Terry Donnelly/Tom Stack and Associates

Introduction

by
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Overview

This report on the distribution, abundance, and health of our nation's biological resources is the first product of the National Biological Service's Status and Trends Program. This information has many potential uses: it can document successful management efforts so resource managers will know what has worked well; it can identify problems so managers can take early action to restore the resource in the most cost-efficient manner; and it can be used to highlight areas where additional research is needed, such as to determine why certain ecological changes are occurring. This report will also be useful to teachers, students, journalists, and citizens in general who are interested in national resource issues.

Another purpose of this report is to help identify gaps in existing resource inventory and monitoring programs. It contains information collected by a variety of existing research and monitoring efforts by scientists in the National Biological Service, other federal and state agencies, academia, and the private sector. The programs that produced the information in this document were not developed in a coordinated fashion to produce an integrated, comprehensive picture of the status and trends of our nation's resources; rather, each was developed for its own particular purpose, usually to help manage a specific resource. Thus, even though articles vary greatly in scope, design, and purpose, this report has identified and attempted to combine many of the existing information sources into a broad picture of the condition of our resources. In the future, these sources will be complemented by additional information from other sources—such as state agencies and other inventory and monitoring studies—to fill in the gaps of knowledge and to provide a more complete understanding of the status of our living resources.

A second report, to be released by the National Biological Service in 1995, will use the information contained in this report and data from other sources to provide a synthesized account of the status and trends of the nation's biodiversity. It will discuss from a historical perspective the factors influencing biodiversity, both natural and human-induced, and provide an integrated description of the status and trends of biological resources on a regional basis.

Status and Trends

The goal of inventory and monitoring programs is to determine the status and trends of selected species or ecosystems. Status studies

produce data on the condition of species or ecosystems for a single point in time; trend studies, in contrast, provide a chronological or geographic picture of change in the same resource. Either can measure a number of different biological indicators, such as population size, distribution, health, or physiological factors such as breeding productivity or seed production. Species composition, biodiversity, and age and physical structure are all important indicators of ecosystem status.

Inventory and monitoring programs can provide measures of status and trends to determine levels of ecological success or stress; if such programs are appropriately designed, they can give early warnings of pending problems, allowing resource managers to take remedial action while there are more management options. These earlier options are less severe than if management response is delayed until problems are critical, such as when a species becomes endangered.

One of the challenges resource managers face is to detect long-term trends because such trends are often masked by short-term, random, or undirectional variations (Figure). Plant and animal species often vary greatly in abundance, distribution, or fecundity as a result of forces that include annual or seasonal variations in climate; chance events such as floods and hurricanes; effects from predators or competing species; and even internal physiological processes. Some variations appear totally random; many are cyclic, recurring periodically; and others are long-term in one predominant direction. Scientists have many ways to determine whether apparent changes are biologically and statistically significant, although it is often difficult to detect such trends in their early stages. The design of monitoring programs should address issues such as the number of samples needed, the sampling technique, and the frequency and duration of sampling. All are critical factors in determining the sensitivity of the monitoring program to detect directional change. Data collected in a standard or consistent fashion over many years are especially critical to identify and document trends.

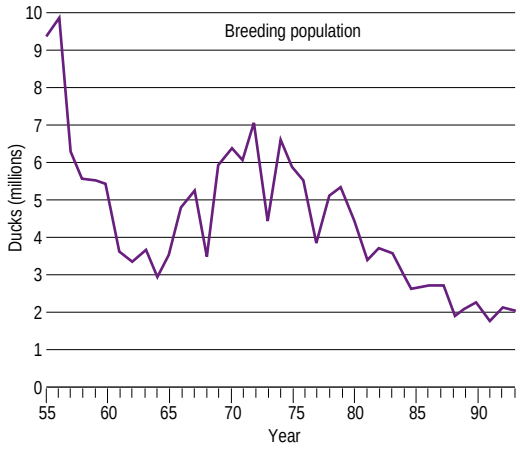

Figure. Northern pintail duck (*Anas acuta*) population data demonstrate the importance of long-term data sets. Annual fluctuations (e.g., 1967-70) reflect yearly fluctuations in breeding success that may have been caused, for example, by differences in rainfall and the abundance of temporary wetlands for nesting habitat. Short-term data sets can give erroneous conclusions; for example, if only data from 1964 to 1972 were available, managers might conclude that populations were increasing. The long-term data, however, describe a statistically and biologically significant population decline. (Source: U.S. Fish and Wildlife Service, 1993. *Status of Waterfowl and Fall Flight Forecast*.)

National Inventory and Monitoring Programs

A number of inventory and monitoring programs have been underway for several to many years in various agencies (Table). Historically, the federal government has been responsible for monitoring the status and trends of migratory species as well as those resident on federal lands. In addition, the federal government monitors habitat conditions on federal lands and, under some circumstances, private lands. Some of the monitoring programs also require international cooperation because many of the migratory species monitored cross international boundaries.

States have monitored resident species and often cooperated in surveys of migratory species. A significant problem with these efforts has been that often the individual agencies or states have used different monitoring procedures and standards, and the results are not comparable from area to area or among different agencies.

The private sector, including particularly The Nature Conservancy, has worked with states to establish Heritage Programs that monitor the distribution and abundance of selected species. This effort has resulted in standardized procedures.

Most inventory and monitoring programs were established for a specific purpose, usually relating to management of natural resources. For example, the efforts to monitor duck populations started 35 years ago to improve the basis for hunting regulations, and the National Wetland Inventory was started in 1979 to determine the condition and rate of wetland loss. Until recently, few, if any, of these programs were intended or have been used to provide broad-based and predictive tools that could help resource managers identify future resource problems.

The National Biological Service has the responsibility for developing information on the status and trends of our nation's plants and animals and the habitats on which they depend. It will achieve this by building on the inventory and monitoring activities existing in the state, federal, and private sectors. The national status and trends effort will continue to depend upon the contributions of these existing programs, and NBS will avoid duplicating programs already under way. Its role will be to coordinate the activities of different agencies into a comprehensive assessment of our living resources,

continuing its own contributions, and when necessary, supplementing the current array of activities.

Organization of This Report

In addition to this overview, the report introduction includes articles on the importance of biodiversity and a historical look at biological study in the federal government.

The articles that follow, contributed by a variety of authors and agencies, represent the first effort to pull together information on the status and trends of different groups of biota, ecosystems, and ecoregions as well as related issues. Individual articles in each section are most often arranged from the most general or large scale, to the most specific or small scale. The organization is somewhat arbitrary in that many articles could appear with equally valid justifications in several different locations.

Animals and Plants

Not all groups have received equal treatment, in large part because our current knowledge is not equal among all groups, and inventory and monitoring are focused on comparatively few species. Scientific studies have been greatly assisted in some areas by the work of natural historians and public volunteers. Bird watchers, butterfly collectors, and shell collectors, for example, have provided invaluable scientific information about the geographic ranges of groups in which they are interested. Some of the professional societies today owe their origins to the efforts of amateurs to organize and improve their understanding of biota.

Many of the less visible or charismatic taxa lack the scientific effort or information, much less the volunteer amateur support, to discuss trends in their abundance or distribution. The very title "Animals and Plants" could be viewed as biased by some biologists; although most of the public views mushrooms and other fungi as plants, specialists consider them a separate kingdom, equal both taxonomically as well as in ecological significance to both plants and animals. Despite their significance, plants are simply underrepresented in this report because the data are lacking.

The report begins with birds, the single group for which we have the most data at national and large-scale levels. Because of the significance of birds as important migratory species, there has been a strong role for federal research scientists as well as scientists from state agencies and from Canada and Mexico. Some of the best long-term scientific information on status and trends comes from the Breeding Bird Survey and the Christmas Bird Count.

Table. Selected examples of existing ecological inventory and monitoring programs.

Subject	Institution
Migratory bird surveys	
Breeding birds	National Biological Service (NBS)
Wintering birds	The Audubon Society
Waterfowl surveys	U.S. Fish and Wildlife Service (USFWS), NBS, and states, with international participation
Rare and threatened species	
Listed endangered and threatened species	States, U.S. federal land managers (e.g., National Park Service, Bureau of Land Management (BLM), U.S. Forest Service (USFS)), USFWS, NBS
State Heritage Programs	State agencies and The Nature Conservancy
Endangered marine species	National Marine Fisheries Service (NMFS)
Resident game species	
(e.g., deer, turkey, furbearers)	State fish and wildlife conservation agencies
Habitats and biological communities	
National Wetlands Inventory	USFWS
Gap Analysis Program	NBS in partnership with states and private sector
Environmental Monitoring and Assessment Program	U.S. Environmental Protection Agency
Resources Conservation Act, inventory of wildlife and habitat conditions of farmlands	U.S. Soil Conservation Service (now Natural Resources Conservation Service)
Wildlife and habitat on public lands	
Resources Planning Act assessment of USFS lands	USFS
Federal Land Policy and Management Act assessment of BLM lands	BLM
Contaminants	
Aquatic and terrestrial (Biomonitoring of Environmental Status & Trends National Water Quality Assessment)	NBS with USFWS; U.S. Geological Survey
Marine and coastal	National Oceanic and Atmospheric Administration and NMFS

Ecosystems and Ecoregions

We have also included information on ecosystems and ecoregions. Ecosystems are groups of plants and animals and their nonliving environment such as air and water. For example, one can speak of a coastal wetland ecosystem, whether in North Carolina or Florida, and understand that it includes several specific features or processes shared by all coastal wetland ecosystems.

Ecoregions are geographically defined ecological units, often containing several types of ecosystems, that share common topographic, climatic, and biotic characteristics. Each ecoregion, such as Alaska or Hawaii, can be defined as a single, individual unit on a map, while ecosystems, if mapped, would be scattered about as separate units.

Special Issues

After the status and trends of animals and plants, ecosystems, and ecoregions are presented, a section on related issues follows: global climate change, human influences, non-native species, and methods of habitat assessment. The proliferation of introduced species, both plant and animal, has had a profound influence on the native biota of this country. Many human activities, such as pollution and urbanization, both directly and indirectly affect the health of our living resources. The possibilities of global climate change are examined, followed by a brief

overview of national programs such as the Gap Analysis Program, which scientists hope will prove useful in acquiring data to help resource policy makers better protect our resources.

Biodiversity: A New Challenge

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Resource managers at many state and federal agencies are in the middle of a fundamental change in the practice and objectives of conservation. Traditional management has been directed toward maintaining, usually for harvest purposes, populations of individual species such as ducks, deer, or salmon. Increasingly, however, resource managers are recognizing the critical importance of conserving biological diversity, or biodiversity.

In its simplest terms, biological diversity is the variety of life at all levels: it includes the array of plants and animals; the genetic differences among individuals; the communities, ecosystems, and landscapes in which they occur; and the variety of processes on which they depend. Conserving biological diversity poses dramatic new problems for comprehensive inventory and monitoring: what should be measured or monitored?

Biodiversity is important for many reasons. Its value is often reported in economic terms: for example, about half of all medicinal drugs (Keystone Center 1991; Wilson 1992) come from—or were first found in—natural plants and animals, and therefore these resources are critical for their existing and as yet undiscovered medicinal benefits. Additionally, most foods were domesticated from wild stocks, and interbreeding of different, wild genetic stocks is often used to increase crop yield. Today we use but a small fraction of the food crops used by Native cultures: many of these underused plants may become critical new food sources for the expanding human population or in times of changing environmental conditions.

But biodiversity has an even greater importance: it is the great variety of life that makes existence on earth possible. As a simple example, plants convert carbon dioxide to oxygen during the photosynthetic process; animals breathe this fresh air, releasing energy and providing the second level of the food chain. In turn, animals convert oxygen back to carbon dioxide, providing the building blocks for the formation of sugars during photosynthesis by plants. Microbes (fungi, bacteria, and protozoans) break down the carcasses of dead organisms, recycling the minerals to make them available for new life; along with some algae and lichens, they create soils and improve soil fertility.

Biodiversity provides the reservoir for change in our life-support systems, allowing life to adapt to changing conditions. In a natural population, for example, some individuals will be more resistant to drought or disease or cold; as the environment changes, from season to season, year to year, or over longer periods, and as plagues come and go, these differences among individuals allow at least some members of the population or species to survive and reproduce. This diversity is the basis not only for short-term adaptation to changing conditions, but also for long-term evolution as well.

Like air, water, and soils, biological diversity is part of the capital upon which all life depends. The need for this diversity is greatest in times of environmental stress when plants, animals, and microbes must develop new characteristics or strategies for survival. As we look at the problems of the globe today—global climate change, decreases in the ozone shield and increasing ultraviolet radiation, losses of natural habitats, and pervasive pollution in our streams and oceans—we must recognize that we, as a form of life on earth, need the ability to change in order to cope with new stresses.

Humans cannot survive in the absence of nature. We depend on the diversity of life on earth for about 25% of our fuel (wood and manure in Africa, India, and much of Asia); more than 50% of our fiber (for clothes and construction); almost 50% of our medicines; and, of course, for all our food (Miller et al. 1985). As previously stated, biodiversity produces other benefits: plants produce oxygen for our atmosphere; microbes break down wastes, recycle nutrients, and build the fertility of our soils. One reason our highways are not littered with the carcasses of dead dogs, cats, skunks, armadillos, and deer is biodiversity, in the form of the many scavengers and microbes that we don't often think about, but which play an essential role in the cycle of life. Even species often viewed as "repulsive," such as vultures and maggots, play critical roles in our lives.

Some people believe that because extinction is a natural process, we therefore should not worry about endangered species or the loss of biodiversity. Certainly extinction is natural; it usually occurs as newer forms of life evolve. But under the forces of population growth, technology, and special interests, humans have driven the rate of extinctions today to about 100 times—two orders of magnitude—the natural rate. Even worse, the rate of extinction is still increasing and will be 100 to 1,000 times faster yet in the next 55 years (Miller et al. 1985); scientists today predict that between now and 2030, half the expected lifetime of a child born today, the Earth will lose between a quarter and a third of all existing species. And this is in the absence of new forms of life to replace them.

The last time Earth lost this large a share of its life was 65 million years ago when it may have collided with an asteroid; the impacts of humans on our planet today may have been last equaled by the collision of two heavenly bodies (Wilson 1992).

Scientists cannot honestly say that we need *all* species that exist today for humans to survive; but as a general rule, the more diversity is diminished, the less stable ecosystems become and the greater the fluctuations that occur in plant and animal populations. The more diversity we lose, the more our quality of life and economic potential are diminished, and the greater the risk that we will cause a critical part of the cycle of life to fail.

If humans were allowed to cause the extinction of other species, who would determine which species? If we had been asked 60 years ago what life we could let become extinct, who among us would have insisted that we preserve the lowly mold that was penicillin, the first of the series of antibiotics that have today so changed the quality of our lives? And who, only 5 years ago, would have identified the need to preserve the Pacific yew, which today yields taxol, one of the greatest new hopes in our arsenal against cancer?

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Conservation Landmarks: Bureau of Biological Survey and National Biological Service

by
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A century separates the recent development of the National Biological Service (NBS) and an early predecessor, the Bureau of Biological Survey (BBS). Both organizations were established at critical crossroads for the conservation of the nation's living biological resources and are conservation landmarks of their times. The BBS of the 1920's was described as "a government Bureau of the first rank, handling affairs of great scientific, educational, social, and above all, economic importance throughout the United States and its outlying possessions" (Cameron 1929:144-145). This stature was achieved at a time of great social, economic, and ecological change. BBS had the vision to pioneer new approaches that led to enhanced understanding of the relation between people, other living things, and the environment. The NBS faces similar challenges to address the issues of the 1990's and beyond.

Diminished Natural Resources in a World of Plenty

Early European colonists had an abundance of wildlife to serve subsistence needs. Seemingly endless flocks of ducks, geese, and swans; an abundance of wild turkeys, deer, and bison; green clouds of Carolina parakeets and millions of passenger pigeons; and a bounty of fish and shellfish. This abundance quickly established a viewpoint that the New World's wildlife resources were inexhaustible.

Habitat changes that disrupted the balance of nature soon resulted in economic losses and other hardships because of insect and rodent eruptions. Negative effects of exotic species brought from the Old World further reduced the well-being of many colonists who had come to the New World for a better life. The nation's inexhaustible natural resources and returns from agriculture began to wane significantly. Decimation of previously vast wildlife resources greatly reduced opportunities for cultural and recreational uses of wildlife (Cameron 1929).

Development of the BBS

Roots of the BBS can be traced to the 1883 founding of the American Ornithological Union (AOU) in New York City. Initially, the AOU focused on three subject areas—distribution, biological information and economic impact, and migratory behaviors of birds—all of which became major activities of the BBS. Collaborations and partnerships were developed with numerous ornithologists, field collectors, sportsmen, and observers of nature who were asked to report specific information relative to bird migration. Cooperation also was obtained from the United States Lighthouse Board and the Department of Marine and Fisheries of Canada (Cameron 1929).

Funds for government biological survey programs related to economic ornithology were allocated in 1885 to the Division of Entomology of the U.S. Department of Agriculture. These funds were provided for "the promotion of economic ornithology, or the study of the interrelation of birds and agriculture, an investigation of the food habits, and migration of birds in relation to both insects and plants." The following year additional funds were provided to include the study of mammals and expand the focus

Activities of the Bureau of Biological Survey (Cameron 1929)

Investigation and research

Study of life habits of wild animals
Classification of wild animals
Studies in geographic distribution of wild animals and plants
Life zone investigations of definite areas
Biological surveys of definite areas
Special big game investigations
Investigations for improvement of reindeer in Alaska
Investigations at reindeer experiment station
Investigations of problems of fur farmers
Studies in fur animal disease and parasites
Investigations of problems of rabbit raisers
Studies of rabbit diseases, etc.
Investigations in animal poisons
Studies in bird migration
Bird censuses (general)
Wild fowl censuses
Bird banding
Food habits studies by laboratory examinations of stomach contents of birds, mammals, reptiles, and amphibians
Studies in game bird propagation
Specific studies in covert restocking
Surveys of food resources for waterfowl
Investigations and experiments in predatory animal control
Investigations and experiments in control of injurious rodents
Investigations and experiments in control of other animal pests
Investigations and experiments in control of bird pests

Encouragement of useful forms of wildlife

Advice on game bird and animal propagation methods
Devising of methods for attracting birds about parks, homes, etc.
Encouragement of conservation of wild fur bearers
Advice on small animal production (for pets and laboratory use)
Maintenance and protection of game preserves and birds refuges
Restocking of reservations
Disposal of surplus animals on reservations
Issuance of permits for fur farming on certain Alaskan islands
Administration of Upper Mississippi Wild Life and Fish Refuge Act
Administration of act protecting wildlife on reservations

Repression of undesirable forms of wildlife

Killing of predatory animals
Leadership and demonstration in cooperative effort against predatory animals
Leadership and demonstration in cooperative effort against injurious rodents
Leadership and demonstration in cooperative effort against other animal pests and injurious birds
Processing of poisons and food stuffs for use against predatory and noxious animals

Protection of wildlife

Administration of Migratory Bird Treaty and Lacey acts by warden service and in cooperation with state law enforcement agencies
Issuance of permits for game propagation
Regulation of importation of wild birds and animals
Preparation of regulations under Alaska game law

Dissemination of information

Preparation and editing of publications
Preparation of exhibits and photographs
Answering of inquiries
Addresses by officers (conventions, universities, etc.)

Miscellaneous

Regulation of grazing of domestic stock in certain Alaskan islands

from agriculture and horticulture to the new subject of forestry. At the same time, the work was moved from the Division of Entomology to the new Division of Economic Ornithology and Mammalogy. Dr. C. Hart Merriam became the first division chief in July 1886 (Cameron 1929).

The new division continued to study wildlife food habits, migration, and species distribution. It placed considerable emphasis on educating farmers about birds and animals affecting their interests so that destruction of useful species might be prevented. Dr. Merriam pursued the development of an extensive biological survey, advancing the argument that mapping of faunal and floral areas would benefit farmers by identifying the boundaries of areas fit for the growth of certain crops and those hospitable for certain breeds of livestock. In 1890, the appropriation language for the Department of Agriculture provided for the investigation of "the geographic distribution of animals and plants," causing Dr. Merriam to note that "the division is now in effect a biological survey" (Cameron 1929:27).

The major part of the division's 1891 activities involved an extensive biological survey and biogeographic mapping of the Death Valley region of southern California and southern Nevada. This was followed by additional biological surveys of various areas of the West. Biological surveys also were conducted beyond the continental borders of the United States into Alaska, Canada, and Mexico. In 1896 the Division of Ornithology and Mammalogy became the Division of Biological Survey (Cameron 1929).

Food habit studies, which were continued along with the survey work, emphasized transmitting information to those who could benefit from it. Popular bulletins were prepared on bird migration, the economic impacts of specific wildlife species on agriculture, and the introduction of exotic species. In 1889, the division initiated the more scientific *North American Fauna* series, which included that year a general paper discussing Dr. Merriam's concept of the life zones of North America (Cameron 1929).

The division was elevated to bureau status on July 1, 1905. During the next 34 years, activities expanded to serve the growing U.S. conservation movement. Diverse investigations and

research were carried out as well as technical assistance to the public and to game managers; animal damage control; regulatory functions including conservation law enforcement; administration of refuge lands; and public education through publications and exhibits (*see* box). Conservation problems included habitat loss, declining wildlife populations, species extinction, control of exotic species, control of predatory and injurious wildlife, pollution and disease control, and competition between wildlife, agriculture, and forestry.

The BBS was transferred to the Department of Interior on July 1, 1939, and was made part of the U.S. Fish and Wildlife Service (USFWS). In November 1993, the biological research components within the Department of Interior, including those from the USFWS, the National Park Service, the Bureau of Land Management, the Bureau of Reclamation, and the Minerals Management Service were reorganized to form the National Biological Survey. The name was changed to the National Biological Service on January 5, 1995, to more accurately reflect the agency's mission.

Then and Now

Dr. Merriam noted that the chief work of the BBS was to obtain facts, for without a knowledge of facts there can be neither efficient administration nor intelligent regulation of wildlife to meet the needs of the nation (Cameron 1929). That same philosophy is inherent in Secretary of the Interior Bruce Babbitt's remarks about the NBS:

> The National Biological Survey will produce the map we need to avoid the economic and environmental "train wrecks" we see scattered across the country. NBS will provide the scientific knowledge America needs to balance the compatible goals of ecosystem protection and economic progress. . . . [The] National Biological Survey will unlock information about how we protect ecosystems and plan for the future. (National Research Council 1993:181-182).

Land management, regulatory, and law enforcement activities of the BBS remained with the USFWS and other parent bureaus within the Department of Interior when the NBS was formed. Only the biological research components of the department have become part of the NBS. This nonadvocacy biological science program will help the nation to resolve increasingly contentious and challenging issues in managing its biological resources.

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