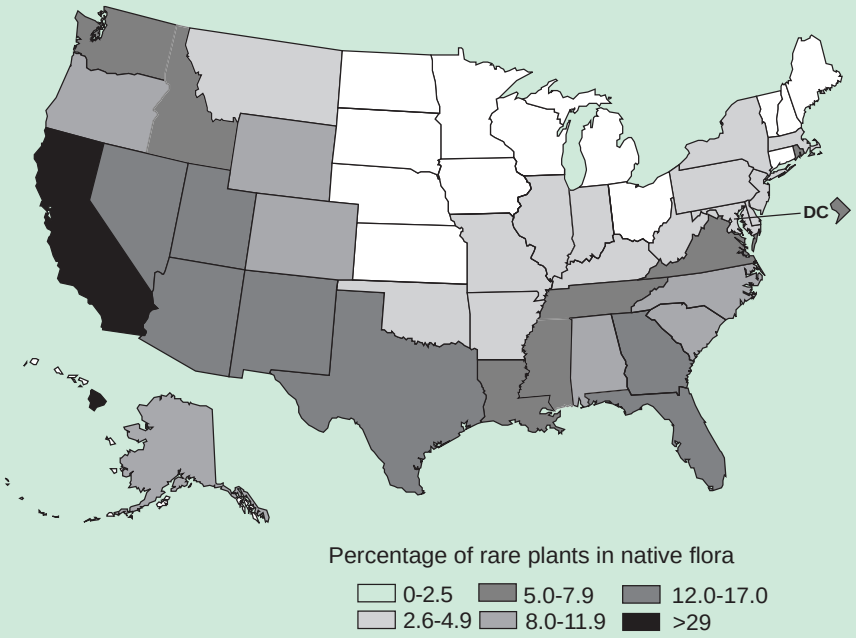
Plant estimates range upward from 17,000 species; only 5 to 10 percent of the estimated 1.5 million fungal species worldwide have been described. California, with 5,000 species, and southern states such as Texas (4,500 species) have the largest number of native vascular plant species in the United States (Figure 8.9). Arizona, Florida, Georgia, New Mexico, and Oregon each have over 3,000 native species.

Habitat loss and incompatible land use are the major threats to most rare U.S. plant species. Species at higher risk of extinction usually include those having small geographic ranges, narrow habitat requirements, unusual life histories, or vulnerability to exotic pests or diseases.

Of the 16,000 vascular plants in The Nature Conservancy survey, about 2,500 are considered imperiled. Globally rare native species are concentrated in the southern and western states (Figure 8.10). Even globally common species may not be altogether secure in the U.S., however; 110 globally common species have been lost from three or more states, and more than 35 have been lost from four or more states.

Opportunistic nonindigenous plant species often displace native plants, particularly those whose habitats have been disturbed. Hundreds of invasive nonnative species have become management problems in many natural areas. Although importation bans and other measures have been imposed by the federal government for a number of species, strict compliance is difficult to implement. Since about 1970, the rate of

Figure 8.10 Proportion of Globally Rare Vascular Plant Species by State, 1994



Source: L.E. Morse, J.T. Kartesz and L.S. Kutner, "Native Vascular Plants," In: *Our Living Resources,* E.T. LaRoe, G.S Farris, C.E. Puckett, P.D. Doran and M.J. Mac, eds., U.S. Department of the Interior, National Biological Service (GPO, Washington, DC, 1995), p. 207.

increase of exotic introductions appears to have moderated, however.

Plant surveys have shown that a significant number of plants are more common than previously believed. For example, Merriam's bearpaw poppy, a native of southern Nevada and neighboring parts of California, has been considered rare and possibly endangered. During an inventory of Nellis Range Air Force Base carried out as part of the Defense Department's Legacy Resource Management Program, many previously unknown populations of the poppy were discovered.

Even a few species that were thought to be extinct have been recently rediscovered. The running buffalo clover was rediscovered in West Virginia in 1983 and subsequently in four other states. During the 1991 field season, the yellow passionflower was found at two sites in Delaware for the first time since the early 1800s. Such examples underscore the value of ongoing inventories and the dynamic nature of local and regional flora.

Loss of biodiversity increases the significance of germ plasm management and conservation. Preservation of the tissues and seeds that comprise the nation's plant germ plasm is the responsibility of the National Plant Germplasm System (NPGS), a diffuse network of cooperative federal and state laboratories and

research stations. Many NPGS collections are considered to be valuable national and global resources for use by agricultural scientists and plant breeders in research to improve crops.

Mammals

Many mammalian population studies have been initiated to determine a species' biological or ecological status because of its perceived economic importance, abundance, threatened or endangered status—or because it is viewed as our competitor for specific resources or habitat. As a result, data on mammalian populations in the United States have been amassed by researchers, naturalists, trappers, farmers, and land managers for years.

The inventory and monitoring programs that produce data about the status and trends of mammalian populations are significant for many reasons. For one thing, mammalian species are significant biological indicators for assessing the overall health of advanced organisms—such as humans—in an ecosystem.

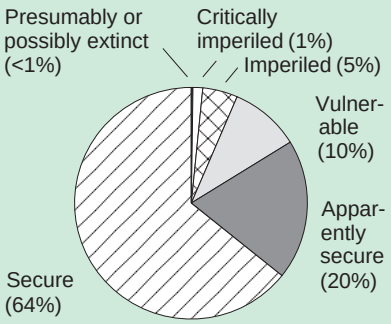
As a group, mammals are relatively secure. Of the 433 mammals listed in The Nature Conservancy's report, 6 are imperiled and 21 are vulnerable (Figure 8.11).

Rapid and sustained habitat and landscape changes, unregulated hunting and trapping, indiscriminate predator and pest control, and urbanization are among

Recolonization of the gray wolf has been successful at Yellowstone National Park.

Photo Credit: L.D. Mech
National Biological Service

Figure 8.11 Status of U.S. Mammal Species, 1995



Source: The Nature Conservancy, *Priorities for Conservation: 1996 Annual Report Card for U.S. Plant and Animal Species* (TNC, Arlington, VA, 1996).
Note: Total=433 species.

the factors that have contributed to the decline of some mammalian populations in North America.

For example, by 1960, the gray wolf was exterminated from all of the United States except for Alaska and northern Minnesota. Following the 1994 Environmental Impact Statement and recovery plan, 34 wolves were reintroduced into Yellowstone National Park and central Idaho during two periods, January 1995 and January 1996. The program is considered successful; the population has expanded to 50 wolves to date. Wolf populations have recovered somewhat since the mid-1970s; the Minnesota population is now estimated at about 2,000. Recolonization also has been successful at Glacier National Park and the surrounding area in Montana, which now has a population of 8 to 10 packs.

Despite being listed as a threatened species in 1975, five of the seven remaining grizzly bear populations in the United States do not have optimistic prospects.

Photo Credit:
National Biological Service

Triplet bald eagles born at George Washington's Birthplace National Monument, Popes Creek, Virginia.

Photo Credit: National Park Service

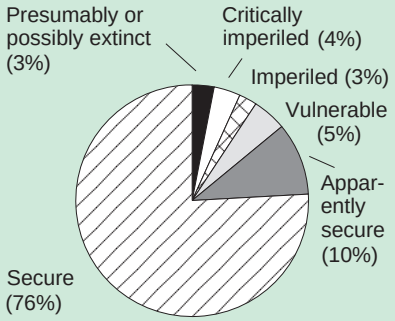
Grizzly bears once roamed over most of the West. In the Great Plains, they favored areas near rivers and streams, where conflict with humans was likely. For this and other reasons, grizzly bears in the United States were vigorously sought out and killed by European settlers in the 1800s and early 1900s. Since listing of the grizzly bear as threatened in 1975, populations have probably stabilized in the Yellowstone and northern Continental Divide ecosystems. But five of seven potential or existing populations do not have optimistic prospects, and even the two largest populations remain at risk.

One of the first species recognized as imperiled was the black-footed ferret. This member of the weasel family is closely associated with prairie dogs, which provide ferrets with both food (they comprise 90 percent of the ferret diet) and shelter (ferrets live in prairie dog burrows). As prairie dog colonies were eradicated by prairie dog control campaigns, ferret populations also declined. Black-footed ferrets, almost extinct by 1985, are being reintroduced from captive breeding. Because of inbreeding, however, their population lacks genetic diversity.

Birds

Birds are valued and highly visible components of natural ecosystems; they are also regarded as good indicators of environmental quality. Moreover, migratory bird populations are an international resource for which there is special federal

Figure 8.12 Status of U.S. Bird Species, 1995



Source: The Nature Conservancy, *Priorities for Conservation: 1996 Annual Report Card for U.S. Plant and Animal Species* (TNC, Arlington, VA, 1996).
Note: Total=759 species.

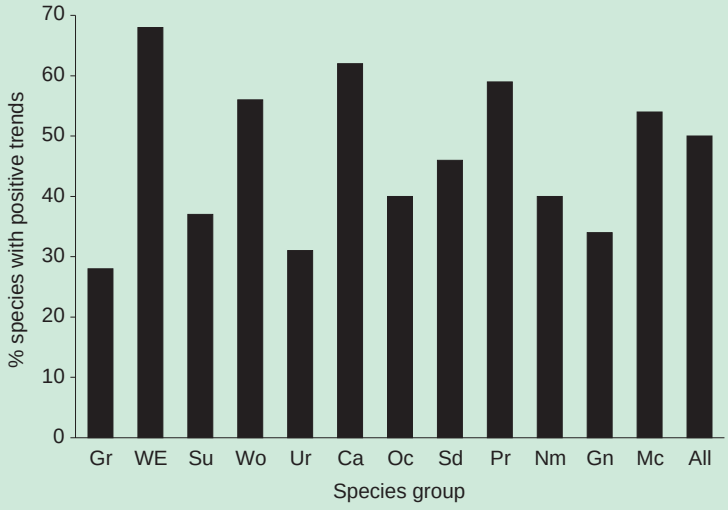
responsibility. Many efforts thus have been directed at measuring and monitoring the condition of North American's migratory birds. This monitoring task is not an easy one, because the more than 700 U.S. species of migratory birds are highly mobile with highly variable migratory patterns, and may appear in the United States only during part of their annual cycle.

As a group, bird species have the lowest ratio of imperiled to secure species in The Nature Conservancy survey. Of the total 759 bird species surveyed, only 6.2 percent were in the imperiled categories (Figure 8.12). Overall, roughly equal numbers of species appear to be increasing and decreasing over the past two to three decades. In general, species that are increasing are usually those that are able to adapt to altered habitats, while declining species are often "specialists" more vulnerable to habitat loss. The most consistent declines are among grassland birds (Figure 8.13).

Long-range data series are available on migratory and nonmigratory birds. Between 1966 and 1994:

- The populations of resident bird species have remained fairly stable over the 1966–94 period, as evidenced by the fact that nearly equal numbers of species of resident birds have increasing and decreasing population trends.

Figure 8.13 Percentage of U.S. Bird Species with Increasing Populations by Group, 1994

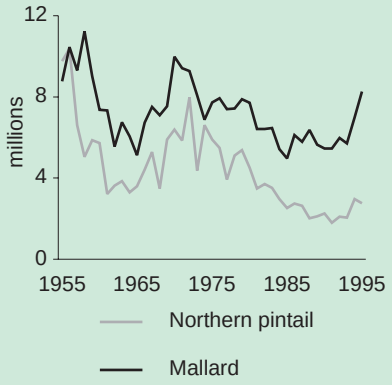


Source: U.S. Department of the Interior, National Biological Service, Breeding Bird Survey.
Notes: Gr=Grassland species. We=Wetland-open water species. Su=Successional-scrub species. Wo=Woodland species. Ur=Urban species. Ca=Cavity nesting species. Oc=Open-cup nesting passerine species. Sd=Short distance migrant species. Pr=Permanent resident species. Nm=Neotropical migrant species. Gn=Ground-low nesting species. Mc=Mid-story-canopy nesting species.

• The 1966–79 period was favorable for the majority of neotropical migrant species, which increased in population during this time. A spruce budworm outbreak in Canada was responsible for dramatic increases in a few species such as the Tennessee warbler, Cape May warbler, and blackpoll warbler.

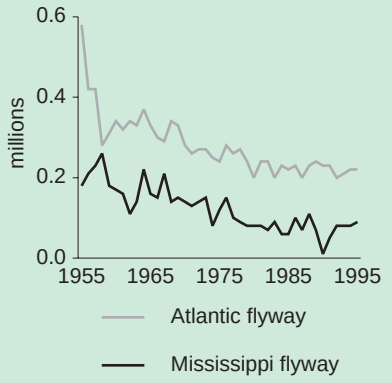
• The 1980–94 period was less favorable for neotropical migrants, with most species exhibiting declining population trends during those years. These declines largely account for overall population decreases experienced between 1966 and 1994.

Figure 8.14 Northern Pintail and Mallard Ducks, 1955-1995



Source: See Part III, Table 22.

Figure 8.15 Black Ducks by Flyway, 1955-1995

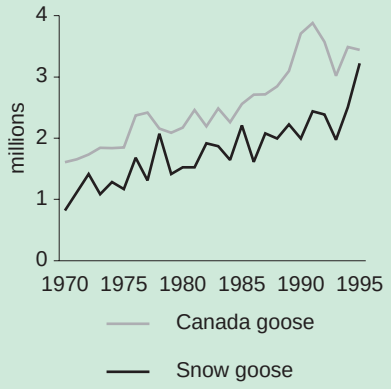


Source: See Part III, Table 22.

Ducks. Since the mid-1950s, duck surveys in North America have provided comprehensive and reliable data on some 30 duck species (Figures 8.14 and 8.15). Increased predation and habitat degradation and destruction coupled with drought, especially on breeding grounds, caused declines in some duck populations. Affected populations have since recovered from the drought of the 1980s to early 1990s, however, and many are at record highs—for example, the gadwall, northern shoveler, canvasback, and redhead. Additionally, habitat conditions, especially in the north central United States and prairie Canada, have greatly improved. The abundance of water in the prairie-pothole area is back to levels last experienced in 1970. Improved cover conditions—in part related to the Department of Agriculture's Conservation Reserve Program—have resulted in increased duck production, particularly in the Dakotas. The status of some duck species is still of concern to waterfowl managers, but, overall, ducks are doing well.

Geese. Most aggregations of wintering geese were overharvested in the early 1900s. Those subspecies that nested in temperate regions closer to humans were most heavily hunted. By 1930, the giant

Figure 8.16 Canada Goose and Snow Goose, 1970-1995



Source: See Part III, Table 23.

Canada geese that nested in the northern parts of the deciduous forest and tallgrass prairie were thought to be extirpated. Numbers of the large geese that nested in the Great Plains and Great Basin were also severely reduced.

Although hunting depleted numbers of Canada geese, human activity also created new habitats for these birds. Agriculture led to the clearing of forests and plowing of prairies, creating the open landscapes preferred by geese. Today, most goose populations appear to be increasing—except for the Atlantic Canada goose, the Southern James Bay Canada goose, and the Dusky Canada goose (Figure 8.16). Snow goose populations are growing so rapidly that they may be adversely affecting their Arctic and migratory habitats.

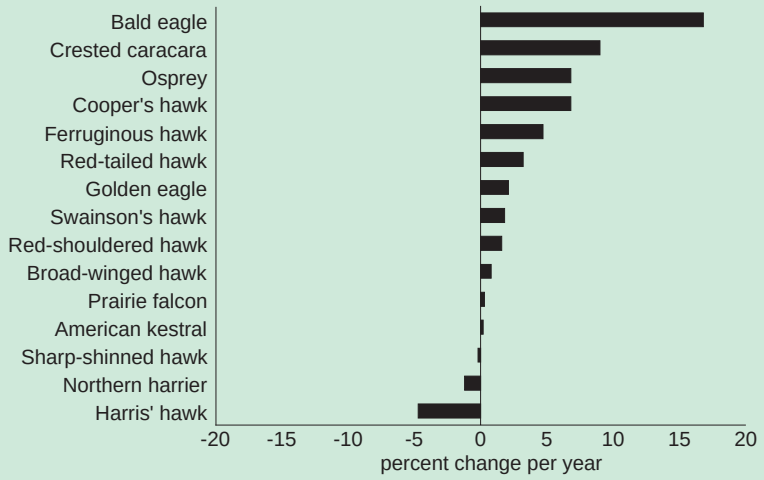
Raptors. Raptors, or birds of prey, include the hawks, falcons, eagles, vultures, and owls that occur throughout North American ecosystems. As top predators, raptors are key species in understanding and conserving ecosystems; changes in raptor status can reflect changes in the availability of their prey species as well as more subtle, detrimental environmental changes such as chemical contamination and the occurrence of toxic levels of heavy metals (e.g., mercury and lead).

Among raptors, populations of ospreys, bald eagles, and peregrine falcons have increased in number as they recover from past effects of pesticides (Figure 8.17). The bald eagle has increased from a low of 400 nesting pairs in 1963 to just over 4,700 pairs in 1995 (Figure 8.18); the 1972 ban on DDT was a significant factor in this recovery. Populations of hawks and owls are either poorly known or believed to be stable.

Wild Turkeys. Historical information on turkeys comes from documented accounts of early explorers. Recent national population estimates are composite figures obtained from individual state wildlife management agencies. Most accounts indicate that turkeys were quite abundant at the time of European colonization of North America. As the nation grew, wild turkeys were harvested without restraint and marketed for human consumption. In addition, their forest habitat was cleared for agriculture and wood products. By 1920, wild turkeys were extirpated from 18 of the 39 states of their ancestral range. Little changed until after World War II, when resources were directed to restoring and managing the nation's wildlife populations, including the wild turkey.

Several factors have contributed to the return of the wild turkey: the maturing of

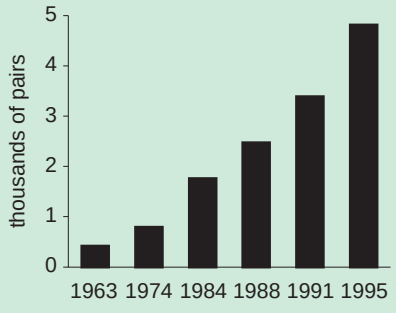
Figure 8.17 Trends in Selected Birds of Prey, 1969-1994



Source: U.S. Department of the Interior, National Biological Service, Breeding Bird Survey.

eastern forest, which had been almost eliminated; increased knowledge from research; spread of sound management practices; and better protection of new flocks vulnerable to poaching. The wild turkey, which was reduced to a population of a few tens of thousands in the early part of the century, now has a population approaching 4 million. (See Figure 8.19.)

Figure 8.18 Nesting Pairs of Bald Eagles in the Coterminous United States, 1963-1995

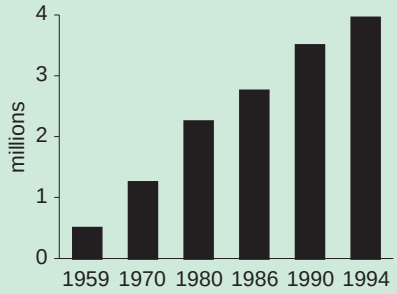


Source: U.S. Department of the Interior, Fish and Wildlife Service, Endangered Species Program.

Marine Species

At least 35 species of marine mammals are found along the U.S. Atlantic Coast and in the Gulf of Mexico; at least 50 species are found in U.S. Pacific waters, though estimates of abundance in U.S. water are variable. According to 1995 stock assessment reports, 23 stocks of marine mammals are increasing in abundance, 24 stocks are stable, and 8 are declining (Figure 8.20). With the exception of the Northern Right whale population in the Atlantic, all other increasing marine mammal populations reside in the Pacific Ocean or off Alaska. Trend data are mixed but, generally, increases result from prohibition of commercial whaling; and declines result from factors

Figure 8.19 Estimated U.S. Wild Turkey Population, 1959-1994

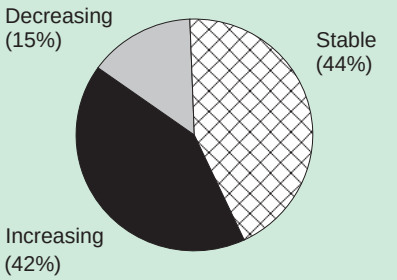


Sources: J.E. Kennamer, M. Kennamer and R. Brenneman, "History," In: *The Wild Turkey: Biology and Management,* J.G. Dickson, ed. (Stackpole Books, Harrisburg, PA, 1992) and update by editor.

such as bycatch associated with commercial fishing, illegal killings, strandings, entanglement, disease, altered food sources, and exposure to contaminants.

All six species of sea turtles found in the United States are listed as either endangered or threatened. It is difficult to determine population sizes of these highly migratory species, but there is little doubt that their populations have declined. For example, in the case of the Kemp's Ridley turtle, 40,000 females were counted nesting on a single day in 1947. The population has since plummeted due to overexploitation and incidental capture in commercial fisheries (Figure 8.21). Measures to protect nesting beaches and habitat are considered critical to recovery of these species.

Figure 8.20 Status of U.S. Marine Mammal Stocks, 1995



Source: National Marine Fisheries Service, *Our Living Oceans: Report on the Status of U.S. Living Marine Resources, 1995* (NMFS, Washington, DC, 1996).
Note: Total=55 stocks (33% of total U.S. stocks) that sufficient long-term population trend information.

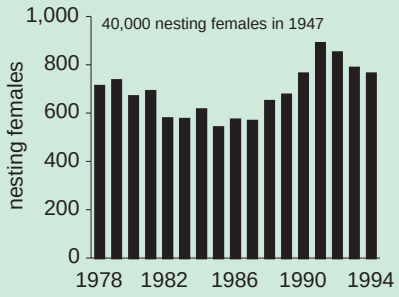
FUTURE CHALLENGES

Much has been learned about the distribution, abundance, and health of the nation's biodiversity. However, the programs that produced this information were not developed in a coordinated fashion so as to form an integrated, comprehensive picture of the status and trends of those resources. By coordinating data-gathering, resource management problems and areas for additional research on why certain ecological changes are occurring can be better identified—and thereby enable resource managers to take appropriate action.

Statistically reliable information on the status and trends of biological resources is an essential step toward better stewardship of the nation's biological wealth. Equally important is an intensive research program aimed at understanding what factors are responsible for biological changes and the incorporation of that understanding into resource management and policy decisions.

Development of tools such as standardized systematics and classification

Figure 8.21 Kemp's Ridley Sea Turtles, 1978-1994



Source: National Marine Fisheries Service, *Our Living Oceans: Report on the Status of U.S. Living Marine Resources, 1995* (NMFS, Washington, DC, 1996).

taxonomies, standardized monitoring protocols, and geographic information systems can aid in information gathering and analysis. For example, metadata for biological information—both federal and nonfederal—are accessible through the National Biological Service's National Biological Information Infrastructure. This infrastructure contributes spatial biological databases to the National Spatial Data Infrastructure. The National Biological Service works with the Federal Geographic Data Committee (FGDC) to ensure coordination of spatial data activities. Additionally, the FGDC Vegetation Classification and Information Standards are being developed to support production of uniform statistics on vegetation resources at the national level. These standards will ultimately support a detailed, quantitative, georeferenced basis for vegetation cover modeling, mapping, and analysis at the field level. Similar standards are being developed through consensus on taxonomy and systematics of biota via the Interagency Taxonomy Information System available on the World Wide Web.

Besides specific programs designed to understand components and functioning of biodiversity, the Office of Science and Technology Policy's Committee on Environment and Natural Resources is developing a working framework to coordinate the nation's environmental monitoring and research programs for biodiversity and ecological resources.

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