United States
Department of
Agriculture

Forest Service

**Rocky Mountain
Forest and Range
Experiment Station**

Fort Collins,
Colorado 80526

**General Technical
Report RM-178**

An Analysis of the Wildlife and Fish Situation in the United States: 1989–2040

A Technical Document Supporting the 1989 USDA Forest Service RPA Assessment

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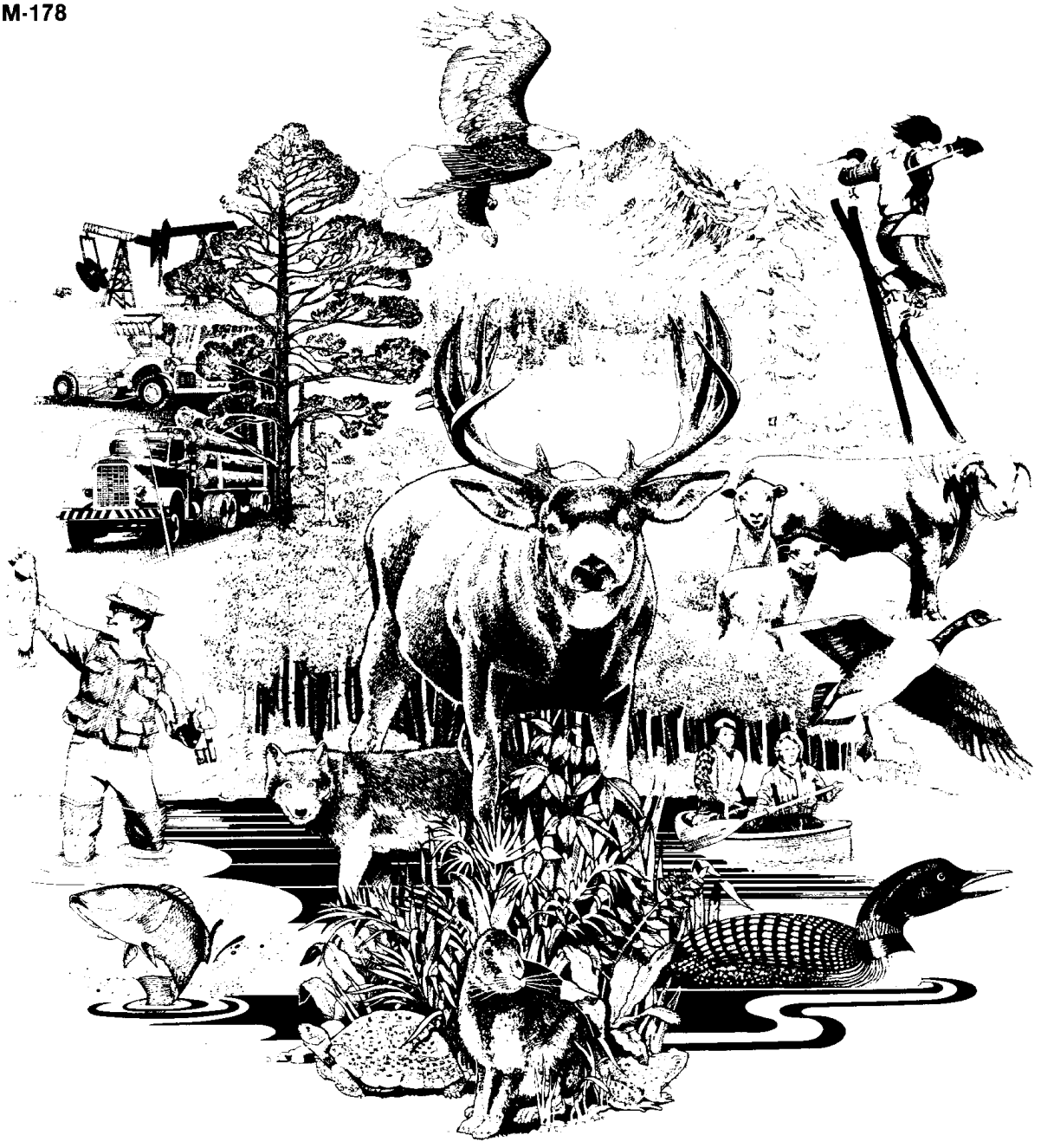

Preface

The Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA), P.L. 93-378, 88 Stat. 475, as amended, directed the Secretary of Agriculture to prepare a Renewable Resources Assessment by December 31, 1975, with an update in 1979 and each 10th year thereafter. This Assessment is to include "an analysis of present and anticipated uses, demand for, and supply of the renewable resources of forest, range, and other associated lands with consideration of the international resource situation, and an emphasis of pertinent supply, demand and price relationship trends" (Sec. 3.(a)).

The 1989 RPA Assessment is the third prepared in response to the RPA legislation. It is composed of 12 documents, including this one. The summary Assessment document presents an overview of analyses of the present situation and the outlook for the land base, outdoor recreation and wilderness, wildlife and fish, forest-range grazing, minerals, timber, and water. Complete analyses for each of these resources are contained in seven supporting technical documents. There are also technical documents presenting information on interactions among the various resources, the basic assumptions for the Assessment, a description of Forest Service programs, and the evolving use and management of the Nation's forests, grasslands, croplands, and related resources.

The Forest Service has been carrying out resource analyses in the United States for over a century. Congressional interest was first expressed in the Appropriations Act of August 15, 1876, which provided $2,000 for the employment of an expert to study and report on forest conditions. Between that time and 1974, Forest Service analysts prepared a number of assessments of the timber resource situation intermittently in response to emerging issues and perceived needs for better resource information. The 1974 RPA legislation established a periodic reporting requirement and broadened the resource coverage from timber to all renewable resources from forest and rangelands.

USDA Forest Service
General Technical Report RM-178

September 1989

An Analysis of the Wildlife and Fish Situation in the United States: 1989–2040

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Acknowledgments

Many individuals from the Forest Service, other federal agencies, state agencies, universities, and conservation groups contributed to this document. Individuals that assisted in compiling information for national forest lands were: Robert Nelson, Jack Capp, Mike Dombeck, Robert Randall, Kirk Horn, Alan Christensen, Glen Hetzel, Dale Wills, William Zeedyk, Richard Wadleigh, William Burbridge, Ronald Burraychak, Randall Long, John Borrecco, Hugh Black, Philip Lee, Jerry McIlwain, Tom Darden, Gordon Sloane, Bruce Hronek, and Donald Hagar. Assistance in compiling information on wildlife and fish resources from the Bureau of Land Management was provided by J. David Almand and Raymond Boyd. Other federal cooperators included: Warren Fisher, John Charbaneau, William Gill, Ronald Lambertson, John Tautin, Terry Cacek, Bill Wilen—Fish and Wildlife Service; Steve Koplin—National Marine Fisheries Service; Steve Brady, Billy Teels—Soil Conservation Service.

The following were instrumental in compiling state wildlife and fish statistics: AL—Charles Kelley, Jim Davis, Barry Smith; AK—W. Lewis Pamplin, Bruce Baker; AZ—Bud Bristow, Duane Shroufe, Roger Sorenson; AR—Steve Wilson, Steve Cole, Scott Henderson; CA—Jack C. Parnell, Terry Mansfield, Bill Griffin, Forest Tucker, John Turner; CO—James Ruch, Cher Threlkeld, Bob Hernbrode, Harlan Riffel; CT—Robert Jones, Paul Herig, Peter Good; DE—William Wagner, II; FL—Smokie Holcomb, Frank Montalbano, III, Frank Smith, Thomas Vaughn; GA—Leon Kirkland, Joe Kurz, Mike Jennings; HI—Libert Landgraf, Ron Walker; ID—Jerry Conley, Tom Reinecker, Tom Parker; IL—Michael Witte, Mike Conlin, James Moak; IN—James Ridenour, John Olson; IA—Allen Farris; KS—Bill Hanzlick, Kent Montei; KY—Peter Pfeiffer, William Graves, Lauren Schaaf; LA—J. Burton Angelle, Sr., Bennie Fontenot, Hugh Bateman; ME—Frederick Hurley; MD—Donald MacLauchlan, Jim Burtis, Mike Burch, Eral Hodil, Joe Schugars; MA—Richard Cronin, Dick Burrell, Bob Madore; MI—Gordon Guyer, Dan Tucker, Don Reynolds; MN—Larry Shannon, Roger Holmes, Dick Hassinger, Tim Burmicker; MS—William Quisenberry, III, Seth Mott, Jack Herring; MO—Larry Gale, Ray Evans, Ken Babcock, George Dellinger, Ollie Torgerson; MT—James Flynn, Arnold Olson; NE—Eugene Mahoney, Ken Johnson; NV—William Molini, George Tsukamoto; NH—Allen Crabtree, III, Howard Nowell, Charles Thoits; NJ—Russell Cookingham, Tony Petrongolo; NM—Harold Olson, Byron Donaldson, Gerald Gates; NY—Kenneth Wich, George Mattfeld; NC—Charles Fullwood, Hal Atkinson; ND—Dale Henegar, C. R. Grondahl; OH—Joseph Sommer, Pat Ruble, Gary Isbell; OK—Steven Alan Lewis, Byron Moser, Kim Erickson; OR—John Donaldson, Frank Newton; PA—Ralph Abele, Peter Duncan, III, Dick Snyder, William Shope; RI—Robert Bendick, Jr., Jim Meyers, Jim Chadwick, Mike Lapisky; SC—James Timmerman, Jr., Jeff Fuller, Joe Logan, Brock Conrad, Darrell Shipes, John Frampton, Billy McTeer; SD—James Salyer, David Hamm, Chuck Backland; TN—Gary Myers, Ron Fox, Hudson Nichols, Greg Wathen; TX—Charles Travis, Ted Clark, Bob Kemp; UT—William Geer, Ed Rawley, Bob Hasen; VT—Stephen Wright, Ben Day, Angelo Incerpi; VA—Richard Cross, Jr., Jack Raybourne, Jack Hoffman; WA—William Wilkerson, Jack Wayland, Rich Lincoln, Rich Poelker, Ken Dixon; WV—Ronald Potesta, Robert Miles; WI—James Addis, Steven Miller, Edward Frank; WY—William Morris, Doug Crowe.

The following individuals provided technical review of an earlier draft: William Gusey, Shell Oil Company; Michael Sale, Oak Ridge National Lab; Larry Harris, University of Florida; Kurt Fausch, Colorado State University; Donald Orth, Virginia Polytechnic Institute and State University; Tony Peterle, Ohio State University; James Teer, Welder Wildlife Foundation; James Peek, University of Idaho; Milton Weller, Texas A&M University; Frederic Wagner, Utah State University.

Special recognition is extended to Michael Knowles for his compilation, organization, and summarization of data that formed the basis of this document; Patricia Flebbe for her assistance in summarizing the fisheries information; and Glen Brink for his computer programming and data base management skills. Appreciation is also extended to David Chalk, Soil Conservation Service, for his assistance in coordinating the acquisition of state wildlife and fish agency data and Soil Conservation Service data on land use and land cover.

HIGHLIGHTS

Wildlife and fish are an integral component of all environments from pristine wilderness to the most intensively managed urban settings. The values associated with wildlife and fish have broadened from the utilitarian views held by early subsistence and market hunters to the recognition that animals contribute to the overall public welfare in a multitude of ways. This is reflected, in part, by increased nonconsumptive uses of wildlife and fish, increased membership in wildlife and fish organizations, increased public interest in policies and programs affecting wildlife and fish, and in the passage of laws intended to ensure protection and stewardship of the resource.

A national assessment of wildlife and fish is one of the reporting responsibilities of the USDA, Forest Service related to the Forest and Rangeland Renewable Resources Planning Act (RPA). The assessment is to serve as the technical basis for developing a national Forest Service Program guiding the management of natural resources. This assessment reports on the current status and recent historical trends of wildlife and fish resources, resource inventory and use projections, and implications and opportunities for resource management programs.

CURRENT STATUS AND RECENT HISTORICAL TRENDS

Four aspects of wildlife and fish resources that are important in a characterization of resource status include habitat, population, harvest, and number of users.

Recent Trends in Wildlife and Fish Habitat

To survive, fish and wildlife need habitat—the availability and appropriate mix of food, cover, and water. Land use and land cover patterns provided a coarse description of the amounts and quality of wildlife and fish habitats.

- *Forestland* has declined by 5% as a result of recent cropland and urbanland conversion. Significant declines in Southern pines, bottomland hardwoods, aspen-birch, and elm-ash-cottonwood have been observed. Mature and old-growth softwood stands are becoming increasingly rare in the major timber producing regions of the Pacific Northwest and South. Demand for eastern hardwoods has not kept pace with forest growth, resulting in greater acreage of older hardwood stands in the North.
- Over recent decades, *rangeland* has declined slightly. The majority of non-federal rangelands are in fair to poor condition. However, available evidence indicates range condition is improving with better management. Two important issues are the loss and fragmentation of grassland habitats in the East and degradation of riparian habitats in the arid West.
- Every state contains some *wetland* habitat. However, wetlands only account for 5% of the total land area in the contiguous U.S. Wetland area has declined significantly over the past several decades. Between 1954 and 1974 forested wetlands declined by nearly 11%; emergent wetlands declined by 14%; and estuarine wetlands declined by 6.5%.
- About 80% of the nation's *flowing waters* have problems with quantity, quality, fish habitat, or fish community composition. Water quality is affected by turbidity, high temperatures, nutrient surplus, toxic substances, and dissolved oxygen availability. Many of these quality-related problems are the result of soil and vegetative manipulation associated with agriculture, forestry, and other human activities.
- Increases in *cropland* area over the last 10 years have been accompanied by more intensive farming practices, larger farm size, and a reduction in shelterbelts, field borders, and odd habitat areas that were previously inconvenient to farm. Fencerow-to-fencerow farming has eliminated much nesting, feeding, and winter cover for wildlife and resulted in increased erosion which has degraded aquatic habitats.

Recent Trends in Wildlife and Fish Populations, Harvests, and Use

The current status and recent historical trend in populations, harvests, and uses of wildlife and fish resources are closely linked to habitat trends. Although trends vary by species category, those species associated with agricultural, mature and old-growth forest, native grassland, and wetland kinds of environments have had declining or unstable populations in the last 20 years.

- Although *nongame* bird surveys indicate that the majority of breeding bird populations have remained stable since the mid-1960s, a significant proportion (13%) of the breeding bird fauna has declined over a 20-year period. The number of breeding bird species that have shown recent population declines are more numerous in the East than the West. Breeding birds that have realized population increases tend to be those adapted to more intensive land uses particularly urban/suburban environments.
- *Migratory game bird* populations, except geese, have generally declined. Breeding duck populations have declined from 44 million in the early 1970s to about 30 million birds in the mid-1980s.
- *Big game* species across all regions have increased, except Pacific Coast deer. Populations of the two most commonly hunted big game species, white-tailed deer and wild turkey, have more than doubled.
- *Small game* population trends were divergent for agriculture and forest species. Those small game species associated with agricultural lands have shown significant declines over the last 20 years,

while most woodland populations have remained stable or increased.

- Trends in *furbearer* populations vary. Some commonly harvested species appear to have stable or increasing populations while other species, such as red fox and mink, have shown regional declines.
- While national and regional appraisals of how *fish* populations are changing are limited, specific regional studies indicate that the capacity of the nation's waters to support warm and coldwater fisheries has declined. The loss owes to human-caused degradation of aquatic habitats and introductions of competing fish species.
- There are 330 animal species that are listed as being *threatened or endangered*—a gain of 130 species since the last national assessment of wildlife and fish. In addition, there are approximately 1,000 candidate plant and animal species for which the Fish and Wildlife Service has sufficient information to initiate formal listing procedures.

Recent trends in the recreational use of wildlife and fish are a function of wildlife and fish availability and the public's relative preference for different kinds of recreational activities.

- Nonconsumptive recreation has increased at a substantially greater rate than other forms of wildlife and fish recreation. Most nonconsumptive wildlife and fish recreation occurs at or near people's homes or in association with other outdoor activities.
- The number of big game hunters has generally increased during the last 20 years, although more slowly now than before. The number of small game and migratory game bird hunters has shown recent declines and is likely a response to lower game populations, reduced access, and crowded hunting conditions. The number of trappers has recently declined in apparent response to declining fur prices, but may also be affected by public and legislative pressure to restrict this activity.
- The numbers of both recreational and commercial fishers have consistently increased during the last 20 years.

PROJECTED INVENTORIES AND USES OF WILDLIFE AND FISH

Resource inventory and use projections are an integral part of national resource assessments. The projections are suggestive of what the future resource situation may become based on recent experiences. A comparison of future inventories against anticipated uses provides insight into possible imbalances between the supply of and demands for wildlife and fish resources.

- In the coming decades, rangeland area will increase 5%; the acreage of forestland will decline by about 4%; needed cropland will probably decline; and wetland habitats will continue to be lost, but at a slower rate.
- State wildlife and fish agencies are optimistic about future big game populations and harvests with the expectation of stable or upward trends for all species.
- Small game population and harvest projections associated with agricultural habitats indicate a continued decline. Northern bobwhite populations and harvests are expected to decline; pheasant and rabbit populations and harvest are projected to increase only in the short-term as a result of the Conservation Reserve Program.
- The future number of participants in wildlife and fish recreation indicate that participation in coldwater fishing and nonconsumptive activities are expected to more than double by 2040. The number of hunters, in general, is expected to decrease as participation in big game and small game hunting declines.
- More hunters are expected to participate under fee-hunting situations in the future. As many as one in five hunters may be participating in some form of fee-hunting by 2040.
- A future of diminished habitat and lower populations of some species indicate that resource supplies may not support future levels of recreational demand. The potential gap of unmet demand is greatest for coldwater fishing, followed by migratory bird hunting, warmwater fishing, big game hunting, and small game hunting. The demand for nonconsumptive recreation does not appear to have any obvious future resource supply constraints.
- The substantial increases in demands for nonconsumptive uses and all forms of fishing imply increased density of use which may degrade the quality of the recreational experience for many people.

THE IMPLICATIONS AND OPPORTUNITIES FOR WILDLIFE AND FISH MANAGEMENT

The wildlife and fish inventory and use projections imply certain economic, social, and environmental consequences that could occur if resource use and inventories are not balanced.

- As wildlife and fish habitat is lost or made unavailable to the recreating public, and as expanding human populations result in more crowded conditions, future recreationists may have to travel greater distances to find suitable sites or may have to pay access fees. Recreation fees for fishing and hunting on private lands have increased rapidly in the past decade which may favor participation by the more affluent of society.
- Potential restrictions on commercial harvests and projected declines in hunting could severely impact local economies that are dependent upon commercial or recreational use of wildlife and fish resources. Because state wildlife and fish agencies derive operating funds primarily from licence fees and excise taxes on equipment, they could also be negatively impacted.
- Important social implications are associated with fish and wildlife resources including cultural,

psychological, physiological, and societal aspects of public welfare. Declining inventories and use restrictions infringe on the lifestyles of certain cultural groups and reduces or eliminates a recreational outlet for which few substitutes exist.

- The growing pressures on wildlife and fish resources are likely to be especially significant for endangered and threatened species, including those species not yet formally listed. As species become rare, or ultimately extinct, there is a reduction in biological diversity, a diminishing of the nation's natural heritage, and a forgoing of future options to meet society's various needs.

Growing human populations will continue to encroach on wildlife and fish habitat; and the demand for timber, livestock, water, and agricultural crops will conflict, in instances, with wildlife and fish resources. Future natural resource management must balance these multiple resource demands within the constraints defined by the environment. Management opportunities can be categorized into four areas: habitat, population, user, and planning.

Opportunities for management of habitat include:

- Protection of key habitats (including wetlands, native grasslands, old-growth forests, fish spawning areas, and critical habitat for threatened and endangered species) through public purchase, easement, leasing agreement, or establishment of natural areas.
- Increasing the size and distribution of key habitat tracts to preserve the natural diversity characteristic of a given region.
- Restoration of degraded ecosystems through direct manipulation of vegetation and water or controlling disturbance factors.

Opportunities for direct management of wildlife and fish populations include:

- Manipulation of populations through appropriate harvest strategies to ensure that populations remain within the productive capacities of their habitat.
- Reintroduction of species into areas where they have been displaced from suitable habitat or where suitable habitat has been developed.
- Increasing fish hatchery production through improved propagation practices, increasing the capacity of extant facilities, and the building of new facilities.

Opportunities for user management include:

- Increasing access to private lands by developing programs that would assist landowners in establishing wildlife and fish-related businesses.
- Increasing land acquisition and management of recreational use to increase the amount of habitat available to recreationists and to better distribute users across suitable sites.
- Increasing public education programs on the value and objectives of wildlife and fish management.
- Implementing techniques to monitor public attitudes and values associated with wildlife and fish resources to better address the public's changing needs and wants.

Opportunities for planning include:

- Increasing cooperation and coordination among the many agencies that have responsibility for management of habitat, wildlife and fish populations, and hunting and fishing.
- Integrating wildlife and fish management objectives more fully into the management of forest and rangelands for multiple resources.
- Through research, improving the information base (e.g., habitat inventories, population inventories, habitat-population relationships, valuation of wildlife and fish resources) needed to effectively manage the wildlife and fish resource.

Managing fish and wildlife resources will be especially challenging in the future because of competing demands for the nation's forest and range resource base. As one of the largest land-managing agencies in the federal government, the Forest Service has the opportunity to play an important role in directing the future wildlife and fish resource situation. This opportunity not only exists on vast acreages of national forests, but also in cooperative assistance programs, and by conducting and promoting research within and outside the agency. The nature and extent to which the wildlife and fish resource situation can be improved will be defined by the next Forest Service program. What this assessment has done is to provide planners with a factual and technical basis upon which to consider a number of Forest Service program alternatives.

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An Analysis of the Wildlife and Fish Situation in the United States: 1989–2040

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INTRODUCTION

Wildlife and fish are important and integral components of environments ranging from pristine wilderness to the most intensively managed urban settings. They are critical to the functioning and persistence of ecosystems with numerous roles including pollination, seed dispersal and germination, nutrient cycling, herbivory, and predation, all of which are important in maintaining the ecological balance of plant and animal communities. The perceived values attributed to wildlife and fish have broadened from the utilitarian views held by early subsistence and market hunters, to the recognition that animals contribute to the overall public welfare in a multitude of ways. The values attributed to, and uses of, wildlife and fish resources are varied owing to the diverse interaction between the number and kinds of animals, and the desires of man.

Wildlife and fish resources possess regulatory and mobility characteristics that collectively make their management unique among other natural resources. Regulatory authority for wildlife and fish resources has its roots in Roman law and English common law. Wildlife and fish are regarded as common resources, owned by all citizens, yet held in trust by the states. The doctrine of state ownership designated that each state retain the primary regulatory and management authority of wildlife and fish. However, passage of the Lacey Act in the early 1900's marked the beginning of an expanding federal role in the regulation and management of wildlife and fish resources. Federal agencies now have stewardship responsibility for migratory birds, marine animals, and for animals on federally owned lands. Public ownership, management authority vested in state and federal agencies, and a mobile resource that does not recognize arbitrary land ownership boundaries, all interact to make the management of wildlife and fish complex and dependent upon cooperation among resource managing agencies and the public.

This report is about wildlife and fish resources—their habitats, populations, and uses. It is a report on how these attributes of wildlife and fish resources have changed in the last 20 years, what may happen in the future if current actions continue, what opportunities we have as a nation to direct that future, and finally how changing these actions could alter the future. The motivation for an evaluation of the nation's wildlife and fish resources stems proximately from recent federal legislation but ultimately from the public's desire and expectation that the stewards of these public resources be explicit and complete in their consideration of wildlife and fish in planning for and managing all natural resources. The public attitude concerning the management of natural resources has been reflected in a number of recent federal laws. This report is a response to one such law—the Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA).

RENEWABLE RESOURCE PLANNING ASSESSMENTS

The national assessment of wildlife and fish is one part of the reporting responsibility of the USDA Forest Service related to the RPA. Resource assessments are technical reports about the nation's natural resources and are used as a basis upon which a second requirement of the RPA is satisfied—the development of a national program for the Forest Service. The Act was amended in 1976 by the National Forest Management Act which further directed the Forest Service to complete land management plans for each national forest as a more detailed part of the agency's planning responsibilities. The national forests are currently developing the first series of plans, while resource assessments and programs for minerals, range, water, recreation and wilderness, and wildlife and fish resources have been carried out in 1975, 1979, and 1984. Timber assessments have been completed since the late 1800's.

The Forest Service is not alone in its national planning requirements. Similar national planning mandates were established for the Soil Conservation Service on all non-federal lands with the passage of the Soil and Water Resources Conservation Act of 1977 (RCA). The Federal Land Policy and Management Act of 1976 (FLPMA) established a related requirement for inventories and documentation to support land use planning and policy development on lands administered by the Bureau of Land Management.

The legislative requirements for national resource planning generally follow a similar format. The resources are to be described in terms of their current and recent historical status and condition. In the case of wildlife and fish, this requirement translates into a characterization of the habitats, populations, users, and use of the resource. In addition, a projection must be made of resource attributes and an exploration of alternative future opportunities that could change the future resource situation. Finally, how the findings affect Forest Service resource management programs must be analyzed. The wildlife and fish assessment has been organized to be consistent with this national planning format.

ORGANIZATION OF THE 1989 WILDLIFE AND FISH ASSESSMENT

The 1989 national assessment of wildlife and fish has been structured as a planning document. The first chapter presents the current status and recent historical trends in wildlife and fish habitats, populations, nonconsumptive and consumptive users, and harvests. Each section of chapter 1 presents available information at the national, regional, and federal ownership levels. Information reported at the state level has been specifically excluded from this report since it is under the jurisdiction of the individual states.

The next three chapters present projections of the future resource situation. A major effort was made during the last 10 years to develop methods for evaluating future recreational uses of wildlife and fish (chapter 2) and future wildlife and fish inventories (chapter 3). A comparison of these projected levels of use and inventories (chapter 4) establishes a basis for identifying potential imbalances in resource supplies and demands.

The fifth chapter describes the social, economic, and environmental implications of the recent trends and future projections of wildlife and fish inventories and their uses. These implications provide the societal justification for future management actions that could improve the resource situation and ultimately enhance public welfare.

Major management issues, and the opportunities that exist to address them, are described in chapter 6. These issues and opportunities are discussed as changes that could be accomplished to improve the future wildlife and fish resource situation. However, opportunities to improve the resource situation can be expected to encounter obstacles in implementation. These obstacles include legal, political, institutional, economic, and biophysical limitations that, unless they are satisfactorily resolved through program implementation or additional research, will limit the full realization of resource improvement expected from the proposed opportunities.

The last chapter broadly identifies the implications of this assessment to the next Forest Service program. These implications are discussed with reference to their potential influence on national forest management, management programs on state and private forests and rangelands, and research programs carried out by the Forest Service.

To clarify terminology, a glossary is provided in appendix A, and Latin names of animal species mentioned in this report have been compiled in appendix B.

The content of this report, as well as previous RPA national assessments of wildlife and fish, is a product of the available information on habitats, populations, and use characteristics. There are many opportunities to improve the quality of data and analyses that could be used to evaluate the status of the nation's wildlife and fish resources. Nonetheless, this report represents the state-of-the-art and is the most comprehensive national effort ever undertaken to assemble historical data and synthesize related analyses to address the requirements implied by national planning legislation. Early in the planning for the 1989 wildlife and fish assessment, it was recognized that an improved technical report would be possible through cooperative efforts with various federal and state agencies. Within the U.S. Department of Agriculture, the Soil Conservation Service made a commitment to assist the Forest Service in collecting and synthesizing information for this report. Similarly, the Bureau of Land Management, the Fish and Wildlife Service, and the National Marine Fisheries Service contributed to the assessment format and provided data and analyses for portions of this report. State wildlife and fish agencies also reviewed the proposed approach for data acquisition and analysis, provided data, and reviewed the document for technical adequacy. Although the Forest Service has the mandated responsibility to assess the nation's wildlife and fish resources, the collaboration that went into the completion of this report makes this assessment a multi-agency effort—the product of which is summarized in the pages that follow.

CHAPTER 1: CURRENT STATUS AND RECENT HISTORICAL TRENDS OF WILDLIFE AND FISH RESOURCES

One objective of renewable natural resource assessments is to evaluate the potential environmental, social, and economic implications of resource production and consumption trends (Hamilton and Thorton 1982). An evaluation that attempts to identify and address future resource management issues first must address an appropriate historical perspective to provide a context within which to interpret present trends. The last national assessment of wildlife and fish (USDA Forest Service 1981) provided recent historical trends through the mid-1970's. Recent history for this assessment is defined as 1965–1985. However, data through 1988 is presented when available. The trends are discussed with respect to the factors considered responsible for the dynamics observed over this approximate 20-year period.

For this assessment, four aspects of wildlife and fish resources are defined, each important to a characterization of resource status: habitats, population levels, number of users, and harvest levels. Owing to the diversity of habitats and the large number of resident and common migrant species, this chapter addresses the four resource aspects by major habitat or species categories. The habitat categories include forestland, rangeland, wetland, water, and agricultural habitats. The species categories include nongame, migratory game birds, big game, small game, furbearers, fish, and threatened and endangered species.

The data available to support an assessment of wildlife and fish come largely from existing information of the Forest Service and cooperating state and federal agencies. In general, the data were not collected specifically for a national assessment of wildlife and fish. No standard national or regional inventory that permits a consistent summarization of wildlife and fish resources exists (Hirsch et al. 1979, Hoekstra et al. 1983). Consequently, the extent to which habitat, population, user, and harvest trends can be discussed depends on the information available from various sources.

The review of the current status and historical trends in wildlife and fish resources is organized into two major sections: *National and Regional Statistics*, and *Wildlife and Fish Resources on Public Lands*. Within the first section, a national level summary discusses the broad emerging historical trends in wildlife and fishery resources observed in the United States. More refined geographic detail is reviewed within four multi-state assessment regions defined by the Forest Service for program planning purposes and include the North, South, Rocky Mountain, and Pacific Coast regions (fig. 1). Regions defined by other criteria are also used when they are established in wildlife and fishery usage. These include waterfowl flyways, Breeding Bird Survey regions, or Bureau of Census regions. The second section of this chapter examines the distributional characteristics of wildlife and fish resources on public lands emphasizing lands administered by the National Forest System and Bureau of Land Management.

NATIONAL AND REGIONAL STATISTICS

Available information regarding the current status and historical trends in wildlife and fish resources is biased heavily towards those few species that are of commercial importance or taken for sport. Information was also available on some threatened and endangered species and nongame birds because of public concern for preserving these species or for their high nonconsumptive recreational value. However, small mammals, amphibians, reptiles, fish, and invertebrates are largely unrepresented in state or federal inventories. Therefore, the trends reviewed here are admittedly incomplete regarding the full compendium of species that play critical roles in the natural environment. Nevertheless, the information reviewed herein does provide insights into the status of wildlife and fish resources in the United States.

Wildlife and Fish Habitat

Wildlife and fish habitat in its most basic sense can be defined as the availability and appropriate mix of food, cover, and water. Habitat represents a spatial

concept characterized by a particular combination of physical and biotic factors within a defined geographic area that interact to determine whether a particular species can survive and reproduce (Partridge 1978). Except for special cases (e.g., critical habitat for some threatened or endangered species), national inventories addressing the amount of habitat specific to a single species or species group do not exist.

Alternatively, habitat may be descriptively defined based on landscape attributes. In many cases, vegetation features can be used to define habitat types that can be inventoried over large geographic areas. Similarly, stream characteristics can form the basis of an inventory of fish habitat. Based on this definition of habitat, the inventory represents a description and estimate of land area that supports a faunal community as opposed to an estimate of the amount of suitable habitat for any given species. This alternative definition forms the basis for the following discussion of habitat trends.

Overview of Land Use and Land Cover Trends

Wildlife and fish are products of how the land is covered (i.e., vegetation present) and how the land is used (e.g., grazed, cropped, urbanized). As indicated in figure 2, major land use categories have changed very little. The most obvious pattern has been a reduction in land supporting natural vegetation types concomitant with increasing land modified by people. Acreage in both forest and range categories has declined by about 5% since about 1960. After declining slightly through the mid-1970's, land area devoted to crop production showed a 3% increase by the early 1980's.

Trends in urbanland have been difficult to estimate precisely because of inconsistencies in definitions (USDA Soil Conservation Service 1987). Frey's (1983) summary of urbanland trends indicates that it has increased from approximately 25 million acres in 1960 to 47 million acres in 1980—an increase of 88% over that 20-year period. Urban expansion has both direct (removal of habitat) and indirect (increased human-related disturbance) impacts on wildlife and fish habitats. Consequently, urbanland uses are discussed as a disturbance factor rather than a specific category of wildlife or fish habitat.

The three land uses in figure 2 constitute a broad classification within which to discuss terrestrial wildlife habitats. Characteristics of the nation's aquatic environments address fish habitat, and wetlands are discussed as important habitats transitional between terrestrial and aquatic ecosystems.

Forestland Habitats

Forestland is defined as land at least 10% stocked by forest trees of any size, or formerly having such cover, and not currently developed for other uses (USDA Forest Service 1981). Forested ecosystems are extensive and diverse. Ninety percent of the resident or common migrant vertebrate species in the United States use forested ecosystems to meet at least part of their life requisites. At least 90% of the total bird, amphibian, and fish species and at least 80% of mammal and reptile species utilize forest ecosystems (USDA Forest Service 1979).

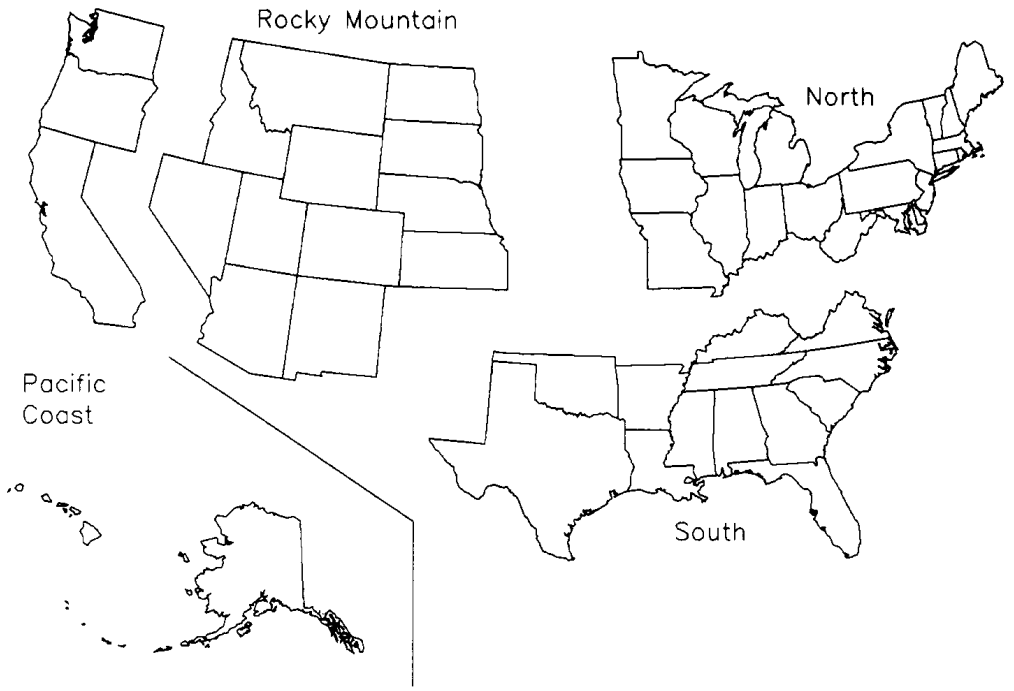


Figure 1.—Forest Service assessment regions.

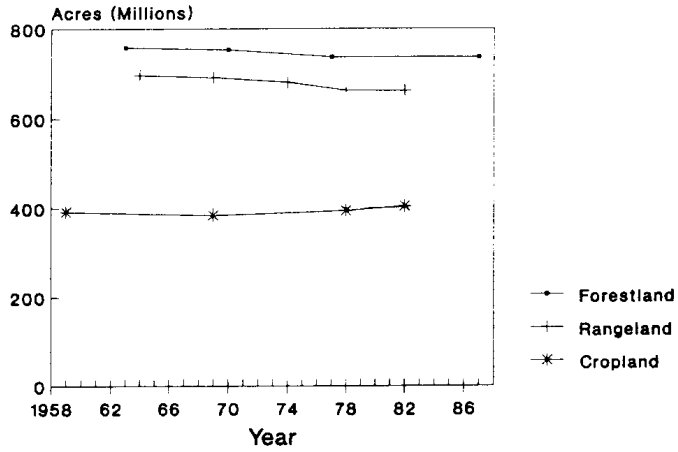
Forestlands currently comprise nearly a third of the total terrestrial land base; however, the extent of forestland has been diminishing (fig. 2). The losses have been attributed to conversion to cropland and pastureland, urban development, and highway and reservoir construction. The distribution of forestland is split evenly between the eastern and western assessment regions. The Pacific Coast region contains the most forestland acres; the Rocky Mountain region has the least.

The majority of the forestland acres recently lost occurred in the eastern half of the country, particularly in the South where forest has declined by 20 million acres over the last decade (table 1). This was expected because of the higher population and economic activity in the East (USDA Forest Service 1982). Forestland acres in the Rocky Mountains and Pacific Coast have remained relatively stable since the early 1960's.

Although complex relationships exist between wildlife and forested environments, it is possible to generalize the description of forest environments to obtain reasonable interpretations for trends in wildlife habitats. Cover type, successional stage, and spatial arrangement affect the kinds, numbers, and distribution of animals which inhabit forest environments. Unfortunately, forest inventories have not been uniformly designed to evaluate these particular attributes. Recent historical trends must be synthesized by gleaning data from existing inventory information compiled for other forest uses. Specifically, information exists on trends in forest ecosystem types and successional stages (as measured by stand-size class) for commercial timberland only. Commercial timberland is land capable of producing 20 cubic feet of wood per acre per year, and which is available for successive harvests of timber products (USDA Forest Service 1982). Similar data on noncommercial forestlands, including those in parks and wilderness, are not available.

Changes in forest types strongly influence wildlife and fish community composition. The forest types discussed in this document are those defined by the Forest-Range Environmental Study (FRES) (Garrison et al. 1977). Because of variation in inventory techniques and standards, historical trends must be interpreted cautiously, particularly in the western regions (USDA Forest Service 1982).

Eastern commercial forests are currently represented by 10 separate types including four softwood and six hardwood forest types (table 2). The most common eastern forest type is oak-hickory, which represents about 24% of the national commercial timberland area. Area trends in oak-hickory have fluctuated. From 1963 to 1977 the amount of land classified as oak-hickory declined by approximately 7 million acres. The decline was largely restricted to the North where forest clearing for crop and dairy farms, and management actions that converted oak-hickory stands to other forest types explain the change. The lack of a market for low-quality hardwoods has discouraged managing for oak-hickory



Source: Frey and Hexem (1985); USDA Forest Service (1965, 1974, 1982); Bones [in press]

Figure 2.—Recent trends in major land use categories in the United States.

Table 1.—Regional trends in forestland in the United States (1963–1985).

Region	1963		1970		1977		1987	
	Million acres (% of total)							
North[1]	178	(24)	186	(25)	178	(24)	182	(25)
South[2]	220	(29)	212	(28)	207	(28)	188	(26)
Rocky Mountain[3]	143	(19)	138	(18)	138	(19)	138	(19)
Pacific Coast	216	(29)	217	(29)	214	(29)	220	(30)

[1]*Includes ND, SD (east), NE, KS, KY.*
[2]*Does not include KY.*
[3]*Does not include ND, SD (east), NE, KS.*
Source: Bones (in press), USDA Forest Service (1965, 1974, 1982).

forests (USDA Forest Service 1982). Since 1977, the area of the oak-hickory type has increased, primarily in the South. Although specific reasons were not cited, Bones (in press) implied that natural succession and the harvesting of pine from oak-pine stands has led to a significant expansion of oak-hickory forests over the last decade.

Eastern hardwood types that have shown significant proportional losses (at least 10% of the 1963 acreage) include oak-gum-cypress, aspen-birch, and elm-ash-cottonwood. In recent years, changing land-use patterns have adversely affected the oak-gum-cypress type. Forests on the alluvial soils of the Mississippi Valley have been extensively cleared for agriculture (Bones in press). Much of the remaining bottomland forests are found as stringers along streams where the soil is too wet for profitable cropping or grazing (Rudis and Birdsey 1986, USDA Forest Service 1982).

Table 2.—Recent trends in eastern commercial forestland by forest types.

Region	Year	White-jack-red pine	Longleaf-slash pine	Loblolly-shortleaf pine	Spruce-fir	Oak-pine	Oak-hickory	Oak-gum cypress	Elm-ash-cottonwood	Maple-beech-birch	Aspen-birch
					Thousand acres						
North[1]	1963	10,680	—	3,818	19,623	2,266	58,896	1,678	18,301	32,812	23,715
	1970	11,910	—	3,422	18,899	4,085	55,536	1,361	21,971	30,657	20,484
	1977	11,455	—	3,423	17,552	4,170	49,956	623	19,074	35,821	19,243
	[3]1987	13,349	—	2,340	16,825	3,550	47,124	795	11,283	43,384	17,774
South[2]	1963	440	25,977	54,177	15	24,675	57,067	36,110	2,102	506	—
	1970	257	18,314	49,409	13	30,942	56,324	29,268	2,756	482	—
	1977	370	16,754	46,576	8	30,470	58,939	26,062	3,243	425	—
	[4]1987	514	15,491	46,248	18	27,775	70,559	27,332	3,007	876	—
Total East	1963	11,120	25,977	57,995	19,638	26,941	115,963	37,788	20,403	33,318	23,715
	1970	12,167	18,314	52,831	18,912	35,027	111,860	30,629	24,727	31,139	20,484
	1977	11,826	16,755	49,999	17,560	34,639	108,895	26,685	22,318	36,246	19,243
	1987	13,863	15,481	48,588	16,843	31,325	117,683	28,127	14,290	44,219	17,777

[1]*Includes ND, SD (east), NE, KS, and KY.*
[2]*Does not include KY.*
[3]*Does not include KY, includes SD (east and west).*
[4]*Includes KY.*
Source: Haynes (in press), USDA Forest Service (1965, 1974, 1982).

Aspen-birch, found in the North region, has been declining as a consequence of uninterrupted succession. Aspen-birch is a pioneer type on recently disturbed sites; when logging, fire, or other natural causes do not set succession back, this type is replaced by more shade-tolerant species such as maple, beech, and hemlock.

Following moderate acreage increases during the 1963–1977 period, elm-ash-cottonwood has declined by 8 million acres. The rapid spread of Dutch elm disease partially explains this trend. In many cases, elm is being replaced by more aggressive and fast-growing species such as red maple which is becoming more prominent particularly in the Northeast (Bones in press).

Some of the greatest proportional losses, for either hardwood or softwood types, have occurred in southern longleaf-slash and loblolly-shortleaf forests. Two significant reasons for the decline in these types have been cited (Bones in press, USDA Forest Service 1982). The first was that a lack of regeneration following harvest permitted encroachment by hardwoods resulting in conversion to oak-pine or oak-hickory. Secondly, less farmland has been abandoned. Until the early 1950's, the reversion of idle farmland accounted for the apparent stability in softwood acreage. The decline in the two southern pine types is particularly worrisome because the endangered red-cockaded woodpecker is an obligate inhabitant of these softwood types. Lennartz et al. (1983) estimated that the mature pine habitats required by this species had declined by 13% in 25 years.

Commercial forests in the western United States are dominated by softwoods (table 3). Because of changes in inventory standards and definitions, meaningful historical interpretations cannot be made (USDA Forest Service 1982). An additional caveat is that reported losses do not necessarily reflect conversion of forest to non-forestlands. Designation of forestland as wilderness removes that land from the commercial timberland base, but this should not be interpreted as a loss of forestland habitat.

Douglas fir and ponderosa pine are the most common western forest types, comprising nearly 45% of the West's commercial timberland. Fir-spruce, hemlock-Sitka spruce, and lodgepole pine constitute an additional 39% of the western commercial forestland base. The remaining softwood types, including larch, redwood, and western white pine among others, account for less than 4% of the commercial forestland base. In addition to these softwood types, western hardwoods comprised about 12% of the 1987 commercial timberland base. Although of limited value to the timber industry, western hardwoods are important for wildlife habitat and watershed protection.

Forest succession is a process whereby vegetation composition and structure change over time as the plant community evolves from bare ground to the climax state. Identifiable stages in this sequence are often called seral or developmental stages (Odum 1971). Verner and Boss (1980) suggested four seral stages for forest communities including grass/forb, shrub/seedling/sapling, pole/medium tree, and large tree. As forest communities progress through this sequence, the fauna changes, too. Maintaining the diversity of wildlife species that are potential inhabitants of any forest community requires that all seral stages be represented. For this assessment, stand-size classes for commercial timber were available

Table 3.—Recent trends in western commercial forestland by forest types.

Region	Year	Douglas fir	Ponderosa pine	Western white pine	Fir-spruce	Hemlock-Sitka spruce	Larch	Lodgepole pine	Redwood	Other softwood	Western hardwood
					Thousand acres						
Rocky[1] Mountain	1963	13,447	18,881	2,360	8,962	200	2,669	13,163	—	—	5,941
	1970	11,885	14,454	631	9,800	896	2,032	9,940	—	—	4,272
	1977	12,220	14,673	320	10,124	1,246	1,749	9,816	—	507	4,555
	[2]1987	13,304	13,714	260	11,009	1,489	1,749	9,397	—	301	4,810
Pacific Coast	1963	23,905	17,116	2,643	6,654	9,808	863	2,633	1,596	—	5,146
	1970	18,902	13,509	198	8,029	9,922	711	3,294	803	—	8,545
	1977	18,677	11,976	126	9,732	11,620	683	2,919	662	—	10,308
	1987	19,023	10,927	14	15,843	9,495	852	2,178	1,102	492	11,028
Total West	1963	37,352	35,997	5,003	15,616	10,008	3,532	15,796	1,596	—	11,087
	1970	30,787	27,963	829	17,829	10,818	2,743	13,234	803	—	12,817
	1977	30,897	26,649	446	19,856	12,866	2,432	12,735	662	507	14,862
	1987	32,327	24,641	274	26,852	10,984	2,601	11,575	1,102	793	15,838

[1]*Does not include ND, SD (east), NE, and KS.*
[2]*Does not include SD.*
Source: Haynes (in press), USDA Forest Service (1965, 1974, 1982).

as indicators of forest seral stages. Stand-size is defined by the predominant size of trees stocking a stand and include seedling/sapling, poletimber, sawtimber, and nonstocked stands.

In 1987, slightly more than half (242 million acres) of the nation's commercial timberland was classified as sawtimber. The number of acres classified as sawtimber increased between 1963 and 1987 (table 4)—a trend due primarily to ageing eastern forests. Since 1963, northern sawtimber stands have increased by nearly 22 million acres or 40%. Sawtimber stands have remained relatively stable in the West over the same period.

Of the remaining size classes stocked with timber, the greatest acreage occurs in the East. Over 80% of the poletimber occurs in the eastern regions. Increases in poletimber acreage have occurred primarily in the Pacific Coast, with declines being observed in the Rocky Mountains and South. About 20% of the commercial forestland acreage exists in seedling/sapling stands—a proportion that has been steadily declining since 1970. The majority of seedling/sapling stands exists in the East; the North and South are the only regions to lose substantial acres of this size class—nearly 25% of the acres that existed in 1977.

An important issue related to stand-size class is the concern for old-growth forests and the obligate inhabitants of this successional stage including such species as the red-cockaded woodpecker in the South, the spotted owl in the Pacific Northwest, and the Sitka black-tailed deer in Alaska. Harris (1984) estimated that of the 118 vertebrates which inhabit western Oregon's coniferous old-growth, 40 species cannot survive in any other seral stage.

Stand-size class is not the best indicator of the amount of forestland in mature successional stages. Age, although a better indicator of mature or old-growth forests, is also insufficient. Important structural characteristics such as snags, dead and down woody material in various stages of decay, multi-layered canopy, and patchy understory (Franklin et al. 1981, Harris 1984) may be absent in intensively managed mature forests.

The definition of "old-growth" is complex and varies by region and by forest type. The result has been a lack of consensus on a general definition (Mannan 1980, Spies and Franklin 1988). Consequently, it is difficult to precisely quantify trends in old-growth forest area. All indications, however, are that old-growth is becoming rare (Harris 1984) and is likely to be less extensive and more fragmented in the future (Fosburgh 1985b). Thomas et al. (1988) reported only 2% to 15% of the presettlement virgin timber (excluding the Alaskan taiga) remains nationwide. Similarly, Spies and Franklin (1988) have estimated that only about 17% of the original old-growth that existed in the early 1800's remains in the Douglas-fir region of western Oregon and Washington. In the last century, old-growth forests have been almost completely cut-over on private lands (Fosburgh 1985b). In the East, sawtimber stands are predominantly young-growth and are comprised of trees in the lower end of the sawtimber size class. Conversely, the remaining sawtimber in the West is primarily found in old-growth stands (USDA Forest Service 1982).

A final characteristic of forested habitats, and one that is inadequately addressed in current forest inventories, is the size, shape, and distribution of forestlands, forest types, and successional stages. There is an increasing recognition that the pattern of forest environments across landscapes needs to be considered in wildlife habitat assessments (Noss 1987, Risser et al. 1984). Although some wildlife species are benefited by increases in the spatial

Table 4.—Trends in stand-size class by assessment region

Class	Year	Total	North[1]	South[2]	Rocky[3] Mountain	Pacific Coast
			Thousand acres			
Sawtimber	1963	208,945	52,974	68,828	38,639	48,504
	1970	215,876	58,949	74,041	36,555	46,321
	1977	215,435	59,098	71,246	38,545	46,545
	1987	242,449	74,548	78,321	41,981	47,599
Poletimber	1963	164,794	64,808	71,580	19,063	9,343
	1970	126,794	60,156	46,151	12,129	8,256
	1977	135,610	55,543	58,316	11,708	10,042
	1987	136,773	60,445	54,888	9,454	11,986
Seedling sapling	1963	99,573	39,327	49,254	4,352	6,640
	1970	131,368	49,223	67,578	5,229	9,337
	1977	115,032	46,676	53,286	4,955	10,115
	1987	92,436	31,547	44,883	5,323	10,683
Nonstocked	1963	35,533	14,680	11,407	3,569	5,877
	1970	20,721	9,571	4,771	2,671	3,707
	1977	16,408	4,823	5,198	2,556	3,831
	1987	11,649	2,247	5,380	2,186	1,836
All	1963	508,845	171,789	201,069	65,623	70,364
	1970	499,692	177,901	192,542	61,631	67,622
	1977	482,485	166,141	188,045	57,765	70,543
	1987	483,309	168,788	183,473	58,944	72,104

[1]*Includes ND, SD (east), NE, KS, and KY.*
[2]*Does not include KY.*
[3]*Does not include ND, SD (east), NE and KS.*
Source: USDA Forest Service (1965, 1974, 1982), Waddell, pers. comm., 1989.

heterogeneity of forestlands, other species appear to require large tracts of homogeneous forest. Providing habitat for both kinds of species is necessary if the diversity of species inhabiting forest environments is to be maintained. There is a concern, both in the East (Burgess and Sharpe 1981) and in the West (Harris 1984), that increasing forest fragmentation will jeopardize the existence of some species as functioning members of certain faunas. At the present time, the most vulnerable forest environments are large tracts of mature and old-growth forests.

Evaluating the impacts of changing forest type, timber size-class, and their interspersion and juxtaposition on wildlife and fish is difficult since species respond differently depending on their habitat requirements. Quantitative analyses are being developed to permit resource planners to explicitly analyze species' responses to forestland changes. An example is the life form system developed for the Blue Mountains in Oregon and Washington (Thomas 1979). Other systems have been developed to specifically utilize Forest Service regional inventories of commercial forestland (McClure et al. 1979, Sheffield 1981).

In a case study for this assessment, we modified the models developed by McClure et al. (1979) and Sheffield (1981) to assess the status and trends in commercial forest habitats for gray squirrel, pileated woodpecker, pine warbler, prothonotary warbler, and red-eyed vireo in the five coastal states from Virginia to Florida. Species were chosen to reflect several forest types and successional stages.

The results of the analysis using the most recent forest survey data in those five states indicate that the rarest habitat of the five species modeled is that required by the prothonotary warbler, followed by the pileated woodpecker (table 5). The prothonotary warbler's habitat includes stands with intermediate to dense canopy cover, in both mesic and hydric sites, and in the intermediate to mature stage of succession. Pileated woodpeckers need dense mature stands on mesic sites.

The gray squirrel, red-eyed vireo, and pine warbler had relatively large amounts of suitable habitat in the Southeast. The gray squirrel habitats are pole and sawtimber stands with 40% to 75% canopy cover, 31% to 75% stocked with hard and soft mast trees, and a well developed understory. Red-eyed vireos prefer hardwood stands over 70 years old with more than 60% canopy closure. The habitats of the pine warbler are described as pole and sawtimber stands of pine forest types with a sparse understory.

South Carolina was the only state suitable for an assessment of trends because two forest inventories that

Table 5.—Analysis of status and trend of commercial forestland habitat for five selected species in the Southeast (SE) and South Carolina (SC).

Species	% good habitat	% fair habitat	% no habitat
Gray Squirrel			
SE	48.5	23.1	28.4
SC 1978	47.4	25.0	27.6
SC 1986	48.5	21.8	29.7
Pileated Woodpecker			
SE	7.3	18.5	74.2
SC 1978	7.1	17.7	75.2
SC 1986	6.7	16.3	76.9
Prothonotary Warbler			
SE	1.9	2.1	96.0
SC 1978	10.1	6.7	83.2
SC 1986	2.1	2.4	95.5
Pine Warbler			
SE	19.5	10.2	70.3
SC 1978	26.9	9.2	63.9
SC 1986	23.8	10.5	65.6
Red-eyed Vireo			
SE	18.3	31.1	50.6
SC 1978	9.5	30.1	60.4
SC 1986	14.3	29.6	56.1

included appropriate variables (1978 and 1986) had been conducted. The rare habitats declined there over the trend period (table 5). The greatest decline occurred in the habitat of the prothonotary warbler. Pileated woodpecker habitat declined slightly as did pine warbler habitat. These trends are consistent with the noted losses of sawtimber-sized stands, the reduction in bottomland hardwoods (e.g., the oak-gum-cypress forest type), and the declining acres in pine types. The development of similar models for other species and regions will require further research before future wildlife assessments can have nationally complete information on wildlife habitat of this nature.

Rangeland and Pasture Habitats

Rangelands include those acres where the potential natural vegetation is mostly grass, grasslike plants, forbs, and shrubs (Short 1986), plus cropland used for pasture. Rangelands often have been evaluated in terms of their capability to support livestock. However, people increasingly recognize that rangeland ecosystems are also important for their recreational and ecological value. Growing public interest in range management verifies interest in these multiple resource benefits (Joyce in press).

Rangeland habitats support a wide diversity of wildlife and fish species. Of the total mammalian and avian species found in the United States, 84% and 74%, respectively, are associated with rangeland ecosystems during some part of the year (USDA Forest Service 1979). Species associated with aquatic environments are the least represented vertebrate groups due to the arid or semiarid climate of most rangeland environments. Only 38% of the nation's fishes and 58% of the amphibians are represented in rangeland ecosystems.

Table 6.—Regional trends in nonforest pasture- and rangeland in the conterminous United States (1964–1982).

Land use	1964		1969		1974		1978		1982	
	Million acres (% of total)									
North[1]	55	(8)	50	(7)	45	(7)	40	(6)	38	(6)
South[1]	177	(25)	180	(26)	178	(26)	171	(26)	178	(27)
Rocky Mountain	404	(58)	403	(58)	398	(59)	394	(60)	388	(59)
Pacific Coast[2]	58	(8)	56	(8)	57	(8)	56	(8)	55	(8)

[1]*West Virginia is included in the South instead of the North.*
[2]*Does not include Alaska or Hawaii.*
Source: Frey and Hexem (1985).

Recent changes in rangeland and pasture acreages have been minor. Since the mid-1960's total acres in pasture and rangeland have declined by 5% (fig 2). Factors contributing to the noted losses include conversion to cropland, withdrawal of land for recreational, wildlife, and environmental purposes, and losses to urban expansion (Frey and Hexem 1985). The distribution of rangeland varies considerably by region. In 1982, the Rocky Mountain region accounted for nearly 60% of the total pasture and rangeland acres in the conterminous United States while the North contributes only about 6% to the total.

Regional rangeland area trends vary somewhat from the national figures. The North has had the greatest relative decline since the mid-1960's, declining by 31% (table 6). However, the North has the least amount of rangeland habitats which magnifies the proportional reduction noted. Rangeland area in the South has remained stable in recent time, fluctuating between 170 and 180 million acres. Declines in the West have been relatively minor—4% in the Rocky Mountains and 5% in the Pacific Coast.

Given the minor changes in pasture and rangeland area, changes in the condition or characteristics of rangeland environments are, in general, more important in evaluating wildlife and fish habitat suitability than conversion to other land uses. Evaluating rangeland in terms of wildlife habitat is complicated, as in all habitat types, by the multiplicity of wildlife responses. Rangeland characteristics that may be detrimental to some species are beneficial to others. This difficulty has been compounded because wildlife managers had not, until recently, developed a consistent system to assess wildlife habitats in rangelands (National Academy of Sciences, National Research Council 1982). The Forest Service and Bureau of Land Management have recently completed a procedure for evaluating wildlife and fish habitats in rangeland environments in the Great Basin of southeastern Oregon (see Maser and Thomas 1983). Development of similar procedures in other regions are

needed for application in national assessments. Despite the absence of a national rangeland evaluation system, a discussion of the important factors affecting wildlife and fish response to range condition provides a qualitative assessment of rangeland habitats. These factors include interspecific competition, vegetation composition changes, effects from human management and development, and spatial patterns of native range ecosystems.

Interspecific competition occurs when two or more species require the same resources that are in short supply. Much scientific literature concerns domestic livestock competition with large ungulate species. There appears to be little doubt that, historically (1920–1940), domestic animals outcompeted wild animals in the West; although grazing pressure has declined significantly since that time, competition still exists (Wagner 1978). Few people disagree that western rangelands are of much reduced quality for grazing herbivores compared to what was present when livestock were first introduced (National Academy of Sciences, National Research Council 1982).

A more recent issue concerning interspecific competition involves wild horses and burros. Originally brought to this country by Spanish conquistadors in the early 1500's, herd sizes have grown steadily through natural reproduction and as animals escaped or were released from captivity (Sowell et al. 1983). Between 1974 and 1980, wild horse numbers grew from 42,700 to 55,400 (Administration of the Wild Free-Roaming Horse and Burro Act 1980). As populations have increased, concern has been raised over vegetation and soil impacts as well as competition with native wildlife (USDA Forest Service 1981). Although specific cases of range degradation involve wild horses and burros, and though many investigators suspect that competition occurs, quantifying the extent and nature of the problem requires further examination (Wagner 1983).

In addition to reducing the availability of forage for wild animals, grazing also alters vegetation composition. The National Association of Conservation Districts (1979) found that brush species had replaced many of the grass and other desirable forage species on 200 million acres in the Southwest and that 77% of the nation's private rangelands needed some form of conservation treatment. Invasion by shrub species in arid grassland communities, caused by grazing and fire control, can significantly alter faunal composition. Examples of how such vegetation changes negatively impact wildlife species include bighorn sheep, pronghorn, sage grouse, masked bobwhite quail, and northern aplomado falcon (Buechner 1961, Gable and Dobrott 1988, Morgan 1971, Schneegas 1967, USDI Fish and Wildlife Service 1986b). However, shrub invasion may have positive impacts on other species, such as mule deer (Wagner 1978). By favoring moderate topography near water, cattle may damage riparian vegetation and stream habitat quality (Kauffman and Krueger 1984, Thomas et al. 1979, Wagner 1978). The need to consider riparian ecosystems in future land management planning is emphasized when one considers that 70% to 90% of riparian ecosystems have been lost to human activities (Ohmart and Anderson 1986).

Range management activities and human development also impact rangeland wildlife species. Certain techniques to improve range for livestock including herbicide applications to control shrubs, pinyon-juniper removal, planting of exotic plant species, predator control, and livestock industry pressure to limit ungulate populations all affect wildlife community composition and the abundance of certain species (Joyce in press, Wagner 1978). Similarly, as human populations have increased, demands for agricultural commodities and subdivision of rangeland environments have increased. This development has tended to occur in valleys and lower slopes which conflicts directly with critical winter range for many wild ungulate species. Land use intensification related to maximizing livestock production, crop production, or human development will adversely affect the diversity and abundance of animals associated with rangelands unless consideration is given to wildlife and fish habitat requirements in the planning for range management activities.

As with forest habitats, the spatial pattern and particularly the fragmentation of native rangeland vegetation cause concern because they affect wildlife communities. In his study of Missouri's tall grass prairies, Samson (1980) concluded that there was an urgent need to consider the size and distribution of habitats with particular attention given to species requiring large contiguous habitats. Another study conducted in Illinois (Graber and Graber 1983) indicated that loss of grassland habitat was responsible for the dramatic decline in prairie birds. The upland sandpiper, bobolink, dickcissel, grasshopper sparrow, savannah sparrow, and Henslow's sparrow all declined by over 90% from the late 1950's to the late 1970's.

Native prairie vegetation is the most vulnerable range ecosystem to fragmentation effects analogous to old-growth forests. A few large and many small tracts of native grassland vegetation remain or have been reestablished. Efforts to reestablish native prairies during the last 20 years have emphasized plant species (see Jordan et al. 1987). As prairie habitats are restored, managers must recognize the wild animal component when evaluating grassland environments.

Unfortunately, quantitative information on the recent trends in rangeland characteristics that are representative of broad regional areas currently do not exist. However, livestock numbers and range condition ratings provide surrogate measures that reflect, in part, the intensity of livestock management.

Trends in livestock numbers vary by assessment region and are reviewed in detail by Joyce (in press). In the North, the number of cattle has shown a general decline. Since 1975, the number of animals has decreased from 38 to approximately 30 million animals.

Trends have been similar in the South and Rocky Mountains, with the number of cattle declining by 12 and 8 million animals after reaching peaks of 50 and 38 million in the mid-1970's, respectively. The Pacific Coast region has shown slight (500,000 animals) increases in cattle numbers since the mid-1970's; however, the magnitude of the change is minor relative to the magnitude of the decline noted in other regions. The nationwide decline in livestock numbers is attributed to changing consumer preference away from red meat consumption (Council on Environmental Quality 1985), and land use shifts from cropland pasture to cropland use for crops (Joyce in press).

Range condition has been defined as the departure of a site's vegetation composition from that expected under the climax plant community (Stoddart et al. 1975). Sites with high similarity to the climax community are rated as "excellent," while sites with low similarity are rated as "poor." This rating was based on a plant's susceptibility to grazing; a causal relationship between livestock overgrazing and range in poor condition was assumed (Joyce in press).

As reported by the USDA Soil Conservation Service (1987), the majority (47%) of nonfederal rangelands was classified in fair condition; 4% was in excellent condition; 31% was rated in good condition; and 17% was in poor condition. The Soil Conservation Service also reported that range condition trends on nonfederal rangelands were static on 69% of the land, improving on 16%, and deteriorating on 15%. Although changes in inventory methodology have taken place, the Soil Conservation Service's data indicate that from 1963 to 1982 nonfederal rangeland condition has improved.

Although livestock numbers have declined nationwide and in most assessment regions, and though range condition on nonfederal rangelands appears to be improving, evaluating the impact of these trends on wildlife is difficult. Information concerning grazing capacity and how much available forage is allocated to livestock and other herbivores is required to assess more accurately the status and condition of rangeland ecosystems as wildlife habitat.

Wetland Habitats

Wetlands are transitional between terrestrial and aquatic systems. Either the water table is at or near the surface, or shallow water covers the land. Water saturation is predominantly responsible for the edaphic properties and the floral and faunal composition characteristic of wetland systems. Specifically, a wetland must have at least one of the following attributes:

"(1) At least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year" (Cowardin et al. 1979).

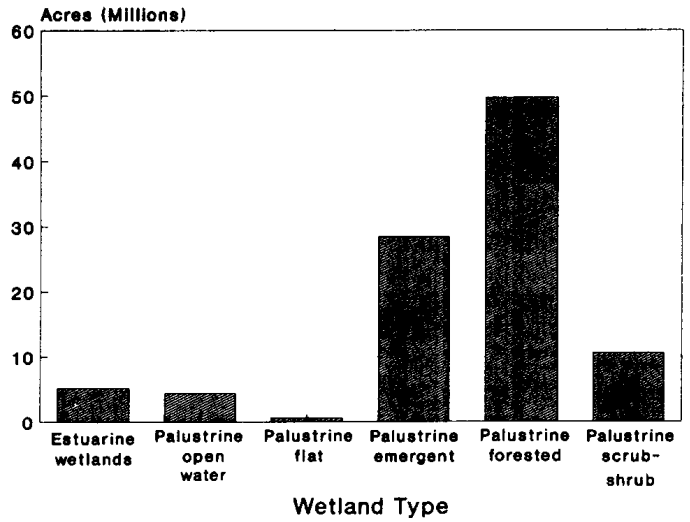
The ecological, economic, and recreational values of this habitat type cannot be overemphasized. Wetland systems are critical to flood and erosion control, recharging aquifers, and water purification. They are among the most productive ecological systems (Weller 1986). This inherent productivity supports a diverse wildlife and fish community including many species of nongame birds, furbearers, and waterfowl, plus threatened and endangered species. Commercial fisheries, furbearer harvest, nonconsumptive recreation and study, waterfowl hunting, and recreational fishing are examples of the diverse commercial and recreational opportunities supported by this single habitat type.

The productive capacity of wetland soils is, ironically, partially responsible for wetland destruction. Dynamic processes at the land-water interface and the anaerobic conditions of the substrate are responsible for large accumulations of organic matter and associated nutrients resulting in sites with very high productivity potential. This aspect of wetlands attracts land uses that can conflict with maintaining the biological integrity of wetland systems. Cattle grazing, timber harvesting, and tillage have all contributed to the degradation and destruction of wetland habitats when managed to the exclusion of other uses. Clearly, the productivity of wetlands targets this habitat type as an area of high resource conflict—a particularly important characteristic given the increasing rarity of wetlands.

Every state contains some wetland habitat; however, wetlands across the nation only account for about 5% of the land area within the lower 48 states, or approximately 99 million acres in the mid-1970's (Tiner 1984). Palustrine (i.e., inland shallow water) wetlands with woody vegetation comprise the majority of extant wetland habitats with 61% classified as forested or scrub-shrub wetlands (fig. 3). Although estimates of original wetland area are difficult to determine, Roe and Ayers (1954) estimated that the conterminous United States had 215 million wetland acres before settlement. If this estimate is accurate, then wetland acres have declined by 54%.

Frayer et al. (1983) completed a more recent study of wetland trends between the mid-1950's and the mid-1970's. Although some less productive wetland types had modest gains, total wetland area declined substantially (table 7).

Approximately 193,000 acres of unvegetated palustrine flats and 2.1 million acres of ponds were created from 1954 to 1974. Pond acres (palustrine open water) nearly doubled and were attributed to farm pond construction between the Rocky Mountains and the western border of the Atlantic coastal states. Most of these acres were formerly upland sites; however, 25% of the converted acres came from flooding forested and emergent wetlands (Tiner 1984).



Source: Tiner (1984)

Figure 3.—Distribution of wetland acres by wetland type.

Apart from these gains, all other wetland types declined dramatically. Total wetland area declined from 108.1 million acres in 1954 to 99 million acres in 1974 for an average loss rate of 458,000 acres per year. Acres lost varied by wetland type; forested wetlands declined by nearly 11%; emergent wetlands declined by 14%; scrub-shrub wetlands declined by 3.5%; and estuarine wetlands declined by 6.5%. Draining and tillage was responsible for 87% of the lost wetland acres, while urban development (8%) and other development (5%) were relatively minor factors in the wetland decline.

Agricultural and urban impacts on wetland habitats are most conspicuous in on-site development activities. However, land-use practices, municipal uses, and human alteration of water courses and ground water hydrology have had less conspicuous but equally detrimental off-site impacts (Cowan and Turner 1988, Weller 1988). Increased water withdrawals have lowered water tables and altered salinity concentrations on a landscape scale which affects plant species composition and contaminates public water supplies. Increased sediment loads from agricultural erosion have buried many aquatic grass beds. Channelization and levee construction have significantly altered the natural marsh building processes in estuarine systems. Protection and restoration of wetland habitats must recognize and address the cumulative effects of both on-site and off-site impacts stemming from human land management activities.

The distribution of wetland acres varies by geographic region and is a function of climate, geology, soils, and past land-use practices. Although only 5% of the land area in the lower 48 states is classified as wetland, wetlands comprise a significantly greater proportion of the land base in certain areas (fig. 4). Two important assessment regions regarding wetland area are the South, and the north-central portion of the North. In Alaska alone, it has been estimated that about 55% of the state's area is classified as wetland (Akins 1982, Saling n.d.).

Although comprising a much smaller component of the land base in other assessment regions, wetlands retain their value and importance to wildlife and fishery habitat. Riparian habitats in the arid portions of the Rocky Mountain region provide critical habitat for the native fauna (Hubbard 1977). Disruption and elimination of stream flows are responsible for the loss of riparian habitat. Similarly, grazing has greatly reduced the quality of regional riparian areas (Swift 1984).

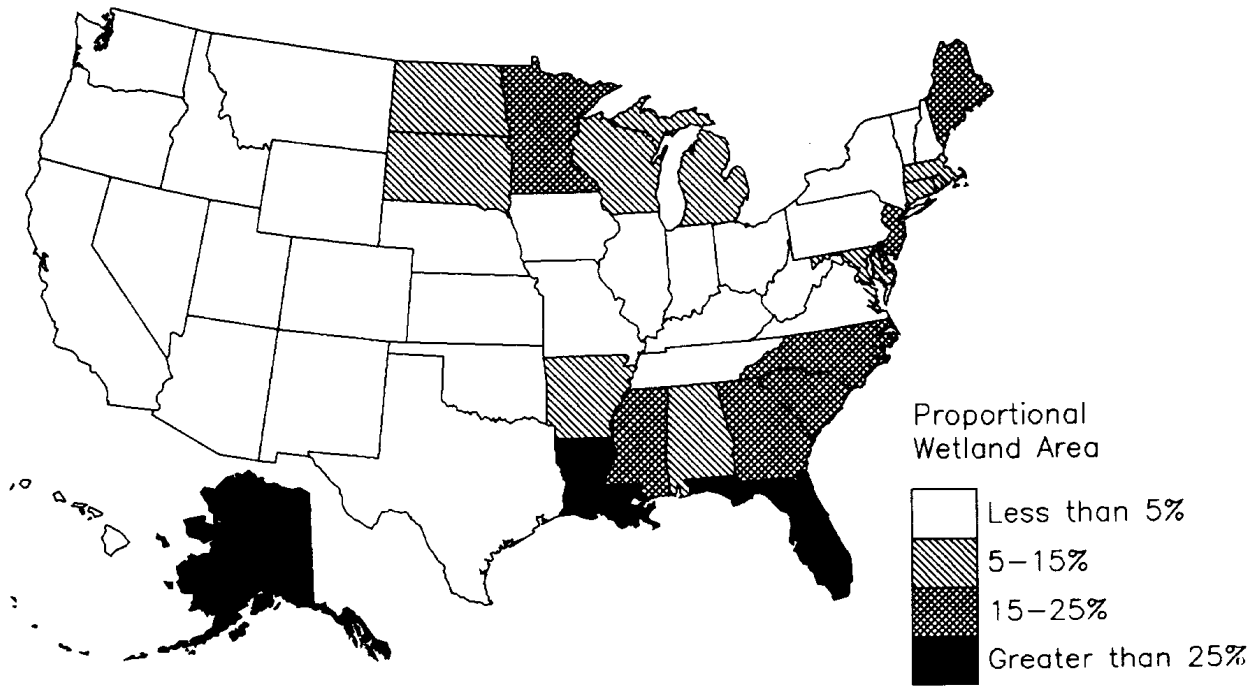
Noted loss rates at the national level are magnified when examined at the regional or state level. Recently published statistics on the amount of wetland habitat lost show that declines ranged from 99% for Iowa natural marshes to 32% for Wisconsin wetlands (Tiner 1984).

Much of these losses can be attributed to destruction that occurred by the turn of the century—destruction motivated by legislation which encouraged drainage of wetlands for agricultural development (e.g., the Swamp Lands Acts of 1849, 1850, and 1860). However, evidence suggests the rate of wetland habitat destruction has remained high in more recent times. As reviewed by Tiner (1984), Illinois was losing approximately 2% of its wetlands annually as of 1981; Kansas lost 40% of its wetlands from 1955 to 1978; half the wetlands along Ohio's Lake Erie coast have been destroyed; and Kentucky wetlands have been reduced by 37% along the Mississippi and Ohio River Valleys.

Table 7.—Area of wetland types for the conterminous United States in 1954 and 1974.

Year	Estuarine wetland	Palustrine				
		Open water	Flat	Emergent wetland	Scrub-shrub wetland	Forest wetland
				Thousand acres		
1954	5,609	2,320	384	33,113	10,998	55,707
1974	5,242	4,393	577	28,442	10,611	49,713
Change	-367	2,073	193	-4,671	-387	-5,994

Source: Frayer et al. (1983), Tiner (1984).



Source: Tiner (1984)

Figure 4.—Distribution of wetland acres by state.

Based on these findings, Tiner (1984) identified nine national wetland problem areas. These represent areas under the greatest threat of continued degradation and should receive primary consideration in future actions to protect and manage this vanishing habitat type. The problems areas include: (1) Estuarine wetlands of the U.S. Coastal Zone, (2) Louisiana's coastal marshes, (3) Chesapeake Bay's submergent aquatic beds, (4) South Florida's palustrine wetlands, (5) the Prairie Pothole Region's emergent wetlands, (6) Wetlands of the Nebraska Sandhills and Rainwater Basin, (7) Forested wetlands of the Lower Mississippi Alluvial Plain, (8) North Carolina's pocosins, and (9) Western riparian wetlands. The distribution of these nine problem areas by assessment region shows that the South incurs the greatest number of wetland-associated conflicts. The Rocky Mountain region also suffers high wetland conflict due to the loss of riparian and pothole wetlands.

These observed wetland declines negatively impact wildlife and fish resources. Although the flooding of upland sites may provide new habitats for ducks and other shallow-marsh birds (National Academy of Sciences, National Research Council 1982), these benefits will be completely masked by the detrimental effects associated with the drainage and development of extant wetland. Because of their recreational and economic importance, and because they depend on wetlands, waterfowl are emphasized as a species category that is particularly impacted by wetland loss. However, waterfowl may be more appropriately regarded as indicators of wetland fauna, for dwindling waterfowl populations may be the first conspicuous indication of a damaged or degenerating wetland. Both breeding habitat in the North, a major portion of which is in Canada, and wintering habitat in the South and Mexico are being lost. The geographic dispersal of habitat used seasonally by wetland species emphasizes the importance of international cooperation in conserving wetlands. This concern has recently been recognized in the approval of the North American Waterfowl Plan by the United States and Canada (USDI Fish and Wildlife Service, and Canadian Wildlife Service 1986a). Efforts are also underway to include Mexico in this cooperative management plan.

Flowing Waters and Associated Impoundments

Information on the nation's fisheries habitat have been surveyed recently by the Fish and Wildlife Service as part of the National Fisheries Survey. The information reported here, except as cited, is a synthesis of that study as reported by Judy et al. (1984). The survey is based on a nationwide statistical sample of 1,303 stream reaches. A more detailed analysis of recent trends in water quantity and quality is reviewed by Guldin (in press).

Two major objectives of the survey were to identify the extent of the nation's stream fishery resources and to identify those factors which adversely affect those resources. Based on the survey, 69% of the streams contained year-round fish habitat, 17% provided habitat seasonally, primarily from March through June, and 14% provided no fish habitat. Although the nation's fishery is extensive, study results also indicated that 80% of the nation's streams have problems with water

quantity, water quality, fish habitat, or fish communities. Water quantity was a problem in 68%, water quality in 56%, fish habitat in 49%, and problems with fish communities in 32% of the streams sampled. In all cases land-use intensification (i.e, agricultural or urban development) was a prominent factor in the implied deterioration of aquatic habitats.

If low flows resulting from natural conditions are disregarded, then diversions for agricultural uses were the most important contributor to water quantity problems (table 8). Other sources of water quantity problems attributed to intensified land use include dam construction for water storage, flood control, and power generation. Considered as a group, dams were responsible for water quantity problems in 9% of the streams sampled. In a more recent analysis of the nation's water quantity situation, Guldin (in press) cites that between 1960 and 1985 total water surface withdrawals increased 55% while human populations increased only 32%—a per capita increase of 16%. Agricultural uses, primarily for irrigation, accounted for the largest amount of withdrawals.

Water quality factors that accounted for over 90% of the problems limiting fishery resources, in order of importance, were turbidity, high temperature, nutrient surplus, toxic substances, and dissolved oxygen (table 8). These problems frequently exist in various combinations to compound the effect on fish communities. The five most important sources of the water quality problems were nonpoint sources (38%), agricultural sources (30%), natural sources (22%), point sources (12%), and logging (8%).

Although water quality problems associated with acid deposition were not directly assessed by Judy et al. (1984), they can be inferred from pH factors. At a pH less than 5.0, most clear lakes do not support game fish. Low pH (too acidic) was a problem in only 2.6% of the water bodies sampled. In a separate study, the USDC National Technical Information Service (1987) found three subregions where lake acidity problems were most prominent. These subregions included the Adirondacks and Michigan's Upper Peninsula where up to 2% of the lake area had pH values less than 5.0. Twelve percent of Florida's lakes were acidic, but many Florida lakes are naturally acidic.

A recent report by the Environmental Protection Agency supports the findings of Judy et al. (1984) regarding the relative importance of nonpoint and point sources of pollution. In a summary of state water quality reports that are required by the Clean Water Act, the Environmental Protection Agency (1987) found that about 25% of the nation's stream miles, lake acreage, and estuarine acreage were not fully supporting the uses designated for those water bodies. Of the waters with impaired use, nonpoint-source pollution was responsible in 76% of lake acres, 65% of stream miles, and 45% of estuarine acres. Conversely, point-sources of pollution were responsible in 9% of lake acres, 27% of stream miles, and 34% of estuarine acres.

The relative importance of nonpoint and point sources of pollution appears to have shifted since the last assessment (Guldin in press). Between 1974 and 1984, Smith et al. (1987) found widespread decreases in fecal coliform bacteria and lead concentrations, and to a lesser extent, phosphorous concentrations—all of which can be traced to control of point-source pollution. They also found evidence that nitrate, chloride, arsenic, and cadmium concentrations (pollution traceable to nonpoint sources) showed widespread increases. So while some aspects of water quality are improving, realizing further improvement will require the more difficult task of controlling nonpoint pollution.

Table 8.—Sources of water quantity problems and water quality factors adversely affecting the nation's fisheries.

Source/factor	Stream miles	Percentage
Source of water quantity problems		
Natural low flows	477,791	50.1
Diversions (agricultural)	130,223	13.6
Dam(s) (water storage)	32,901	3.5
Dam(s) (flood control)	28,002	2.9
Dam(s) (power)	24,821	2.6
Other	18,851	2.0
Diversions (municipal)	10,694	1.1
Channelization	10,629	1.1
Flood/low flows	10,527	1.1
Irrigation	8,897	0.9
Logging	6,271	0.7
Ditches	5,335	0.6
Diversions (industrial)	3,292	0.3
Water quality factors		
Turbidity	328,261	34.4
High water temperature	250,187	26.2
Nutrient surplus	119,519	12.5
Toxic substances	93,603	9.8
Dissolved oxygen problem	91,022	9.5
Nutrient, deficiency	40,603	4.3
Low water temperature	29,877	3.1
Other	26,685	2.8
pH too acidic	24,793	2.6
Low flow	24,364	2.6
Salinity	17,217	1.8
Sedimentation	14,378	1.5
Siltation	9,644	1.0
Gas supersaturation	5,500	0.6
Intermittent water	4,839	0.5
Herbicides and pesticides	4,356	0.5
pH too basic	3,998	0.4
Channelization	2,937	0.3

Source: Judy et al. (1984).

The National Fishery Survey identified two specific fish habitat components which, when lost, most adversely affect fish communities. They are juvenile/adult and egg/larva habitats, accounting for 40% and 28% of stream miles sampled, respectively. Overhead cover was found to be inadequate in 14% of the streams. These habitat problems were caused by siltation (28% of the stream miles), bank erosion (18%), natural causes (18%), channelization (12%), and migration blockage (5%).

Factors that directly impacted fish communities included fish kills, contamination of fish flesh, overharvest, disease, and parasites. Fish kills were found to be a problem in 15% of the nation's streams, while

contamination and overharvest (including poaching) were a concern in 9% and 7% of the streams, respectively. Natural causes (e.g., low flows that result in lethal water temperatures), pesticides, and other toxic or noxious substances were the three most prevalent causes of fish community problems.

In most cases, the net result of problems with water quantity or quality, or with specific fish habitat characteristics is not a complete elimination of fish but an alteration of species composition. Citing the over-reliance on water quality measures to evaluate aquatic habitats, Karr (1981) developed a fish community index of biological integrity to improve on past habitat assessments. Applications in the Midwest (Karr 1981, Karr et al. 1986) have quantified the negative impacts associated with urban and agricultural development which result in lower species diversity, a dominance of pollution-tolerant species and habitat generalists, and a higher proportion of diseased fish. Although the technique has been adapted to other regions outside the Midwest, regional application of the technique needs further refinement and testing (Miller et al. 1988).

Agricultural Habitats

Agricultural land differs in a very basic sense from the other habitat types discussed. Agriculture is typically thought of as a disturbance to natural plant and animal communities. However, agriculture is such an expansive modification process that attributes associated specifically with agricultural land can be evaluated as either beneficial or detrimental to wildlife and fish habitat.

Cropland acres, in recent history, have been relatively stable. After reaching a low in 1969, cropland began increasing in response to escalating world demand and market trends (fig. 2). Cropland is not evenly distributed across the nation. In 1981, the North accounted for about 36% of the total cropland area while the Pacific Coast only accounted for 6% (table 9).

Trends in cropland by assessment region are consistent with the national trend (table 9). Between the late 1940's and early 1970's, the acreage of land in crops declined in all regions. Cropland acres during the next 10 years increased and exceeded the acres cropped in 1949 in all regions except the South.

In addition to agricultural land area changes, the productivity of harvested lands has increased through the uses of pesticides, fertilizers, improved seeds, and advances in farm machinery and irrigation (The Conservation Foundation 1984). Agricultural intensification has caused changes in farm numbers, farm size, field size, and land in permanent vegetative cover including shelterbelts, hedgerows, and field borders. Changes in these farm land characteristics are what impact those wildlife and fish species associated with agricultural habitats.

The number of farms is inversely related to the size of farms. Since 1945, the number of farms has declined by nearly 60%. Over the same period, farm size has increased by over 120% with the largest gain occurring in the South (Council on Environmental Quality 1985). Farm production and management has become concentrated among fewer and larger farms. Attendant with these noted changes in farm size has been a trend toward larger field size and reduced crop diversity. Larger fields and regional specialization in one or two crops have been necessary to capture the efficiency of large farm equipment (Burger 1978).

Collectively, these changes in farming technique and practices have encouraged the elimination of wildlife and fish habitat. The removal of hedgerows, field border strips, wetlands, and woodlots to maximize crop production has reduced the amount of vertical and horizontal habitat diversity and with it the last remaining wildlife habitat in agriculturally dominated landscapes (Burger 1978, Office of Technology Assessment 1985). Since 1950, the amount of farm land in woodlots has declined by over 50% (fig. 5). Fencerow-to-fencerow farming has eliminated much of the nesting, feeding, and winter wildlife cover associated with agricultural land use (Carlson 1985).

Many wildlife species are adapted to agriculturally dominated landscapes. Upland game including northern bobwhite, ring-necked pheasant, and cottontail rabbit commonly utilize habitat associated with agricultural land. Recent trends in these species' populations and harvests indicate increasing agriculture-wildlife

Table 9.—Trends in cropland use for crops by assessment region.

Region	1949	1972	1981
	Thousand acres (% of total)		
North[1]	133.4 (34)	117.4 (35)	141.4 (36)
South[1]	103.8 (27)	73.9 (22)	91.8 (24)
Rocky Mountain	128.6 (33)	122.2 (37)	131.6 (34)
Pacific Coast[2]	20.8 (5)	20.0 (6)	22.1 (6)

[1]*West Virginia is included in the South instead of the North.*
[2]*Does not include Alaska or Hawaii.*
Source: Frey and Hexem (1985).

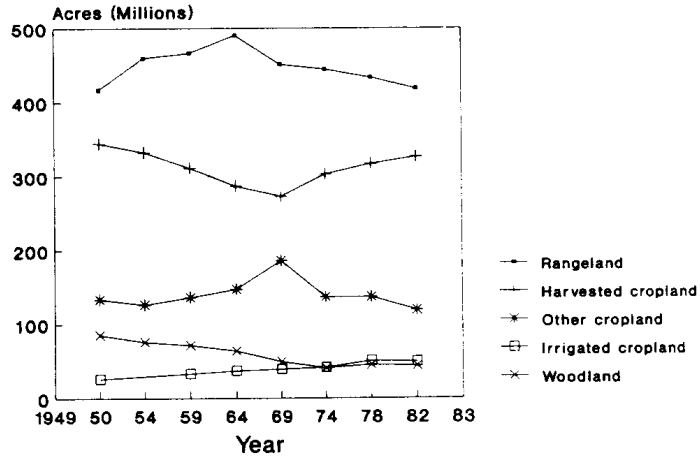


Figure 5.—Historical uses of farmland area from 1950–1982.

conflicts. Brady (1985) found a statistically significant correlation between increasing acres in row crops and reduced harvests of pheasant, quail, and rabbit in Illinois. Similar declines in other farm-associated wildlife have been noted over their entire range (Berner 1984, Farris and Cole 1981).

Not all agriculture-related wildlife and fish impacts occur or remain on site. Soil erosion degrades stream habitats and has resulted in the loss of native fish species (Menzel 1983). Nonpoint chemical pollution from cropland has also been implicated as a contributing factor in the decline of striped bass (Fosburgh 1985a). In general, wildlife and fish managers are seeing an overall decline in all species associated with agricultural lands (Carlson 1985).

The noted national and regional trends in agriculture have recently had negative impacts on wildlife and fish communities. Subsequent sections in this report concerning populations and harvests will further document the declining value of agricultural lands as wildlife habitat. Although federal agencies have been promoting conservation practices that would reduce wildlife and fish habitat impacts (see Office of Technology Assessment 1985), recent levels of implementation have not been sufficient to reverse declining habitat quality.

Summary

Current and recent historical trends in wildlife and fish habitats reflect, in part, national and regional policies concerning the use of forest, range, and agricultural lands. National trends in these major land-use types showed relatively minor changes in the last 20 years. Because net land area dynamics were small, evaluating land-use impacts on wildlife and fish habitat required examining characteristics within each land-use category that affect habitat quality.

Forest changes in the East showed major declines in Southern pine types, bottomland hardwoods, aspen-birch, and elm-ash-cottonwood. Changes in forest successional stages (as measured by stand-size class) were related to timber demands. Mature and old-growth softwood stands are becoming increasingly rare in the major timber producing regions of the Pacific Northwest and South. Commercial demand for eastern hardwoods has not kept pace with forest growth, allowing a greater acreage of older hardwood stands in the North.

Rangeland wildlife habitats are affected importantly by the levels of grazing and management practices directed toward increasing livestock production. Livestock numbers have been recently declining, probably because of low prices and reduced human diet preference for red meat. With the declining number of livestock, the potential exists for increased quality of rangeland environments for wildlife and fish. Two issues that remain important are the reduction in total area and fragmentation of grassland habitats in the East, and degradation of riparian habitats in the arid West.

Agricultural development is an important modifier of natural environments. Although cropland area has increased in the recent past, the most important changes related to wildlife and fish habitat are more intensive farming practices and larger farm size. This intensification has eliminated or reduced the size and frequency of shelterbelts, field borders, hedgerows, and odd habitat areas that were previously inconvenient to crop. Similarly, wetland habitats have declined and other aquatic environments have witnessed degradation in quality as agricultural land-use has intensified.

Finally, urban and suburban land uses have been increasing in response to growing human populations. Urban development not only removes land directly from natural vegetation conditions, it increases human-related disturbance on remaining fragments of habitat and the wildlife and fish inhabiting them.

Land-use and land-cover patterns provide a coarse description of wildlife and fish habitats that is appropriate for national and regional evaluations. The amounts and characteristics of the various land types discussed above are the ultimate basis for the kinds and quality of habitat available to wildlife and fish. The wildlife and fish populations, number of users, and harvests supported by these habitats are the subject of the next section of this report.

Wildlife and Fish Population, Use, and Harvest Trends

Recent trends in populations, number of users, and harvests of wildlife and fish are derived from a data base that was compiled in cooperation with state and federal wildlife agencies. In some cases, these data were available for a long series of years for a particular species; in other cases, data were available for only a few years in a few states. Harvest and use data were more generally available than were estimates of populations, and population data for game species was more complete than for nongame wildlife. The wildlife and fish species groups that have been used in this assessment are a result of available information and it must be realized that the estimates reviewed, in many cases, are the best judgments of qualified professional wildlife and fisheries biologists. Consequently, the actual magnitude of the estimates is less important than the trend.

Nongame Wildlife

For the purposes of this report, nongame is defined as those native vertebrate species that are not consumptively taken for sport, fur, food, or profit. As such, nongame constitutes a majority of the approximately 3,000 vertebrate species that are resident or seasonal inhabitants within the United States. Although threatened and endangered species are included in nongame by this definition, a more detailed discussion of threatened and endangered species is covered in a later section of this chapter.

Populations.—Very little information exists on the status of nongame wildlife populations at a geographic scale that would permit evaluation of national or regional population patterns. Part of the reason for this

limited information base is the historical emphasis that state and federal wildlife managing agencies have placed on documenting game species populations for management purposes (Cerulean and Fosburgh 1986). In addition, the magnitude of a complete national inventory of nongame species would be prohibitively expensive and impracticable. Many of the species are difficult to monitor because of their secretive habits (Miller 1984).

One species group where sufficient population information exists to support an analysis of nationwide abundance patterns is birds. Systematic surveys conducted during breeding, migration, and winter seasons provide useful data sources. The Fish and Wildlife Service administers the Breeding Bird Survey (BBS) which is based on randomly distributed roadside routes within each one degree block of latitude and longitude (Robbins et al. 1986). This survey is designed to assess the population trends of breeding birds in the United States and southern Canada. However, not all species are adequately represented by the BBS. Erskine (1978) noted the shortcomings of the BBS when the species are nocturnal, wide-ranging, or flocking.

The Conservation Foundation (1984) reported on the trends in the BBS from 1968 through 1981 for 552 species. Their summary indicated that 66 (12%) species had increasing populations, 46 (8%) had decreasing populations, 298 (54%) had no statistically significant trend, and 142 (26%) had a sample too small for analysis. More recent trend analysis results from 1966–1987 (Droege, pers. comm., 1988) revealed that 18% of the bird species sampled had increasing populations, 13% were decreasing, 39% had no significant trend, and 30% had an insufficient sample size.

Although these BBS trend analyses provide evidence that the majority of breeding bird populations have remained stable since the mid-1960's, a significant proportion of the breeding bird fauna has declined over a 20-year period. Species that have shown significant declining trends varied by region owing to differences in species distribution, climate, and land use (table 10). The regional boundaries in this case are those defined by the Fish and Wildlife Service. The Eastern Region includes all states east of the Mississippi River; the Central Region is comprised of states between the Rocky Mountains and Mississippi River; and the Western Region extends from the Rocky Mountains to the Pacific Coast. Progressing from East to West, one encounters fewer species with significantly declining populations. This suggests the East's greater human population and associated human activity have contributed to eastern birds' decline.

The factors explaining these trends are in most cases unknown. As reported by Robbins et al. (1986), habitat gain was the most common reason for 10 cases of population growth. Increases in available habitat was associated with species that were adapted to urban environments and the use of human structures for nest sites (e.g., barn swallow, cliff swallow, and house finch). Other reasons cited for expanding breeding populations included reductions in the use of organochlorine pesticides and increases in food sources associated with insect outbreaks. The red-eyed vireo, warbling vireo, worm-eating warbler, blue-winged warbler, Tennessee warbler, and American robin are examples of species that have likely responded positively to reduced pesticide usage and an outbreak of spruce budworm in the East.

More cases of decreasing populations of breeding birds were attributed to specific environmental factors. Of the 23 reasons cited by Robbins et al. (1986), the most common was severe winter weather conditions during the mid to late 1970's which increased the mortality of eastern phoebe, winter wren, Bewick's wren, and song, field, and white-throated sparrows. Loss or degradation of habitat was a factor cited in the decline of loggerhead shrike, prairie warbler, yellow-breasted chat, and lark bunting. Interspecific competition involving starlings was also an important factor contributing to the decline of several cavity-nesting species including the eastern bluebird and northern flicker. Although weather and habitat factors are discussed independently, their influence on wildlife populations cannot be separated. While harsh weather may have been the direct cause of population declines, insufficient cover or food has likely predisposed individuals to increased mortality during extreme weather events.

Raptors are a particularly unique bird group that is not well represented in the breeding bird survey. Their positions at the top of their food chains make them important indicators of environmental change. The plight of certain raptor populations during the 1960's and 1970's provided a focal point for the environmental movement and brought about regulations and intensive management that has resulted in significant recovery of several species.

Evans (1982) evaluated the status of 12 raptor species that were characterized by either recent population declines or had inconclusive evidence concerning population change. The 12 species included: bald eagle, burrowing owl, crested caracara, Cooper's hawk, ferruginous hawk, northern harrier, merlin, northern aplomado falcon, osprey, peregrine falcon, prairie falcon, and sharp-shinned hawk. Half of these species appear to be recovering from recently observed declines. The bald eagle, Cooper's hawk, osprey, peregrine falcon, merlin, and sharp-shinned hawk have responded favorably to U.S. restrictions in the use of organochlorine pesticides. Continued use of pesticides in South and Central America, however, has the potential to counteract the gains that have recently been observed.

Three raptor species have continued to decline over their ranges, primarily owing to lost critical habitat elements. The crested caracara has suffered from the clearing of chaparral brushlands (Porter and White 1977) and the conversion of native prairies and pastureland to urban and agricultural development (Paradiso 1986). The elimination of burrowing rodents has dramatically reduced the available habitat for burrowing owls. The northern aplomado falcon has declined due to encroachment by creosote and mesquite on the preferred grassy plains and savanna habitats, and continued use of organochlorine pesticides in Mexico (USDI Fish and Wildlife Service 1986b).

Table 10.—Nongame breeding birds with significant declining trends from 1966–1987.

Eastern	Central	Western	Continental
Little Blue Heron	Northern Harrier	Turkey Vulture	Northern Harrier
Common Tern	Sharp-shinned Hawk	Northern Goshawk	American Avocet
Black Tern	Ring-billed Gull	American Avocet	Lesser Yellowlegs
Black Skimmer	Black Tern	Caspian Tern	Black Tern
Common Ground-Dove	Ladder-back. Woodpecker	Black Tern	Common Ground-Dove
Common Nighthawk	Northern Flicker	White-throated Swift	Belted Kingfisher
Chuck-will's-widow	Eastern Wood-Pewee	Ladder-back. Woodpecker	Red-headed Woodpecker
Chimney Swift	Acadian Flycatcher	Northern Flicker	Sapsucker species
Red-headed Woodpecker	Vermilion Flycatcher	Olive-sided Flycatcher	Ladder-back. Woodpecker
Sapsucker species	Black-billed Magpie	Horned Lark	Northern Flicker
Northern Flicker	Verdin	Pinyon Jay	Olive-sided Flycatcher
Olive-sided Flycatcher	Cactus Wren	Black-billed Magpie	Eastern Wood-Pewee
Eastern Wood-Pewee	Bewick's Wren	Yellow-billed Magpie	Vermilion Flycatcher
Least Flycatcher	Veery	Black-capped Chickadee	Scissor-tail. Flycatcher
Eastern Phoebe	Wood Thrush	Golden-crowned Kinglet	Gray Jay
Gray Jay	Northern Mockingbird	Veery	Blue Jay
Blue Jay	Brown Thrasher	Brown Thrasher	Pinyon Jay
Boreal Chickadee	Curve-billed Thrasher	California Thrasher	Black-billed Magpie
Bewick's Wren	Loggerhead Shrike	Sprague's Pipit	Boreal Chickadee
Ruby-crowned Kinglet	White-eyed Vireo	Loggerhead Shrike	Golden-crowned Kinglet
Veery	Bell's Vireo	Chipping Sparrow	Veery
Wood Thrush	Northern Parula	Clay-colored Sparrow	Wood Thrush
Gray Catbird	Yellow Warbler	Black-chinned Sparrow	Northern Mockingbird
Northern Mockingbird	Prairie Warbler	Song Sparrow	Brown Thrasher
Brown Thrasher	Prothonotary Warbler	White-crowned Sparrow	Curve-billed Thrasher
Loggerhead Shrike	Worm-eating Warbler	Bullock's Oriole	California Thrasher
European Starling	Ovenbird	House Finch	Sprague's Pipit
Golden-winged Warbler	Kentucky Warbler	White-winged Crossbill	Loggerhead Shrike
Prairie Warbler	Hooded Warbler		European Starling
Bay-breasted Warbler	Pyrrhuloxia		Bell's Vireo
Cerulean Warbler	Painted Bunting		Golden-winged Warbler
Common Yellowthroat	Cassin's Sparrow		Prairie Warbler
Yellow-breasted Chat	Brewer's Sparrow		Bay-breasted Warbler
Northern Cardinal	Field Sparrow		Cerulean Warbler
Indigo Bunting	Lark Sparrow		Kentucky Warbler
Painted Bunting	Black-throated Sparrow		Yellow-breasted Chat
Dickcissel	Lark Bunting		Northern Cardinal
Rufous-sided Towhee	Grasshopper Sparrow		Pyrrhuloxia
Field Sparrow	Bobolink		Indigo Bunting
Vesper Sparrow	Western Meadowlark		Painted Bunting
Savannah Sparrow	Orchard Oriole		Rufous-sided Towhee
Grasshopper Sparrow	House Sparrow		Cassin's Sparrow
Henslow's Sparrow			Clay-colored Sparrow
Song Sparrow			Field Sparrow
White-throated Sparrow			Black-chinned Sparrow
Red-winged Blackbird			Lark Sparrow
Eastern Meadowlark			Lark Bunting
Western Meadowlark			Baird's Sparrow
Rusty Blackbird			Grasshopper Sparrow
Common Grackle			Henslow's Sparrow
Brown-headed Cowbird			Song Sparrow
American Goldfinch			White-throated Sparrow
House Sparrow			White-crowned Sparrow
			Slate-colored Junco
			Eastern Meadowlark
			Western Meadowlark
			Rusty Blackbird
			Common Grackle
			Brown-headed Cowbird
			Orchard Oriole
			Bullock's Oriole
			White-winged Crossbill
			American Goldfinch
			House Sparrow

Source: Droege, pers. comm., 1988.

Because of inadequate information, the status of the ferruginous hawk, northern harrier, and prairie falcon is unclear. Although there is little population information on these species, loss of habitat is generally suspected. Alteration of the semi-arid western plains habitat (ferruginous hawk), drainage of wetland habitat (northern harrier), and agricultural development, water impoundments, and pest control in the arid West (prairie falcon) have all been implicated as prime factors for the decline of these species in portions of their range (Evans 1982).

A primary objective of the various monitoring programs conducted by the Fish and Wildlife Service is to detect trends in bird populations early so that appropriate management or regulations can be implemented before population levels become critically low. In an effort to consolidate the findings from various bird monitoring efforts, and to isolate the causes for bird population declines, the Fish and Wildlife Service has developed criteria for the identification of birds with declining or unstable populations nationwide over the last 10–15 years (USDI Fish and Wildlife Service 1982a). The identification of species was based on several sources including the BBS, state endangered and threatened species listings, National Audubon Society's Blue List, Office of Endangered Species "Watchlist," and expert opinion. Of the 237 nominated species, 28 species were identified as exhibiting unstable or declining populations (table 11). The distribution of these 28 species across assessment regions is surprisingly even with 15 species occurring in the North, 14 in the South, 15 in the Rocky Mountain, and 10 in the Pacific Coast.

Taxonomically, most of the species are marsh or wading birds, followed in rank order by passerines, birds of prey, shorebirds, and marine birds (fig. 6). On the basis of habitat, species associated with wetlands dominate the list (fig. 6). The next most critical habitat is grassland types followed by open woodland or forest species, and mixed habitats.

Factors contributing to the decline in these bird populations have been difficult to determine, and therefore conclusions are based on the collective impressions of experts (USDI Fish and Wildlife Service 1982a). Without question, the primary cause cited for population declines is the loss or degradation of breeding, feeding, or wintering habitat (fig. 7). The pattern of habitat loss discussed earlier gave presage to the distribution of species by habitat type. The destruction and development of wetland habitats was the major concern for those species listed. Increased loss of grasslands due to agricultural development or natural succession from farm fields to forestland is also of major concern. The harvesting

Table 11.—Nongame migratory bird species with unstable or decreasing trends.

Species	Assessment region where status is of concern				Primary reason for listing		
	North	South	Rocky Mountain	Pacific Coast	Apparent population decline	Small population size	Restricted habitat
Common Loon	X				X		
Reddish Egret		X	X			X	X
Least Bittern	X	X	X	X	X		X
American Bittern	X				X		X
Wood Stork		X			X		X
White-faced Ibis			X	X		X	X
Trumpeter Swan			X	X		X	X
Red-shouldered Hawk	X				X		X
Ferruginous Hawk			X	X	X	X	
Northern Harrier	X	X	X	X	X		X
Black Rail		X	X	X	X		X
Piping Plover	X	X	X		X		X
Snowy Plover		X	X	X	X		X
Long-billed curlew			X	X			X
Upland Sandpiper	X				X		X
Gull-billed Tern	X	X			X	X	X
Roseate Tern	X	X			X	X	X
Least Tern	X	X	X		X		X
Black Tern	X		X		X		X
Common Barn-Owl	X	X			X		X
Spotted Owl			X	X		X	X
Loggerhead Shrike	X				X		
Bell's Vireo			X	X	X		X
Golden-cheeked Warbler		X					X
Baird's Sparrow			X		X		
Henslow's Sparrow	X				X		
Seaside Sparrow		X					X
Bachman's Sparrow	X	X			X		

Source: USDI Fish and Wildlife Service (1982a).

of old-growth forests and loss of riparian woodlands are of primary concern in forested environments.

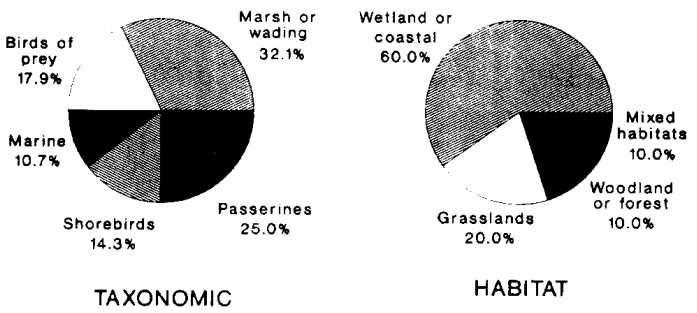
One additional characteristic associated with habitat loss is that over half (57%) of the species listed are Neotropical migrants. Not only is there concern for the loss of wetlands and deforestation in the tropics, but other factors including unregulated hunting, pesticide use, and pollution probably all interact to increase the mortality of Neotropical migrants on their wintering areas.

Restricted distribution, and therefore the vulnerability of their habitat to future disturbance, was also cited as a reason for the decline of several species classified as having unstable or declining populations. These species (reddish egret, golden-cheeked warbler, snowy plover, and roseate tern) have, in many cases, always been rare and therefore require special consideration in the prevention of future declines.

Human disturbance, recreational developments, and pesticide use are also considered factors responsible for population declines. However, of greater importance to the conservation of these species is the fact that in 31% of the cases the cause of the decline was either unknown or the species is not adequately monitored at this time. This emphasizes the need for continued research on the causes of population declines, and the development of monitoring techniques appropriate for inconspicuous species such as the American bittern, least bittern, and black rail.

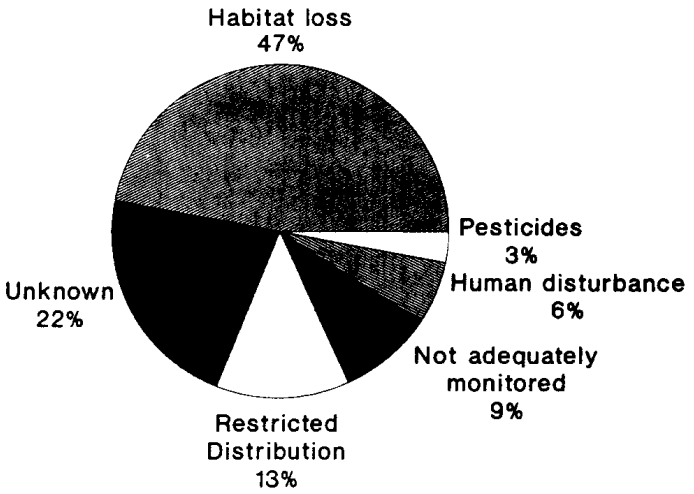
Nonconsumptive recreational use.—Nonconsumptive uses of wildlife and fish resources has been defined as those activities that do not result in the death or attempted death of an individual animal (More 1979). This definition is necessarily broad to accomodate nonconsumptive uses of both game and nongame. The findings from the 1979 national assessment (USDA Forest Service 1981) found qualitative evidence that nonconsumptive uses of wildlife and fish resources had increased greatly during the 1970's (More 1979).

Since the last RPA wildlife and fish assessment, the Fish and Wildlife Service has completed two surveys (1980 and 1985) of participation in wildlife and fish related recreation (USDI Fish and Wildlife Service, and



Source: USDI, Fish and Wildlife Service (1982a)

Figure 6.—Taxonomic and habitat characteristics of bird species listed as having unstable or declining populations.



Source: USDI, Fish and Wildlife Service (1982a)

Figure 7.—Reasons contributing to the decline in bird species listed as having unstable or declining populations.

USDC Bureau of Census 1982; USDI Fish and Wildlife Service 1988b). These two surveys permit more quantitative estimates of participation and trends in nonconsumptive activities. For the purposes of clarifying the kinds of nonconsumptive activities, four categories of use were defined (USDI Fish and Wildlife Service, and USDC Bureau of Census 1982):

Primary, nonresidential.—Trips of at least 1 mile from place of residence for the primary purpose of observing, photographing, or feeding wildlife.

Primary, residential.—Activities around the residence for which primary purpose is wildlife related.

Secondary, nonresidential.—Enjoyment from seeing or hearing wildlife on a trip at least 1 mile from place of residence that is taken for another purpose (camping, driving, boating).

Secondary, residential.—Enjoyment from seeing or hearing wildlife while pursuing other activities around the residence.

The results from these two surveys substantiate what many have predicted to occur: wildlife-related, nonconsumptive recreational activities have become much more important to U.S. citizens in recent decades (table 12). The percentage of the U.S. population 16 years of age and older that participated in some form of nonconsumptive recreation increased from 55% in 1980 to 74% in 1985. Although both primary and secondary activities increased, secondary activities increased by a greater amount. Similarly, residential activities increased to a greater degree than nonresidential activities.

An important pattern that emerged from this comparison concerned primary nonresidential activities. This category may be thought of as a strong indicator of the public's preference for nonconsumptive wildlife-related recreation because it requires people to forgo other activities for the sole purpose of viewing, photographing, or feeding wildlife away from their residences. The number of persons participating in primary nonresidential activities increased by only 1.8% from 1980

Table 12.—Participation in nonconsumptive wildlife-related recreation from 1980–1985 for people 16 years old and older.

Year	Total nonconsumptive users		Primary						Secondary					
			Total		Nonresidential		Residential		Total		Nonresidential		Residential	
	# in thous.	% of U.S. pop.	# in thous.	% of U.S. pop.	# in thous.	% of U.S. pop.	# in thous.	% of U.S. pop.	# in thous.	% of U.S. pop.	# in thous.	% of U.S. pop.	# in thous.	% of U.S. pop.
1980	93,249	54.9	83,173	48.9	28,822	17.0	79,670	46.9	88,272	51.9	69,407	40.8	80,475	47.4
1985	134,697	74.0	109,597	61.0	29,347	16.0	105,286	58.0	127,427	70.0	89,532	49.0	117,411	65.0

Source: USDI Fish and Wildlife Service (1988b); USDI Fish and Wildlife Service, and USDC Bureau of Census (1982).

Table 13.—Participation in nonconsumptive wildlife-related recreation by region from 1980–1985 for people 16 years old and older.

	Primary						Secondary					
	Total		Nonresidential		Residential		Total		Nonresidential		Residential	
	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985	1980	1985
	Thousands											
North[1]	43,291	52,947	14,867	14,585	41,543	51,098	44,958	59,757	34,747	42,483	41,632	54,992
South[2]	22,959	35,951	6,754	8,129	22,224	35,010	24,348	42,188	18,510	27,117	22,227	39,328
Rocky Mountain[3]	4,574	6,098	2,125	2,119	4,133	5,667	4,991	7,634	4,290	6,081	4,307	6,834
Pacific Coast	12,347	14,320	5,076	4,431	11,770	13,228	13,976	17,566	11,861	13,695	12,309	16,005

[1]*Includes the states of ND, SD, KS, and NE and excludes MD, WV and DE.*
[2]*Includes the states of MD, WV, and DE.*
[3]*Excludes the states of ND, SD, KS and NE.*
Source: USDI Fish and Wildlife Service (1988b); USDI Fish and Wildlife Service, and USDC Bureau of Census (1982).

to 1985—a rate of increase that was less than the general population increase. Consequently, there was an actual decline in the proportional participation from 17% of the population in 1980 to 16% in 1985. Although changes in survey methodology are a potential source of error that may affect interpretation, these data suggest that the recent increases in nonconsumptive activities stem primarily from people becoming more aware of the associated wildlife benefits while at home or while taking part in other activities rather than from the exclusive pursuit of nonconsumptive wildlife-related recreation.

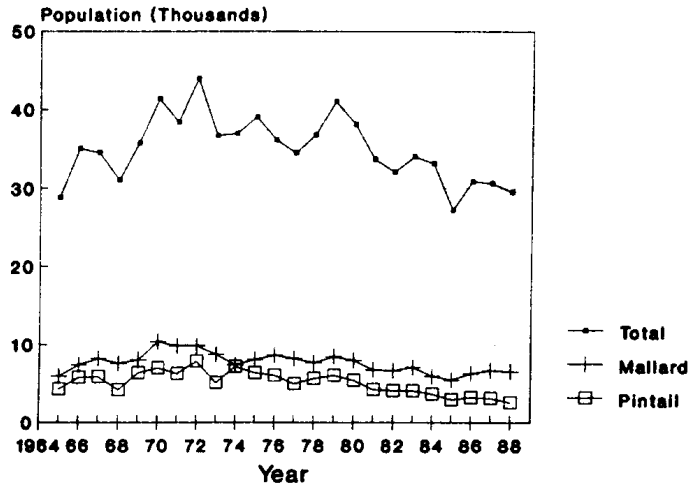
The regional trends in nonconsumptive wildlife-related recreation are generally consistent with the national trends (table 13). The Fish and Wildlife Service uses human census regions to describe regional use patterns. These regions can be aggregated to approximate the assessment region boundaries used here (see fig. 1). The greatest gains in primary and secondary nonconsumptive recreation have been in the South, which had the lowest proportional participation in 1980. The absence of significant increases in primary nonresidential participants is observed in all regions, and the absolute number of such participants actually declined in the North and Pacific Coast regions from 1980 to 1985. Significant gains in the number of participants in secondary nonconsumptive recreation were observed in all regions.

Migratory Game Birds

Migratory game birds, as defined in this report, include waterfowl (ducks, geese, and swans) along with webless migratory species such as the woodcock and mourning dove. Information on the current status of and trends in populations, harvest, and number of migratory bird hunters comes primarily from Fish and Wildlife Service annual reports.

Populations.—Waterfowl populations are one of the most significant and familiar wildlife resource legacies. Waterfowl habitats and populations reflect a long history of management concern in the United States. These concerns have been heightened recently because populations and habitat continue to decline throughout North America (USDI Fish and Wildlife Service, and Canadian Wildlife Service 1986a).

Ducks.—Although the 20-year trend in breeding populations varies depending upon the species and the geographic region being considered, notable declines have occurred in many species since the early 1970's. Breeding populations for 10 species that collectively comprise 97% or more of the breeding population in the surveyed areas (USDI Fish and Wildlife Service 1974) have declined by more than 30% since the early 1970's. After peaking around 44 million birds in 1972, populations dropped to a record low of approximately 28 million birds in 1985 (fig. 8). The two most abundant species



Source: USDI, Fish and Wildlife Service and Canadian Wildlife Service (1986b); and data on file with the USDI, Fish and Wildlife Service, Office of Migratory Bird Management

Figure 8.—Trends in total duck, mallard, and pintail breeding populations from 1965–1988.

of ducks, the mallard and northern pintail, also have shown significant historical declines (fig 8). The decline has continued as the 1988 breeding populations were 20% and 54% below the 1955–1987 average, respectively. Other species that have also declined over this time period include the blue-winged teal, canvasback, and scaup. In contrast, the following species have had relatively stable or increasing populations: gadwall, American wigeon, green-winged teal, northern shoveler, and redhead.

Winter flyway surveys of ducks permit examination of recent trends on a regional basis. North American waterfowl management has been organized by flyways since 1948 and they generally represent the major pathways along which waterfowl migrate between breeding and wintering habitats. Although primarily defined by the migration routes of numerous breeding subpopulations, there are many exceptions where species migrate across flyway boundaries. Consequently, the main value of flyway management has been as an administrative tool, grouping those states together with similar waterfowl problems (Bellrose 1976). The four flyways are identified generally by the major north-south watercourses and named accordingly: Atlantic, Mississippi, Central, and Pacific (fig. 9).

The Atlantic flyway contains the smallest number of ducks. Wintering populations have shown a steady decline from about 2.9 million birds in 1966 to 1.5 million in 1986 (fig. 10). The Mississippi flyway has had the greatest number of wintering ducks, averaging about 8 million ducks annually in the late 1960's. Average winter populations dropped 35% to around 5 million by the mid-1980's. The trends in wintering ducks have been similar in the remaining two flyways—after increasing through the early 1970's, the number dropped by over 30% and 40% in the Central and Pacific flyways, respectively.

Populations of ducks found in winter flyway surveys are the product of several factors. The process begins with the number of breeding birds that flew north the previous spring, the weather during breeding, suitability of the breeding habitat, breeding success, and losses from natural and hunting mortality as the birds migrate to the wintering areas in the south. As was discussed in the habitat section, one of the most critical factors

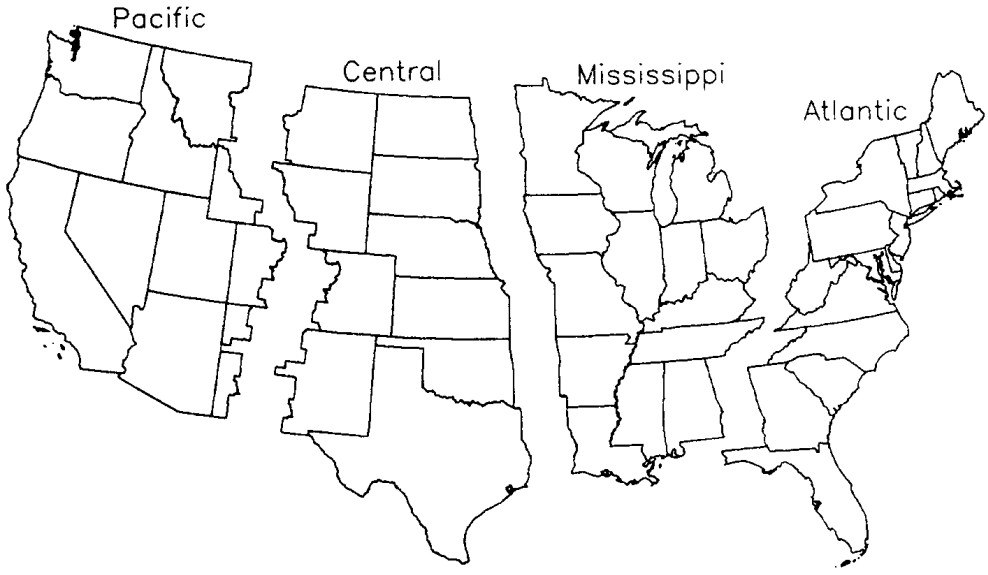
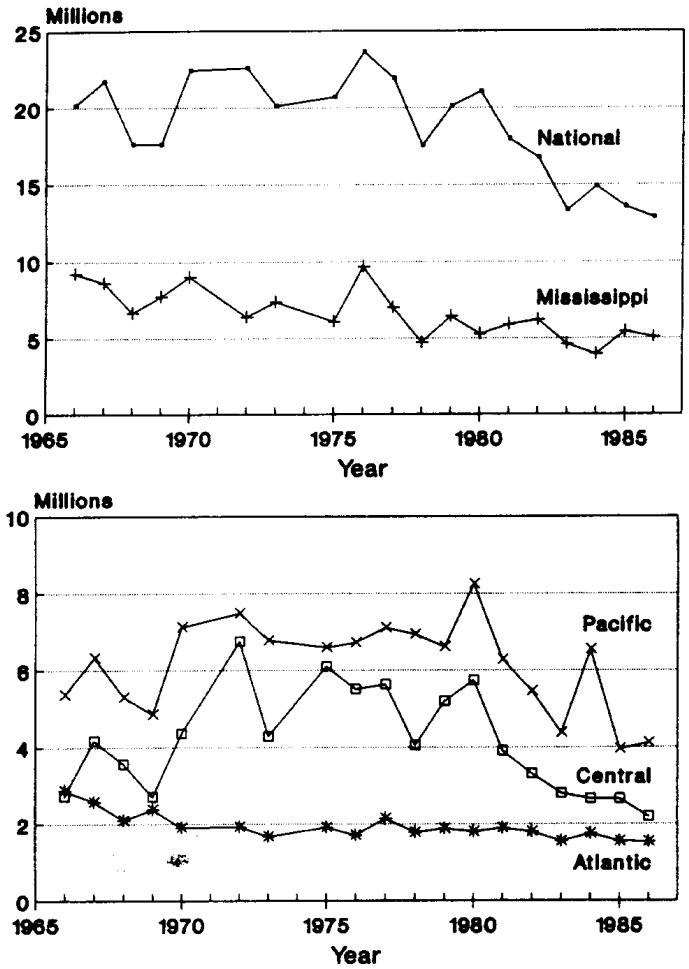
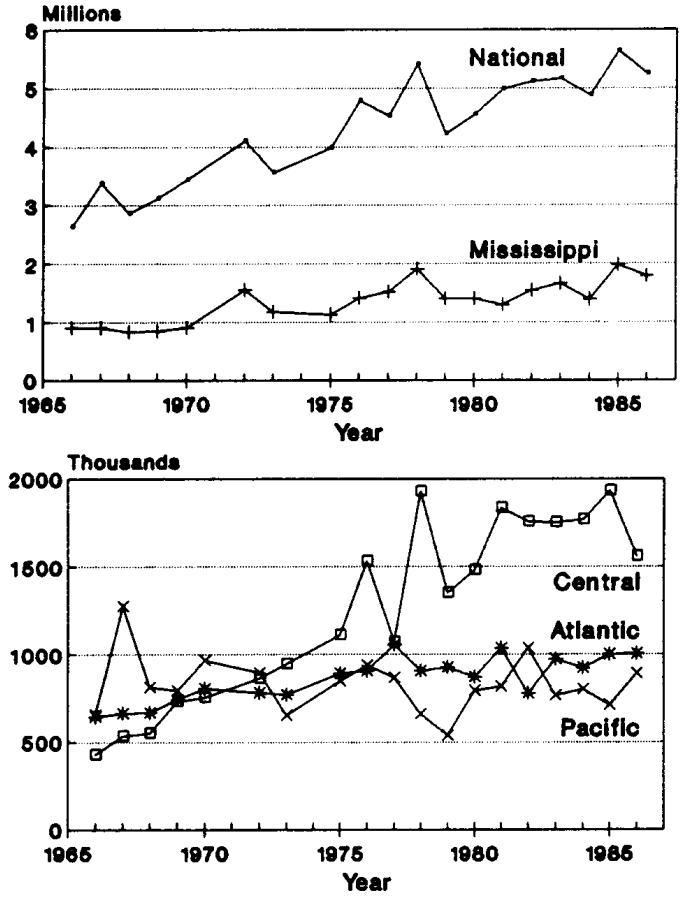


Figure 9.—The waterfowel administrative flyways.



Source: USDI. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife (1966, 1967, 1968a, 1969, 1971, 1972); USDI, Fish and Wildlife Service (1975, 1980a, 1980b, 1981a, 1982b, 1987a); and data on file with the USDI, Fish and Wildlife Service, Office of Migratory Bird Management

Figure 10.—Recent historical trends in duck wintering populations for the nation and by administrative flyway.



Source: USDI. Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife (1966, 1967, 1968a, 1969, 1971, 1972); USDI, Fish and Wildlife Service (1975, 1980a, 1980b, 1981a, 1982b, 1987a); and data on file with the USDI, Fish and Wildlife Service, Office of Migratory Bird Management

Figure 11.—Recent historical trends in goose wintering populations for the nation and by administrative flyway.

in the equation is the amount and quality of wetland habitats (USDI Fish and Wildlife Service 1987a).

A specific habitat-quality issue that warrants discussion concerns the accumulation of toxic shot in wetland systems. Lead poisoning caused by ingestion of spent shotgun pellets inflicts significant mortality on some duck populations. The issue has been fully evaluated by the Fish and Wildlife Service; the agency has scheduled complete conversion to nontoxic shot by 1991 which should eliminate lead poisoning as a significant cause of mortality in the future (USDI Fish and Wildlife Service 1987a).

Geese.—Because most geese nest outside the breeding survey region, goose trends are based only on winter surveys. Recent trends in wintering continental goose populations have, in general, been more favorable than for ducks with most species showing stable or increasing populations (USDI Fish and Wildlife Service, and Canadian Wildlife Service 1986a). This is due, in part, to the remoteness of Arctic and subarctic breeding areas which have been isolated from extensive development and habitat degradation (USDI Fish and Wildlife Service 1987a). Goose populations have gone from an average of 3.0 million during 1966–1969 to an average of 5.2 million during 1982–1985 (fig. 11). Exceptions to this trend include the Aleutian, cackling, and dusky subspecies of Canada goose which have all declined due to reduced habitat, hunting (recreational and subsistence), and natural disturbance (Amaral 1985, Butler 1985, Cline and Lenhart 1985).

Wintering geese, surveyed within the same flyways as ducks, climbed steadily in the Atlantic flyway from a low of 650,000 in the mid-1960's to 1 million by 1986 (fig. 11). The Mississippi and Central flyways have typically had the greatest number of wintering geese. Populations have risen steadily in these two flyways with wintering populations approaching 2 million birds in the mid-1980's. Wintering populations of Pacific flyway geese have demonstrated variation in the recent past. However, significant declines have occurred with certain subspecies. The Pacific flyway contains the only threatened and endangered goose in the continental United States, the Aleutian Canada goose with a 1984–85 wintering population of about 3,800 birds. In

addition, decreasing numbers of the dusky and cackling Canada geese and white-fronted geese occur in the Pacific flyway (Raveling 1984).

As was the case for ducks, a primary influence on goose numbers is the amount and quality of wetland habitats. However, geese have prospered from some practices that have been detrimental to ducks, especially the expansion of cropland acreage (USDI Fish and Wildlife Service 1987a). The introduction of Canada geese into nesting habitats previously not used or underutilized by geese has also contributed to the observed population increases in this species.

Swans.—Recent wintering population levels of swans have varied from 72,000 to 148,000 birds. Eastern and western subpopulations of the tundra swan have demonstrated a slow but consistent upward trend. The trumpeter swan population is one of North America's brightest waterfowl successes. From a population of approximately 66 birds known in 1933, the species now numbers approximately 10,000 birds. Trumpeter swans are divided into three subpopulations, none of which are now considered to be in danger of extinction (USDI Fish and Wildlife Service, and Canadian Wildlife Service 1986a).

Woodcock.—The American woodcock is censused annually by volunteers throughout its breeding range. Annual indices (number of singing males per route) of the breeding population have been relatively stable throughout the composite range of the species during the last 20 years (fig. 12). The woodcock breeding index was lower during the 1982–1984 period than at any other time since the survey began. However, the indices have since recovered and are approaching the long-term mean.

When annual totals of the breeding populations are examined together, important differences among subregions are masked. Present evidence suggests two distinct breeding subpopulations of woodcock (Owen 1977). The Eastern region is comprised primarily of Atlantic coastal states, the Central region includes those states from the north-central lake region south to Louisiana, Mississippi, and Alabama. The Central region has consistently reflected higher numbers of singing males per route than has the Eastern region and has experienced a general increase of nearly one singing male per route from 1968 to 1987. Despite the observed increases, recruitment as measured by the number of young per adult female in the central region has declined significantly (Kelly 1986)—a trend that has raised concern for the long-term maintenance of population levels.

In contrast to the Central region, the Eastern region has shown a gradual decline of nearly one singing male per route during the last 20 years. Although the cause for the decline has not been identified, evidence suggests that land-use changes and forest succession probably have resulted in deterioration of preferred breeding habitat (Coulter and Baird 1982, Dwyer et al. 1983). Woodcocks prefer early successional stages of second-growth hardwood forest associated with fields and forest openings on mesic sites (USDI Fish and Wildlife Service 1987a).

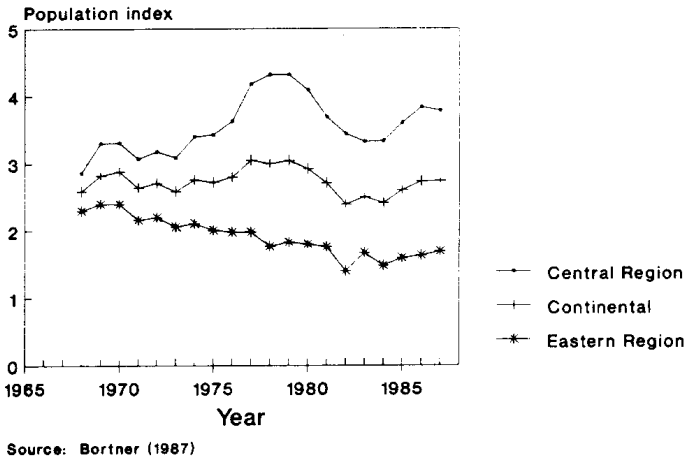


Figure 12.—Woodcock breeding population indices (singing males per route) by management region.

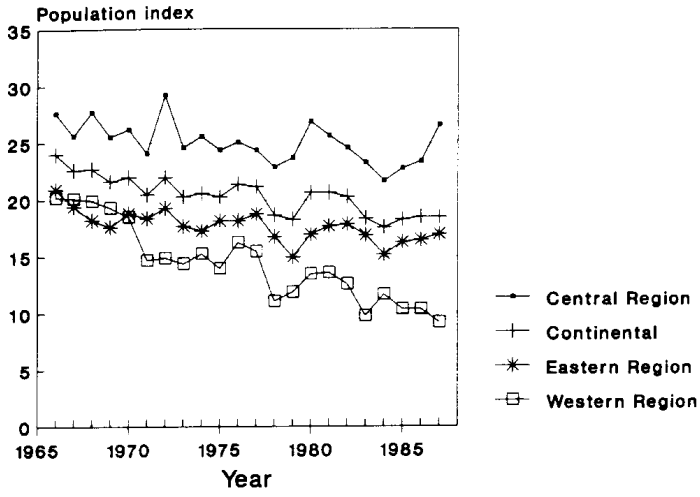
Mourning dove.—With populations estimated at about 500 million, the mourning dove is one of the most abundant birds in North America (Dolton 1986, USDI Fish and Wildlife Service 1987a). The Fish and Wildlife Service surveys breeding dove populations throughout three management regions of the nation with the assistance of volunteers. These regions are the Eastern, bounded on the west by the Mississippi River except it includes Louisiana; the Central composed of the states between the Mississippi River and the western edge of states between New Mexico and Montana; and the Western, which includes the remaining seven western states.

Nationally, breeding populations of mourning doves have gradually declined over the period of 1966–87 (Dolton 1987). Indices of breeding dove populations reached a low in 1984 at a level approximately 75% of the breeding populations in 1966 (fig. 13). Regionally, call-count indices of mourning dove populations have been declining in the East and West during the same period. The decline has been greatest in the Western region, where the average number of doves heard per route declined from 20.2 in 1966 to 9.2 in 1987 (Dolton 1987).

Although doves are tolerant of human activity (USDI Fish and Wildlife Service 1987a), changes associated with agricultural practices, including the loss of shelterbelts, may be having negative impacts on breeding populations (Dunks et al. 1982, Tomlinson et al. 1987).

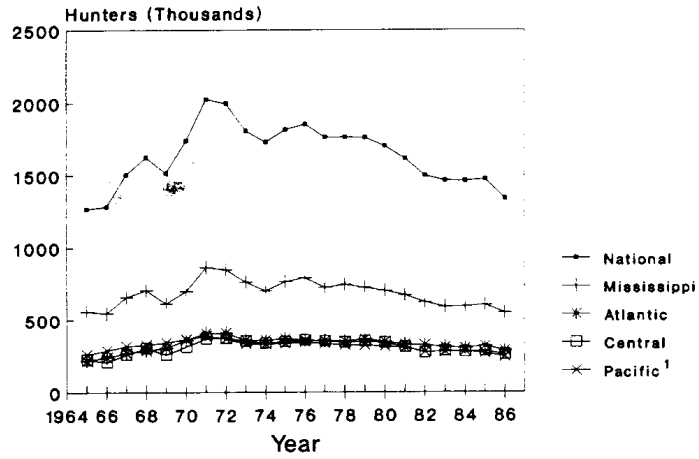
Migratory game bird hunters.—Hunting activity associated with migratory game birds is influenced by hunting regulations that combine ducks and geese on one licence, and the webless migratory game birds (doves, woodcock, snipe, and other shorebirds) on another.

Duck and goose hunters.—The number of active waterfowl hunters in the nation climbed from 1.2 million in 1965, to a high of over 2 million in 1971, and has since declined steadily to 1.3 million by 1986 (fig. 14). Waterfowl hunters in each flyway have been consistent with the national trend. The Mississippi flyway has had about 2.5 times more hunters as occur in any other flyway.



Source: Dolton (1987)

Figure 13.—Mourning dove breeding population indices (average number of birds heard per route) by management unit.



[1]Includes Alaska

Source: Data on file with the USDI, Fish and Wildlife Service, Office of Migratory Bird Management

Figure 14.—Number of waterfowl hunters by administrative flyway.

After reaching a peak of nearly 850,000 hunters by 1971, the number dropped to around 550,000 hunters in 1986 for an average annual flyway loss of 20,000 hunters. The Atlantic, Central, and Pacific flyways reflect similar hunter trends. These flyways climbed from 200,000 to 300,000 hunters in 1965, to nearly 400,000 by 1971, and then declined to levels characteristic of the mid-1960's. The average annual rate of decline since the 1970's is consistent across all flyways at about 2.4%.

The decline in waterfowl hunters represents a continuation of a long-term trend (Trost et al. 1987); however, the specific factors responsible for the decline have not been identified. The decline does not appear to be the result of stabilized season lengths and bag limits during the period 1980 to 1985 (Trost et al. 1987). One explanation for fewer waterfowl hunters may be the accessibility of land. A recent survey by the National Shooting Sports Foundation (1986) reported that land accessibility and crowded hunting conditions constrained waterfowl hunting opportunities more frequently than any other type of hunting. This may result from wetland acreage loss, closure of acres to hunting, or increased access restrictions to the general public from hunter lease agreements.

The decline in active waterfowl hunters is also reflected in the number of migratory bird hunting and conservation stamps sold. These stamps are required of hunters but they are also purchased by collectors and more recently by nonhunting conservationists. From a total of 1.6 million stamps sold in 1965, to a high of 2.4 million in 1971, the number of duck stamps sold dropped to approximately 1.9 million in 1985. The number of stamps sold has declined less rapidly than the number of hunters since 1971 indicating increasing interest in waterfowl conservation by the non-hunting public. Conservationist interest stems, in part, from the fact that a portion of the money goes towards wetland habitat acquisition and management.

Woodcock hunters.—Because there is no national survey of woodcock hunters (USDI Fish and Wildlife Service 1987a), information on woodcock hunter participation is much less complete than for waterfowl. A recently completed environmental assessment of woodcock harvests (USDI Fish and Wildlife Service 1985) estimated the number of woodcock hunters for the 34 states that regulated seasons to be approximately 700,000 (split evenly between the two woodcock management regions). The number of woodcock hunters was believed to be increasing from the 1960's through the early 1970's, but participation has declined since that time (USDI Fish and Wildlife Service 1985).

More detailed trends of woodcock hunters was available for the South. However, since woodcock hunting effort is often incidental to the hunting of other game, interpretation of trends is difficult (Wood et al. 1985). The Southeastern Association of Fish and Wildlife Agencies periodically surveys the number of woodcock hunters. For the period 1980–1986, the total declined by 32% in the seven states from Maryland to Florida (table 14). In the southern part of the Central woodcock management region, the trend has been considerably different. A 15% increase in hunters was estimated between 1980 and 1982, after which the number of hunters dropped by 29% in the next 4 years.

Mourning dove hunters.—Although information on the nationwide number of dove hunters is not available, some information exists for portions of specific management regions. Hunter trends since the mid-1960s in the western management region were addressed by Tomlinson et al. (1987). The average number of dove hunters declined from 418,000 to 376,000 between the periods of 1966–1968 and 1981–1983. This trend could be expected given the previously noted decline in dove populations over the same period.

Trends for the most recent decade in the Eastern and Central mourning dove management regions have been estimated by the Southeastern Association of Fish and Wildlife Agencies. The majority of these states are in

Table 14.—Estimated number of woodcock and mourning dove hunters in the southern United States by management region.

Year	Woodcock		Mourning Dove	
	Eastern management region (7 states)	Central management region (7 states)	Eastern management region (12 states)	Central management region (4 states)
1980	32,272	69,691	1,024,589	463,907
1981	31,641	79,169	1,092,152	457,706
1982	28,063	80,052	1,108,142	616,572
1984	25,977	77,176	1,077,213	620,471
1986	22,071	57,502	1,082,588	594,303

Source: Southeastern Association of Fish and Wildlife Agencies (1980–1982, 1984, 1986).

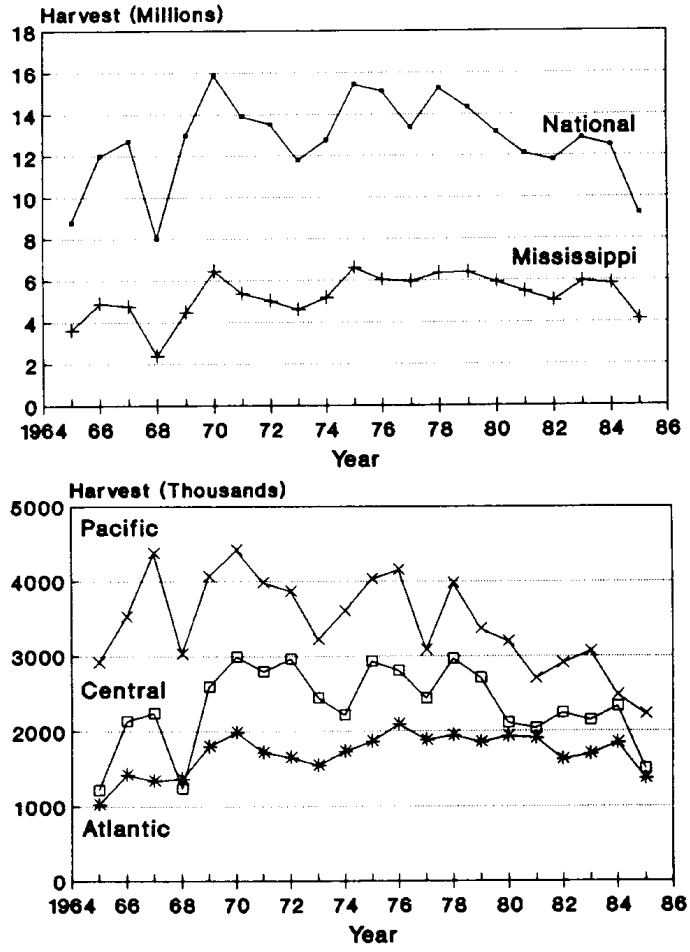
the Eastern region with the Central region being represented by four states. The trend in number of hunters pursuing mourning dove for the period 1980–1986 was stable in the East (table 14). The trend for four states in the southeastern part of the Central region increased during the period 1981–1984, then declined slightly by 1986. The estimated number of dove hunters in the Central region is heavily weighted by the large number of dove hunters from Texas where they are three to five times more numerous than in any other state in the region.

Migratory game bird harvest.—Because of their migratory habits, waterfowl and the webless migratory birds have a harvest regulation history of national and international interest. Laws and international treaties have been rigorously enforced and have made the harvest of migratory game birds a positive management tool in recent history. A recent cooperative study between the United States and Canada to examine the effects of harvest on waterfowl populations (Brace et al. 1987) offers evidence for the continuing desire to base harvest regulations on scientifically sound principles.

Duck harvest.—The 20-year trend of total duck harvest is one of general increase with harvests going from an average of 10.9 million ducks during the 1965–1969 period, to an average of 11.8 million ducks during the 1981–1985 period (fig. 15). The short-term pattern, however, is downward—harvests have declined by 28% since 1980.

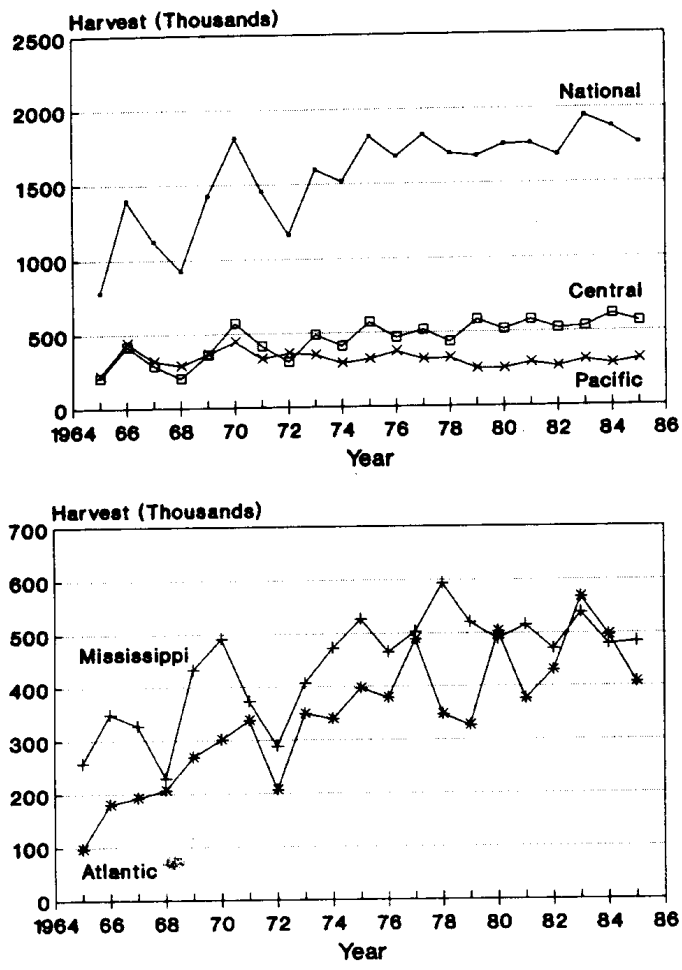
Duck harvests by flyway show little deviation from the noted national trends. Since the early 1970's, the Atlantic and Mississippi flyways have shown generally stable duck harvests, Central flyway harvests have fluctuated, and the Pacific flyway has shown a downward harvest trend. The Atlantic flyway has consistently harvested the smallest number of ducks of the four flyways with 1 million ducks harvested in 1965, increasing to around 2 million by 1970 and remaining there. The Mississippi flyway has consistently harvested the largest number of ducks, fluctuating between 5 and 6 million since 1980. The Mississippi flyway, as with the Central and Pacific flyways, realized a sharp decline in 1969. Reduced production caused by drought on the breeding grounds may have been responsible for the low 1969 harvest. The Central flyway harvests have remained between 2 and 3 million ducks since 1970. Harvest in the Pacific flyway, after peaking near 4.5 million ducks in 1971, has declined by 40%.

Several factors affect the annual duck harvest including population levels, numbers of hunters, weather, and regulations. The relatively stable harvests since the early 1970's noted in the Atlantic and Mississippi flyways is particularly surprising given the significant declines in the number of active hunters and the breeding duck



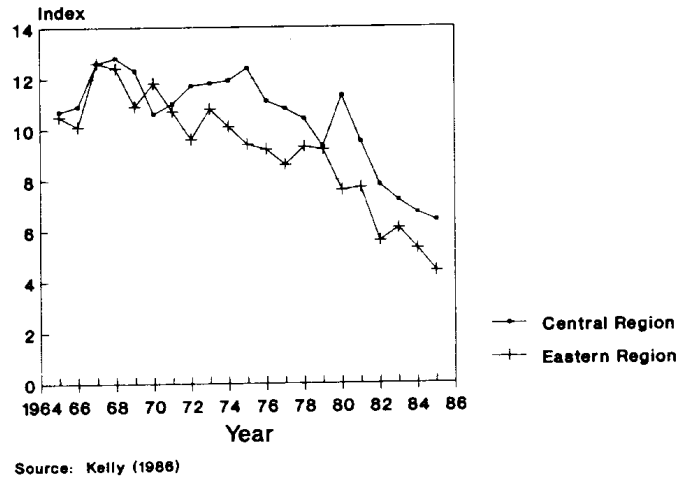
Source: USDI, Fish and Wildlife Service (1987a)

Figure 15.—National and flyway duck harvest trends.



Source: Data on file with the USDI, Fish and Wildlife Service, Office of Migratory Bird Management

Figure 16.—National and flyway goose harvest trends.



Source: Kelly (1986)

Figure 17.—Trends in woodcock seasonal hunting success by management region.

populations. Thus, it appears that success rates have been increasing since the early 1970's (USDI Fish and Wildlife Service 1987a).

To learn more about the factors that affect harvest rates, the United States and Canada undertook a 5-year (1980–1985) cooperative study to evaluate stabilized season lengths and bag limits. The preliminary findings of this study indicated that harvests are a direct function of hunter numbers together with hunter success and population abundance (Trost et al. 1987). Weather and population age structure were not clearly established as affecting harvest levels. The relationship between the number of hunters and the number of waterfowl harvested was also found to be nonlinear such that the harvest rate of small populations was higher than the harvest rate of large populations. Finding the harvest rate threshold for each species requires further research.

Goose harvest.—The number of geese taken by hunters has increased since 1965 (fig. 16). Harvests have gone from a low of 750,000 in 1966 to nearly 1.9 million in 1985. Harvests during the last 10 years have been consistently at or above 1.5 million. The Canada goose is the most abundant species harvested, accounting for 60% of the harvest (USDI Fish and Wildlife Service 1987a). The influence of growing national goose populations explains, in part, the significant gain in harvests over the last 20 years.

The harvest trend for geese has been upward in three of the four flyways. The Atlantic flyway goose harvest has been increasing since 1965. Slightly more than 150,000 geese were harvested in 1965 and that number grew to nearly 500,000 by the mid-1980's. The Mississippi and Central flyway goose harvests have each increased from about a quarter million birds in 1965 to around a half million in 1971, where harvests have remained at fairly stable levels. The Pacific flyway has shown gradual declines in the goose harvest since the mid-1970's. After peaking at 450,000 birds in the early 1970's, the Pacific goose harvest has stabilized near 300,000 birds.

Woodcock harvest.—American woodcock harvests are monitored annually by the states and the Fish and Wildlife Service through bag checks and voluntary submissions of bird wings by woodcock hunters. Recent harvest calculations by the Fish and Wildlife Service (1987a) estimate that 827,000 birds were taken by hunters in the Eastern management region, while approximately 1.2 million birds were harvested in the Central region. Trends in woodcock harvests are not estimated directly, but are monitored through an index of success (birds per season per hunter). During the period of 1965–1975, the index ranged between 10 and 13. Since the mid 1970's, however, success has declined significantly (Kelly 1986). Both the Eastern and Central management units have experienced approximately a 50% decline in the average number of birds bagged per season (fig. 17).

A second source of woodcock harvest information comes from the Southeastern Association of Fish and Wildlife Agencies annual Vital Statistics reports. The trends are generally consistent with those described by Kelly (1986). In the southern portion of the Eastern management region, as represented by the seven states

from Maryland to Florida, woodcock harvests steadily dropped by 43% during the period 1980–1986. In six southern states in the Central management region, woodcock harvests increased from 1980 to 1982 and then dropped a dramatic 70% by 1986.

Mourning dove harvest.—No national survey monitors mourning dove harvests. Data derived from state agencies yield a national harvest estimate of up to 51 million birds (USDI Fish and Wildlife Service 1987a). This estimate far exceeds the harvest of any other game species. Consistent with the population and hunter participation declines noted in the Western region, Tomlinson et al. (1987) estimated that harvests have declined from an average of 7.3 million in 1966–1968 to 5.7 million in 1981–1983. Trends in the Eastern and Central management regions have remained relatively stable in recent years. The Southeastern Association of Fish and Wildlife Agencies has estimated the number of doves harvested in the cooperating states and found that in the southern portion of the Eastern management region harvests fluctuated between 24 and 25 million during 1980–1986. Harvest statistics from three states in the Central management region showed an increase from 7.7 to 10.1 million birds during the 1980–1984 period, followed by a slight drop in 1986.

Big Game

Big game is a general term that includes large mammals taken for sport or subsistence. Some states regard the wild turkey as big game, too. Besides being an important outdoor recreational activity, big game hunting is also important to many rural economies which benefit from food, lodging, and other travel-related expenditures. In 1985, big game hunters accounted for 60% of all hunting-related expenditures (USDI Fish and Wildlife Service 1986b).

People do not generally appreciate that many big game populations are now more secure, more widely distributed, and more abundant than they were at the turn of the century (Wildlife Management Institute Staff 1978). It is important to recognize, however, that despite significant gains in some selected populations, the diversity of big game within certain regions of the country has changed dramatically over time. Where deer now dominate in the East, elk, bison, moose, wolves, and mountain lions were once members of the regional fauna (Matthiessen 1987).

Enactment of protective legislation and professional management have undoubtedly contributed to the recovery of many big game species. For example, the most widely hunted big game species, white-tailed deer (USDA Forest Service 1981), has a population 47 times larger now than at the turn of the century (Downing 1987). However, past successes may not reflect future resource status. Increased expenditures for management will be required to maintain the quantity and quality of big game habitats and populations (Bailey 1980, Flather et al. 1989, Halls 1984, Miller and Holbrook 1983).

Populations.—As is the case with many wildlife species, no standardized inventory assesses national or regional trends in big game populations. Even the "Big Game Inventory" formally conducted by the Fish and Wildlife Service was simply a compilation from state wildlife agencies. The information reported here also represents a compilation of data that was obtained largely from cooperating state wildlife agencies. The species discussed as representative of big game population status vary by assessment regions (see fig. 1) due to regional differences in animal distributions and management emphasis.

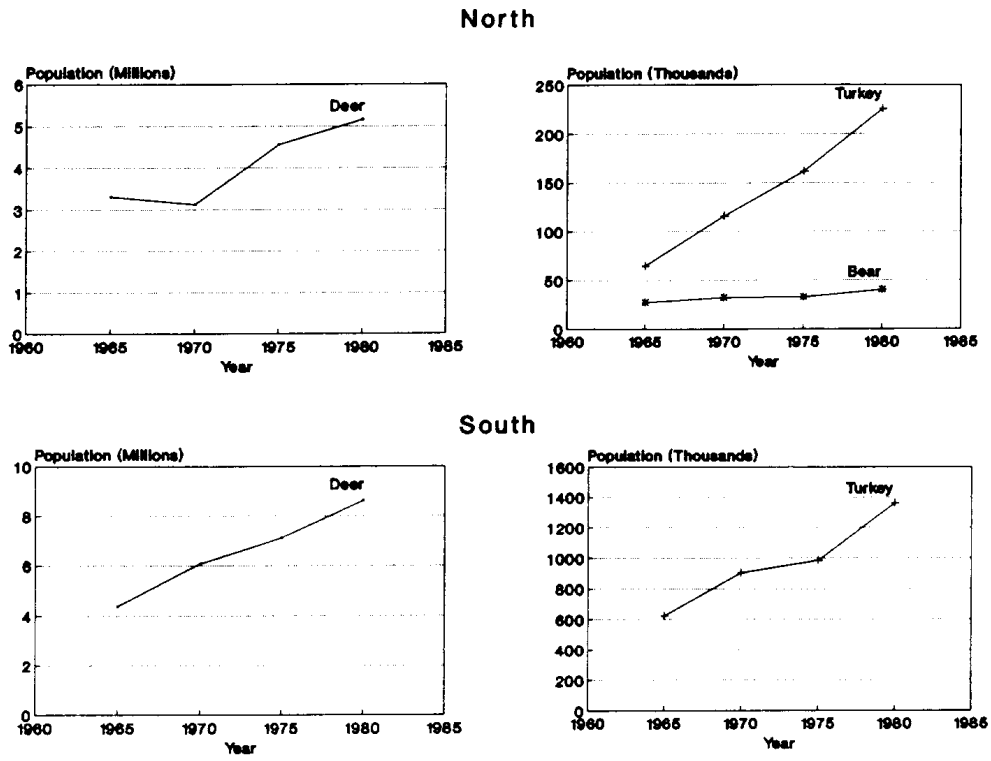
North.—The big game species in the Northern region include white-tailed deer, black bear, and wild turkey. White-tailed deer is by far the most abundant. Of the 20 states comprising the region, 19 reported trend information since 1965. Eighty percent of the states reported increased deer populations since 1965; the remaining 20% split evenly between stable or downward trends.

A more quantitative evaluation of deer trends was possible with the majority of the states. Eighteen states provided deer population estimates from 1965 through 1980, and 11 states provided a complete time trace through 1985. In both cases, significant increases in white-tailed deer populations have been observed. From 1965 to 1980, deer populations increased by approximately 120,000 animals (4%) per year (fig. 18). The reasons for these gains can be attributed to the adaptability of the species and more favorable habitat associated with land-use and land management shifts (Downing 1987).

Black bear trends have been more variable. Of the 11 states reporting trends since the mid-1960's, five showed increases, one state reported a decline, and the remainder had relatively stable populations. Of the states with relatively stable populations, two have shown declining trends since the mid-1970's. However, states that have witnessed both long and short-term declines contribute less to the total regional population than states with increasing trends. Consequently, the net increase in black bear populations in nine states reporting quantitative trends has averaged 850 bears (3%) per year (fig. 18). Though black bears have remained relatively abundant, they are now restricted primarily to the more remote and inaccessible portions of their former range (Raybourne 1987) and are relatively less tolerant of human activities in their habitat than are deer or wild turkey.

The wild turkey has experienced the greatest gains of the three big game species in the North. Of the 18 states that have provided population trends, all have estimated population increases over the period from 1965 to 1985. Turkey populations across these reporting states have increased by nearly 250% from 1965 to 1980—an average increase of nearly 8% annually (fig. 18). Restocking programs along with favorable landscape changes have contributed to the significant increases in turkeys.

South.—The two most important big game species in the South are the white-tailed deer and wild turkey (USDA Forest Service 1981). These species have been monitored and managed more intensively than most species in the region because of their importance to hunting. As of 1980, a compilation of state agency statistics showed that the South supported 8.6 million deer and



Source: Data supplied by state fish and wildlife agencies

Figure 18.—Recent trends in big game populations in the Northern and Southern regions.

1.4 million turkeys, levels 29 and 47 times the national population estimates for these species in the early 1900's, respectively. The recovery of these populations since the turn of the century has continued over the last 20 years. Deer populations have increased 96% (70,000 animals/ year), while turkeys have increased by 120% (50,000 birds/year) (fig. 18). The population increases of both deer and turkey appear to be consistent in the majority of southern states. Twelve out of the 13 southern states reported significant increases in deer and 10 states reported gains in turkeys.

Rocky Mountain.—The West has a greater diversity of big game animals than the East. Information provided by the states was sufficient to discuss trends for deer (mule and white-tailed combined), elk, and pronghorn. Population trends for bighorn sheep, mountain goat, and moose were available from federal land managing agencies and therefore are discussed in the Wildlife and Fish Resources on Public Lands section of this chapter. Because big game habitats in the West are predominantly found on public land, most big game species are more numerous on and more heavily hunted on public lands (Hoekstra et al. 1981).

Mule deer are by far the most abundant big game species in the Rocky Mountain region. Because mule and white-tailed deer are not always distinguished in state statistics, the two species are combined here. The decline in deer populations during the early 1970's (fig. 19) was due to the documented decline in mule deer that apparently occurred throughout the West. Wallmo (1978) speculated that loss of habitat associated with human development was partially responsible for the decline. However, this does not explain why the number of mule deer have since recovered. An alternative explanation for the decline is that deer herds could not support the liberal hunting regulations that were in place during the 1970's—with more restrictive harvest regulations populations increased (Wagner, pers. comm., 1988). In 1985, 11 of the 12 Rocky Mountain states reported populations of more than 3 million animals.

Elk were once the most widely distributed cervid in North America (Boyd 1978). Restriction of elk range resulted from both exploitation and land-use conversions associated with human settlement (Thomas and Bryant 1987). Their current distribution is now essentially confined to the West. Populations over the current range have been recovering due to harvest regulation and intensive transplanting programs. Populations in 11 out of the 12 western states have increased approximately 85% for an average annual increase of 10,000 animals since 1965 (fig. 19).

Pronghorn populations also have experienced significant increases in the last 20 years. Once numbering 30–40 million, populations in the 1920's had been reduced to 13,000 animals (Yoakum 1978). Pronghorn populations have increased dramatically since that time. Eleven states in the Rocky Mountain region estimated the 1985 pronghorn population to be between 550,000 to 600,000

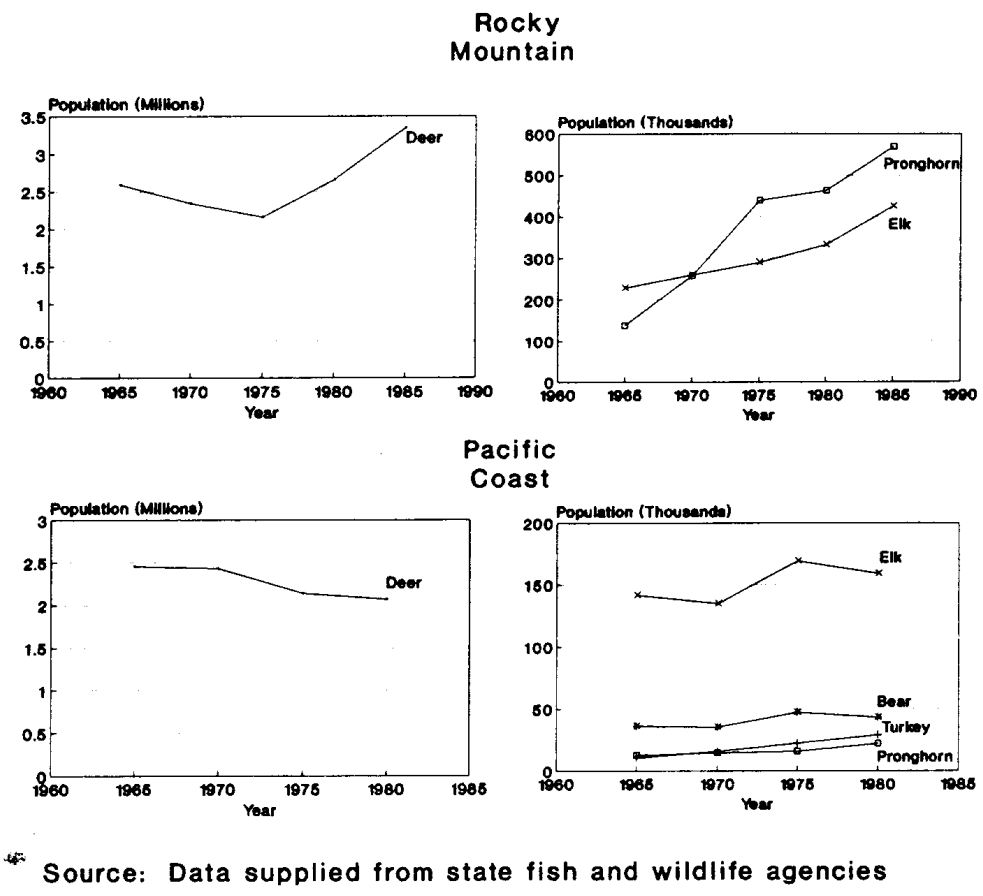


Figure 19.—Recent trends in big game populations in the Rocky Mountain and Pacific Coast regions.

animals. Trends over the last 20 years show consistent increases with an average annual gain of approximately 22,000 animals (fig. 19). Regulation of hunting has been an important factor in the recovery of the species; however, improvement in range conditions and reversion of land to more suitable pronghorn habitat have also encouraged recovery (Wagner 1985, Yoakum 1978).

Pacific Coast.—The trends of big game populations in the Pacific Coast region are similar to those in the Rocky Mountains. Deer (mule, black-tailed, and white-tailed) are the most abundant big game species comprising nearly 90% of the total big game population in the region. Deer populations declined from 1965 through 1980 for an overall loss of about 15% (fig. 19). Declines were most rapid from 1970 through 1975, after which populations appeared to stabilize. Commonly cited reasons for the decline include severe weather and deterioration of winter and summer habitat due to fire suppression, grazing, road development, and human harassment (Connolly 1981).

Elk population trends have fluctuated recently. The general trend, however has been upward since the 1960's (fig. 19). The reasons for the increase are more intensive management through harvest regulations and transplanting programs and the availability of habitat to support expanding numbers (Thomas and Bryant 1987).

Black bear, pronghorn, and wild turkey comprise a much smaller proportion of big game in the Pacific Coast region (fig. 19). Bear population estimates are incomplete and the trends depicted only represent information from two states. Bear populations appear to have increased from the 1960's through the early 1970's. Pronghorn and wild turkey populations grew consistently, nearly doubling and tripling their numbers from 1965 to 1980, respectively.

Big game hunters.—The number of big game hunters is influenced by harvest regulations and socioeconomic factors affecting recreational preferences. The number of big game hunters increased from about 6.6 million in 1965 to 12.6 million in 1985 (table 15)—a proportional increase from 4.6% to 6.4% of the U.S. population 12 years old or older. The percent of the population participating in big game hunting increased a constant 0.4% through 1975. After declining slightly in 1980, proportional participation increased to mid-1970 levels in 1985. Potential causes for the declining national rate of participation include decreasing land accessibility, crowded hunting areas, and less leisure time to participate (National Shooting Sports Foundation 1986).

Regionally, the number of big game hunters has increased in the North, South, and Rocky Mountains

Table 15.—National and regional participation trends in big game hunting.[1]

Region	1965	1970	1975	1980	1985
			Thousands		
Total	6,566	7,774	11,037	11,047	12,576
(% population)	(4.6)	(5.0)	(6.4)	(6.0)	(6.4)
North				5,832	6,121
				(7)	(7)
South				4,173	4,599
				(8)	(8)
Rocky Mountain				1,412	1,694
				(11)	(13)
Pacific Coast				969	935
				(4)	(4)

[1]*Regional totals do not sum to national total since hunters may hunt in more than one state.*

NOTE: Total participants based on people 12 years old and older. Regional participants in 1980 and 1985 are based on persons 16 years and older. For the purposes of trend analysis, the national figures reported here for 19651985 have been adjusted to permit comparison across years, as explained in appendix C of USDI Fish and Wildlife Service (1988b).

Source: USDI Fish and Wildlife Service (1988b); USDI Fish and Wildlife Service, and USDC Bureau of Census (1982).

(table 15). The number of big game hunters actually declined in the Pacific Coast region.

Deer are by far the most commonly hunted big game species—over 95% of all big game hunters sought deer in 1980 (USDI Fish and Wildlife Service, and USDC Bureau of Census 1982). Wild turkey was the second most commonly sought species, with 12% of big game hunters pursuing this bird. The number of elk, bear, pronghorn, or moose hunters was relatively small, constituting about 12.5% of all big game hunters. The abundance of deer and their distribution near high population centers in the East explains the large numbers of deer hunters. Examining trends in species hunted from 1981–1985, the National Shooting Sports Foundation (1986) found that deer and turkey were the only big game species that were hunted more frequently over that 5-year period.

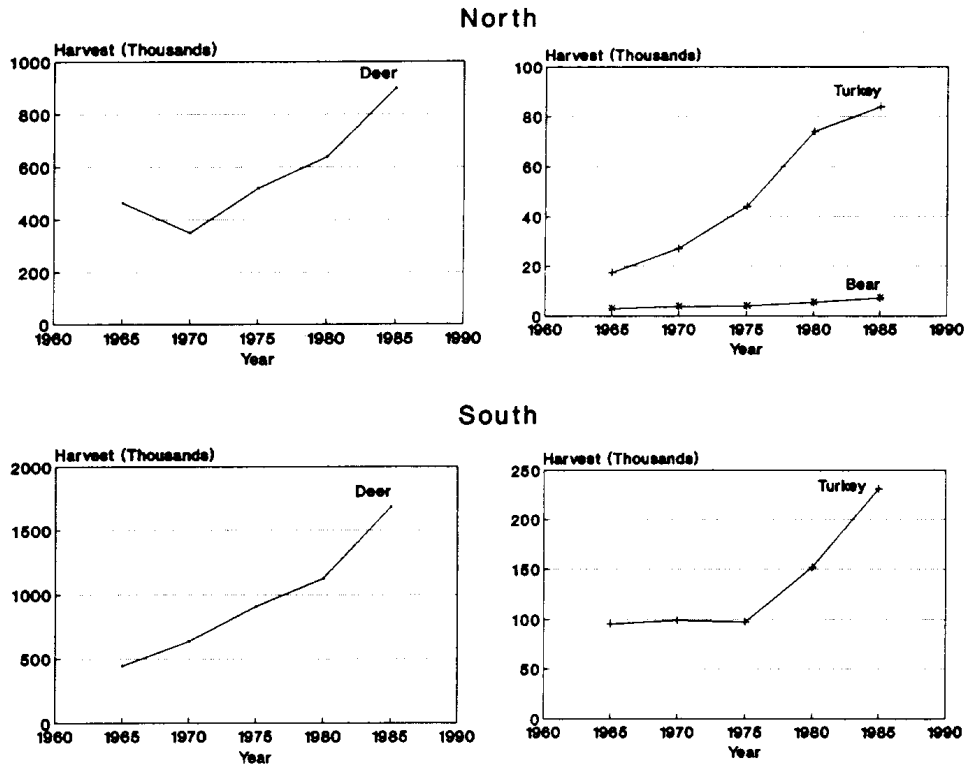
Big game harvest.—One of the major tools available to states for managing big game species is harvest regulation. This is particularly true where natural predators of big game are no longer present and some form of removal helps balance animal numbers with habitat resources. Much of the research recently developed to aid big game management has focused on quantifying the effects of exploitation on large mammal populations (see Caughley 1977, Fowler and Smith 1981, Starfield and Bleloch 1986). Because of this focus and the relative ease of estimation, big game harvest statistics have tended to be more geographically and temporally complete. The most basic factors influencing big game harvests are population levels and hunter effort. However, factors such as weather, special regulations, and accessibility will modify the expected hunter success rates. Generally, the harvest levels reported here follow the expectation based on animal populations and hunter effort.

North.—Of the 20 states comprising the North, 15, 7, and 10 states provided harvest trends from 1965 through 1985 for deer, bear, and turkey, respectively. All harvest levels have increased over the last 20 years (fig. 20), as expected given the notable population increases of these species. Wild turkey showed the greatest increase in harvest levels—380% over the last 20 years for an average increase of 3,300 birds annually. Bear harvests, in the seven reporting states, increased 140% or 210 animals per year. Although deer showed the smallest proportional increase (94%), the observed annual increase of nearly 22,000 animals harvested over the last 20 years emphasizes the dominating importance of this species to big game hunters in the North.

South.—The dramatic increases in deer and turkey populations in the South is tracked closely by harvest trends (fig. 20). Deer harvests increased nearly 280% while turkey harvests increased 143% from 1965 to 1985. These relative increases translate into average annual gains of 62,000 and 6,800 animals bagged, respectively. The increase in deer harvests were relatively steady over the period, in contrast to turkey harvests which showed more rapid gains in the last 10-year period (1975–1985). This may indicate that turkey populations reached sufficient levels in the mid-1970's to trigger an influx of new users.

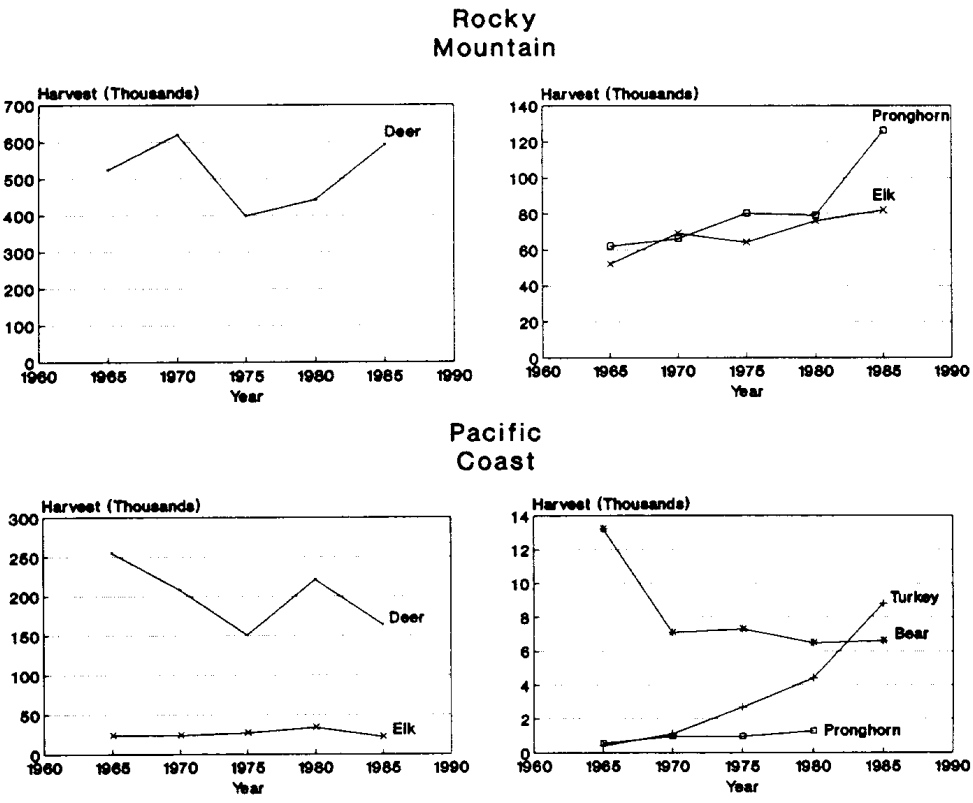
Rocky Mountain.—Big game harvest trend data were available from all states in the Rocky Mountain region. Elk and pronghorn harvests have increased by 58% and 104%, respectively, over the last two decades (fig. 21). Elk harvest increases appear to be consistent across reporting states. Conversely, pronghorn harvest trends varied by state with eight states reporting increases, two reporting declines, and two reporting relatively stable harvests. States not reporting increases are characterized by low pronghorn populations and contribute little to the overall regional harvest trend.

Deer (mule and white-tailed) harvests have qualitatively mimicked the noted population trends. Although deer populations declined consistently from 1965



Source: Data supplied by state fish and wildlife agencies

Figure 20.—Recent trends in big game harvests in the Northern and Southern regions.



Source: Data supplied from state fish and wildlife agencies

Figure 21.—Recent trends in big game harvests in the Rocky Mountain and Pacific Coast regions.

through the mid-1970's, harvests actually increased between 1965 and 1970, before declining by 36% in 1975. By 1985, deer harvests increased to near 1970 levels. State trends tended to be consistent with the regional trend. Exceptions occurred in states along the eastern border of the region where whitetails are the predominant deer species. In these states, consistent increases in harvests have been observed.

Pacific Coast.—Changes in deer harvest over the last 20 years have been heavily influenced by the mule deer decline that evidently occurred throughout the West. Deer harvests declined by over 40% from 1965 to 1975, increased to pre-crash levels in 1980, only to decline again in 1985 (fig. 21).

Elk and pronghorn harvest trends have consistently increased from 1965 through 1980 (fig. 21). Pronghorn harvests more than doubled between 1965 and 1980. As with deer, elk harvests have declined since 1980. The magnitude of the decline (35%) was influenced heavily by a record high harvest in 1980 in one of the reporting states.

After dropping nearly 50% between 1965 and 1970, bear harvests have fluctuated since 1970 (fig. 21). Not all reporting states were consistent in this pattern; harvests have doubled since 1970 in one state and declines have been reported in two others.

Turkey harvests have experienced the greatest relative increase of all big game species in the Pacific Coast region. From a low of about 400 birds in 1965, harvests have increased to nearly 9,000 in 1985 (fig. 21).

Small Game

Animals considered small game generally include resident game birds and mammals but exclude migratory birds and furbearers. The word "upland" frequently modifies the designation small game to indicate these animals associate with forest, range, or agricultural habiats rather than wetland or aquatic systems. States vary in the species managed as small game. For the purposes of this report, population and harvest trends of grouse, squirrel, rabbit, quail, and pheasant are reviewed as repesentative examples of the nation's small game resource.

Populations.—Most states do not monitor small game populations, but rather use harvest data to evaluate resource status. Consequently, few states contributed small game information; therefore, trends must be interpreted with caution. Harvest statistics provided a more regionally representative sample of states from which trends in small game resources could be evaluated.

Populations of small game are relatively more responsive to environmental factors such as weather and vegetation than big game. Vegetation, as a habitat component, is probably the major factor that can be influenced to change small game populations. Harvest of small game populations generally does not withdraw sufficient numbers of the population stock to effectively change the population because most small game species have a high reproductive potential.

Some national trends in small game populations are apparent from an overview of regional summaries. Small game populations associated with agricultural land uses are declining. Pheasant, quail, prairie grouse, and eastern cottontail populations all have shown a downward trend over the 1965 to 1985 period. Small game species associated with forested habitats, including squirrel and grouse, remained stable or increased slightly over the same 20-year period. A more detailed account of recent population trends by assessment region follows.

North.—Northern small game population trends are, in general, consistent with national pattern by species and habitat (fig. 22). Northern bobwhite reach the northern extent of their range in this region. Consequently, weather is an important factor influencing quail numbers. The trend in northern bobwhite numbers has been slightly downward (10%) since 1965 with the greatest decline occurring in the last 10 years. Rabbit and hare populations have gradually declined by 20% since 1965 while pheasant numbers have declined by over 60% in one mid-Atlantic state. The declines in quail, rabbit, and pheasant populations are considered to be habitat related. These species have dwindled with reduced interspersion of early forest succession and agriculture, with bigger farms but fewer fencerows and field borders, and with more intensive farming including more herbicide use and fall plowing (National Academy of Sciences, National Research Council 1982).

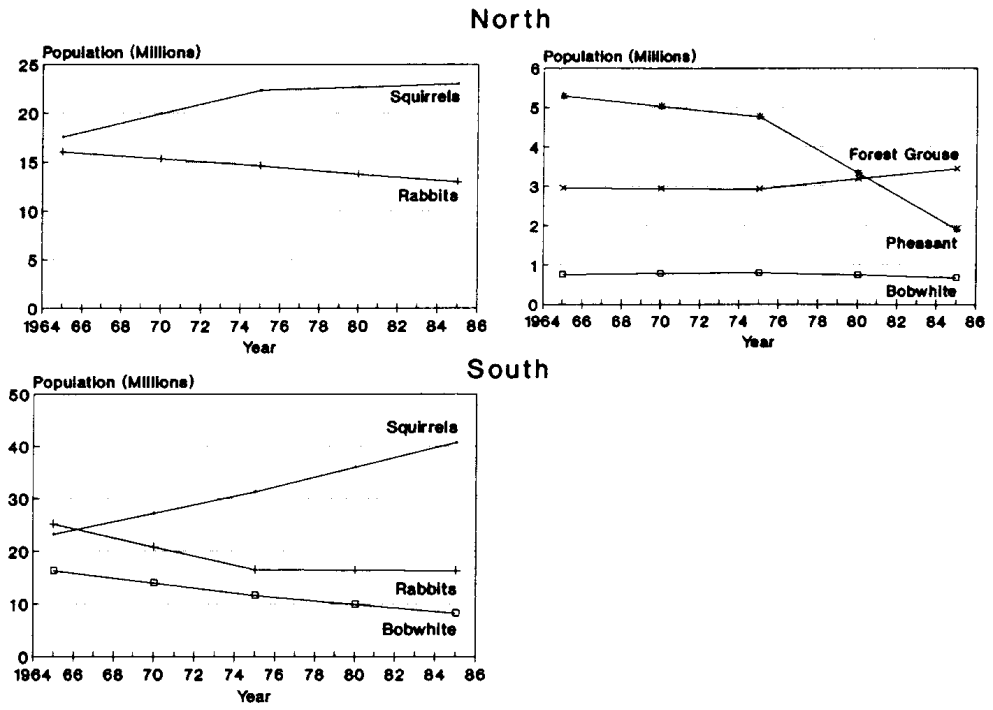
In contrast to the small game species associated with agricultural and shrubland habitats, squirrel populations have increased by over 30% in the forested Northeast, yet have declined slightly in the more agricultural Midwest. These trends follow the changes in land-use patterns—small farm woodlots are being removed in the Midwest while maturing forests in the Northeast are providing more suitable squirrel habitat.

South.—The South's populations of northern bobwhite and eastern cottontail have recently declined by 50% and 35%, respectively (fig. 22). States along the northern boundary have had relatively stable quail populations; the decline has occurred mostly in the deep South. In addition to more intensive agricultural practices and the decline of early succession vegetation, state regulations restricting the use of prescribed burning have resulted in less favorable habitat conditions (Landers 1987) for many small game species such as northern bobwhite.

As in the North, trends for forest small game have been more favorable than for species associated with agricultural habitats. Squirrel populations in four states have been increasing steadily over the last 20 years, for an overall increase exceeding 75%.

Rocky Mountain.—Pheasant populations in the Great Plains have declined in the traditionally high-population central states and remained relatively stable in the more northeastern states. In three states that have reported population trends from 1965 to 1985, pheasant numbers have dropped by over 50% (fig. 23).

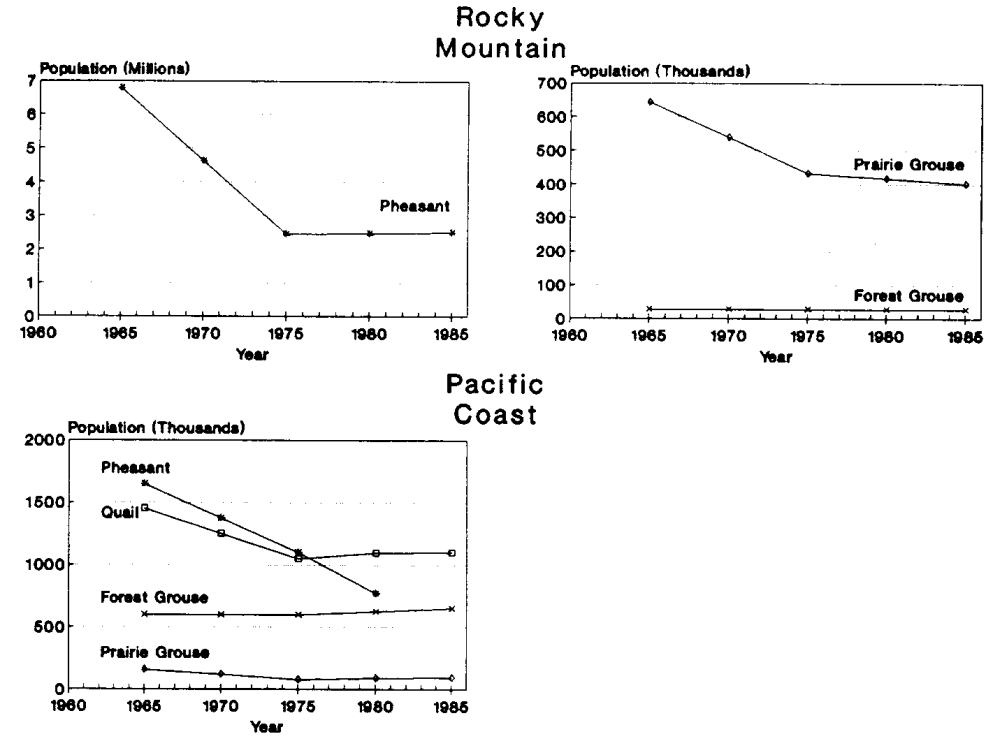
Grouse populations have varied by species. Composite population trends for prairie grouse species have shown consistent declines over the recent historical period, while forest grouse species have shown relatively



NOTE.—Number of Northern states reporting population trends through 1985: Pheasants-1, Quail-2, Rabbits-2, Squirrels-2.Forest Grouse-3. Number of Southern states reporting population trends through 1985: Quail-3, Rabbits-4, Squirrels-4

Source: Data supplied by state fish and wildlife agencies

Figure 22.—Recent trends in small game populations in the Northern and Southern regions.



NOTE.—Number of Rocky Mountain states reporting population trends through 1985: Pheasants-3, Prairie Grouse-3, Forest Grouse-1. Number of PAcific Coast states reporting population trends: Pheasants-1, Quail-1, Prairie Grouse-1, Forest Grouse-1

Source: Data supplied by state fish and wildlife agencies

Figure 23.—Recent trends in small game populations in the Rocky Mountain and Pacific Coast regions.

stable numbers. Populations of sharp-tailed grouse (Miller and Graul 1980) and sage grouse (Autenrieth 1986) in the Rocky Mountain region have declined due to agricultural practices which have reduced critical cover and food plants.

Pacific Coast.—Small game population estimates were available from one state. As observed in the other regions, trends have been mixed. Forest and prairie grouse populations show divergent trends. Forest grouse species have increased slightly since 1975 while sage grouse have declined by 40% since 1965. Quail populations (bobwhite and western species) dropped by 25% and pheasants have declined by more than 50% (fig. 23).

Small game hunters.—The number of small game hunters has historically represented approximately 8% of the U.S. population 12 years old and older (table 16). Until recently, more hunters pursued small game than any other category of game. As is true in the pursuit of nearly any recreation activity, small game hunters have a dedicated core of individuals. They hunt almost regardless of population changes among their preferred species. Consequently, declining small game populations associated with agricultural land has primarily affected the "incidental" small game hunter.

Though the number of small game hunters increased through 1975, the 1985 National Survey of Fishing, Hunting and Wildlife Associated Recreation (USDI Fish and Wildlife Service 1988b) indicated that small game hunting has since declined (table 16). The proportion of the U.S. population that hunted small game dropped by over 2% since 1975. Regional trends in the number of small game hunters have been declining in all assessment regions since 1980 with the greatest losses occurring in the North and South.

In the National Shooting Sports Foundation survey (1986), small game hunters attributed declining participation to several factors. Dwindling access to hunting land and crowded hunting areas were judged to be greater problems than in the past by 45% of the small game hunters polled, and the South was more greatly affected by these factors than other regions. Fifty-one percent of the hunters further indicated that game population declines were a greater problem than in the past. Insufficient game was a greater problem in the North (cited by 56% of the hunters), than in the South (43%), or the West (52%).

Small game harvest.—The harvest of small game generally represents between 10% and 30% of a species' annual population according to state agency data. There is a high degree of correlation between population size and number of small game harvested. Except for the Southern region, pheasant harvests generally have been declining throughout the nation. Quail harvests generally have dropped with some short-term increases in all but the Southern region. Rabbit harvests have declined consistently in all regions. Harvests of forest small game have been variable but a general increase is evident during the last 20 years.

North.—Small game harvests in the North have declined for species associated with agricultural lands (fig. 24). An initial increase in bobwhite harvests during the early 1970's was followed by a consistent 15-year decline of over 65%. Pheasant harvests peaked in the mid-1970's, after which a 50% decline has been observed. Rabbits follow the same 20-year pattern noted for pheasants—slight increases in harvest through 1975 followed by a 40% decline by 1985.

Forest small game have not demonstrated the same pattern as agriculturally associated species (fig. 24). Squirrel harvests have steadily increased by 10% since the mid-1960's. Grouse harvests have been variable in recent history. For the six states which reported grouse harvests during 1965–75, no pattern was evident. During the 1975–1985 period, however, grouse harvests have increased in five states, and declined in three states. No particular geographic pattern to the states reporting increased or decreased grouse harvests is evident.

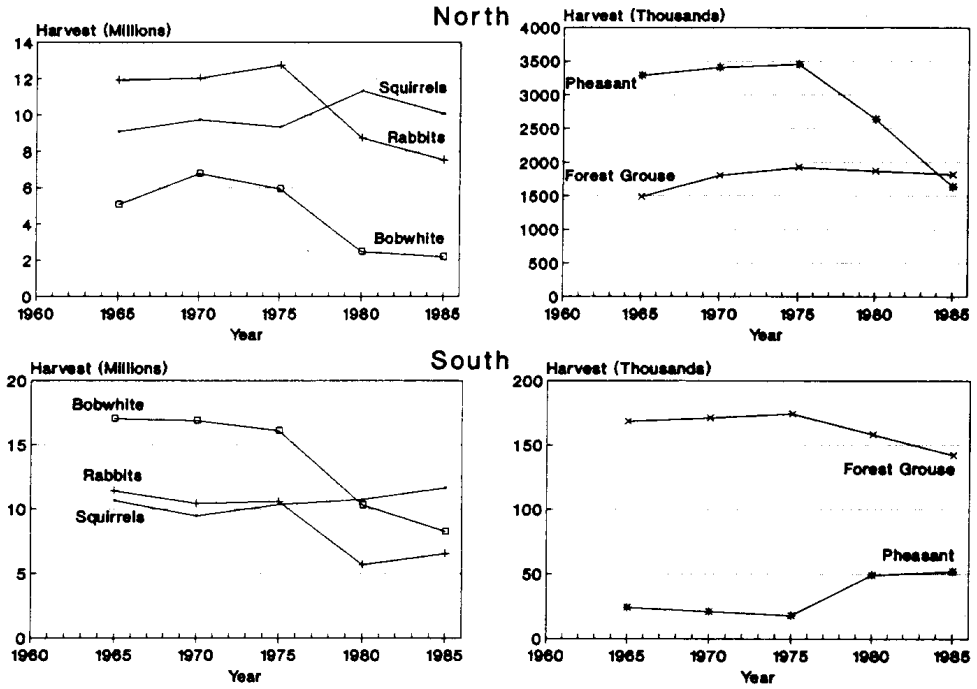
Table 16.—National and regional participation trends in small game hunting.[1]

Region	1965	1970	1975	1980	1985
			Thousands		
Total	10,576	11,671	14,182	12,496	11,130
(% population)	(7.5)	(7.5)	(8.3)	(6.8)	(5.7)
North				5,707	5,071
				(7)	(6)
South				4,766	4,140
				(9)	(7)
Rocky Mountain				1,534	1,387
				(12)	(10)
Pacific Coast				922	731
				(4)	(4)

[1]*Regional totals do not sum to national totals since hunters may hunt in more than one state.*

NOTE: Total participants based on people 12 years old and older. Regional participants in 1980 and 1985 are based on persons 16 years and older. For the purposes of trend analysis, the national figures reported here for 1965–1985 have been adjusted to permit comparison across years, as explained in appendix C of USDI Fish and Wildlife Service (1988b).

Source: USDI Fish and Wildlife Service (1988b); USDI Fish and Wildlife Service, and USDI Bureau of Census (1982).



NOTE.--Number of Northern states reporting harvest trends through 1985: Pheasant-9, Quail-6, Rabbits-7, Forest Grouse-9, Squirrels-7. Number of Southern states reporting harvest trends through 1985: Pheasant-2, Quail-7, Rabbits-7, Forest Grouse-3, Squirrels-6

Source: Data supplied by state fish and wildlife agencies

Figure 24.—Recent trends in small game harvests in the Northern and Southern regions.

South.—Pheasant harvests in the Southern region are heavily influenced by the estimates from the western and northern fringe states since pheasants do not occupy most of the region. Data from two southern states indicated increases in pheasant harvest since the mid-1970's (fig. 24)—a notable deviation from the significant declines observed in all other assessment regions. Northern bobwhite harvests have closely followed the trend in their populations with a consistent drop of over 50% during the last 20 years. The decline in rabbit harvests has been slightly more moderate than quail with a 40% drop being reported. Squirrel harvests declined slightly between 1965 and 1970 but have since recovered to levels that exceed those observed in 1965. In the three southern states reporting grouse harvests, the number of birds taken has declined by over 20% since 1975 and may be associated with the decline in early forest successional stages.

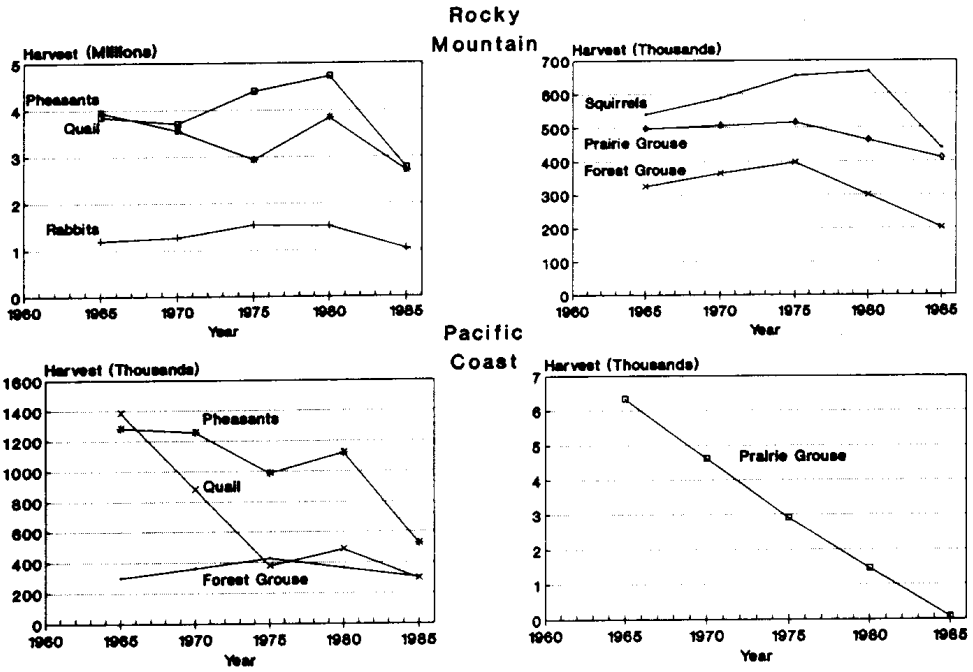
Rocky Mountain.—In general, small game harvests in the Rocky Mountain region have shown a convex pattern—increases through the mid-1970's and early 1980's followed by declines (fig. 25). Quail-harvest gains through 1980 have recently been lost. More recent harvests have dropped well below levels observed during the late 1960's and early 1970's. After increasing through the mid-1970's, rabbit harvests by 1985 had declined to 1965 harvest levels. The highest grouse harvests were experienced during the mid-1970's after which significant declines have been observed. Squirrel harvest increased by 18% by 1980, after which it dropped nearly 40% by 1985. Pheasant-harvest trends, an exception to the convex pattern in 20-year harvests, have declined by more than 30% since 1965.

Pacific Coast.—Obvious declines in pheasant and quail harvests have been observed in the Pacific Coast region since 1965. Pheasant harvests have declined by 60% while quail harvests have declined by 80% (fig. 25). After increasing through the mid-1970's, forest grouse harvests have declined to levels observed in the mid-1960's. Sage grouse harvests have declined dramatically since 1965.

Furbearers

Mammals referred to as furbearers constitute a wildlife resource valued not only ecologically and recreationally but also for income. Most furbearing animals are taken by trapping rather that hunting due to their secretive habits (Deems and Pursley 1983). This furtiveness makes information on population status difficult to collect. For most species, the only available information is on harvest levels, the trends of which may be more a reflection of fur price than of population status.

In addition to the information deficiencies on status and trends in the furbearer resource, trapping is further



NOTE.--Number of Rocky Mountain states reporting harvest trends through 1985: Pheasant-10, Quail-5, Rabbits-8, Prairie Grouse-10, Forest Grouse-9, Squirrels-3. Number of Pacific Coast states reporting harvest trends through 1985: Pheasant-3, Quail-2, Forest Grouse-3, Prairie Grouse-2

Source: Data supplied by state fish and wildlife agencies

Figure 25.—Recent trends in small game harvests in the Rocky Mountain and Pacific Coast regions.

characterized by long-term controversy. Trappers are under growing pressure to abandon their activity (Reiger 1978) to the extent that anti-trapping sentiment threatens the future of trapping in many areas of the country (Foner 1982; Linscombe, pers. comm., 1987).

Populations.—Few data on the population status of furbearers exist that are of sufficient scope and extent for use in national resource assessments. Two national summaries that have addressed furbearer population trends were completed by Deems and Pursley (1983) and Sisson-Lopez (1979). These reports provide qualitative indications of recent historical trends—the findings of which are summarized here. Only those species that are most commonly harvested, of significant economic value, or of particular public interest are reviewed.

The five furbearers most commonly harvested in the 1980's were the muskrat, raccoon, nutria, opossum, and beaver (Linscombe 1988). Muskrat populations have been, and continue to be, abundant throughout their North American range. Trends indicate fairly stable populations with short-term fluctuations tracking wetland habitat condition. One exception to this general trend was in the Rocky Mountain region where there was a gradual decline from 1955 to 1975 (Sisson-Lopez 1979), possibly reflecting diminishing wetlands.

The remaining four species have all shown recent population increases. The raccoon has become more numerous since the turn of the century, its adaptability reflected by increasing urban and suburban populations and by range extension to the north. Nutria, a rodent introduced from South America, has become so abundant in some areas that it is regarded as a pest. Now established in 15 states, the nutria raises concern about competition with native species such as the muskrat (Linscombe and Kinler 1985). Beavers are probably more abundant now than they were at the turn of the century (Deems and Pursley 1983). The few and isolated populations that existed in the early 1900's have expanded to include most of the beaver's original range. Transplanting programs, harvest regulations, and an abundance of suitable habitat are factors responsible for the observed increase. The Virginia opossum has been expanding its range northward; however, it remains most abundant in the South. A high reproductive rate, use of a broad range of land cover types, and adaptability have contributed to the opossum's increased distribution and abundance.

The red fox and mink are two additional species of interest because of their economic importance. In terms of total value (price per pelt x total harvest), the red fox

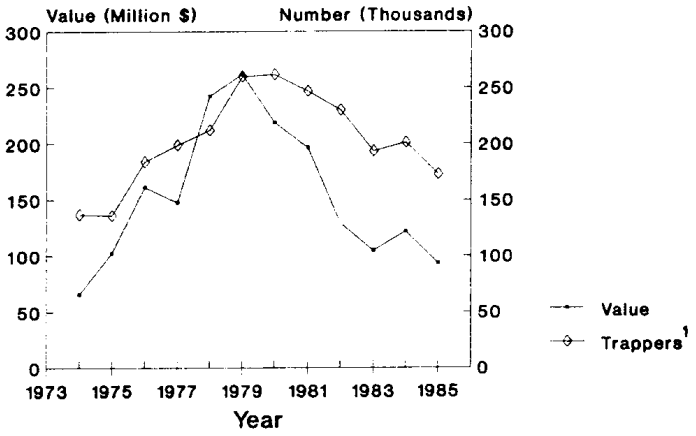
and mink were the fourth and fifth most valuable species in 1985, behind raccoon, muskrat, and beaver (Linscombe 1988). Recent trends for fox and mink are less favorable than for the more commonly harvested furbearers. Sisson-Lopez (1979) found evidence that both species had declining trends in some regions of the country. Fox declines appear associated with human pressures in the open prairie regions while mink declines may be tied to loss of important wetland habitats.

Two other species that warrant consideration because of high public interest are the coyote and bobcat. Because of depredation problems, the coyote has been a center for debate on predator control issues. Despite intensive control programs, coyote numbers appear to be increasing in many regions of the country. In addition, the coyote's range has been expanding eastward through northeastern (Moore and Millar 1984) and some southeastern states. Coyote range expansion probably results from elimination of the gray wolf, clearing of forests, agricultural practices, and adaptation to suburban environments (Carbyn 1982).

The bobcat became a species of particular public concern when pelt prices rose exponentially during the mid-1970's. The dramatic price increase followed high demand for spotted-fur garments when supplies were low due to restrictions on imported spotted-cat pelts. Because bobcats are susceptible to excessive hunting and trapping pressure (Koehler 1987), there was widespread public contention over the impact that increasing trapping pressure would have on the viability of bobcat populations. Part of the difficulty was a general dearth of information on bobcat abundance and ecology to accurately assess population status. Existing information suggests that bobcat populations increased during the 1950's and early 1960's but have since declined (Anderson 1987). The increase coincided with intensive control efforts to reduce coyote populations which are thought to compete with bobcats (Nunley 1978). Despite changes in abundance, the distribution of bobcats has changed little historically—exceptions include the midwestern and mid-Atlantic states where they have been eliminated from much of the area by intensive agricultural practices (Deems and Pursley 1983, Koehler 1987).

Trappers.—Trappers, themselves, share attributes of the species they pursue. Trappers tend to be withdrawn (Reiger 1978) and comprise a small percentage of the U.S. population, which makes studying their activity difficult. Unlike hunters, trappers have a profit motive attached to their activity. In addition to economic incentives, growing public and legislative pressures to eliminate trapping or restrict trapping methods affect trapper numbers. Many states have passed, or are considering, legislation that would outlaw trapping or significantly restrict where and how trapping is done.

Although regulations can affect participation in trapping, price is the dominant factor explaining recent trends in the number of trappers. There has been a strong correspondence between number of trappers and total fur value (fig. 26), and there is some indication of a 1-year lag in trapper response to prices. Based on data from



[1]Number of states reporting: 30

Source: Linscombe (1988)

Figure 26.—Comparison of trends in total annual value of furs taken and the number of trappers from 1974–1985.

30 states, 1974–1985, trapper numbers peaked in 1980 after which numbers declined by nearly 35% (Linscombe 1988).

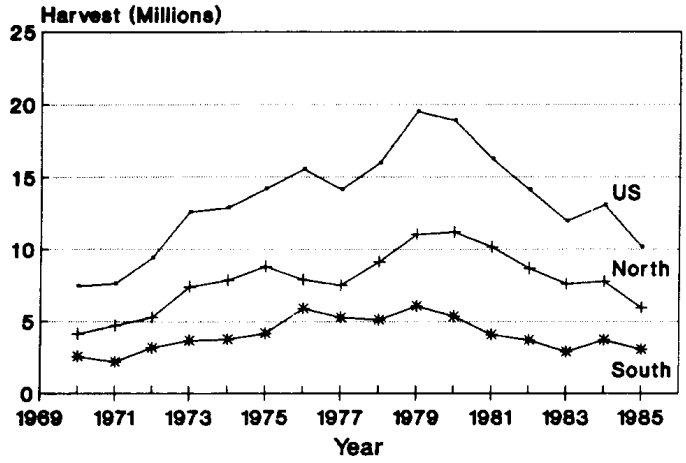
Furbearer Harvest.—Data on furbearer harvest trends are more complete than data on population levels or number of trappers. National harvest trends since 1970 correspond to the expected pattern given the value and trapper trends reviewed above. Number of furbearers harvested showed nearly a three-fold increase over the 1970–1980 period. However, by 1985, furbearer harvest had been halved from peak levels (fig. 27). This pattern is consistent within each assessment region, with peak harvests all occurring during the 1979–1980 period.

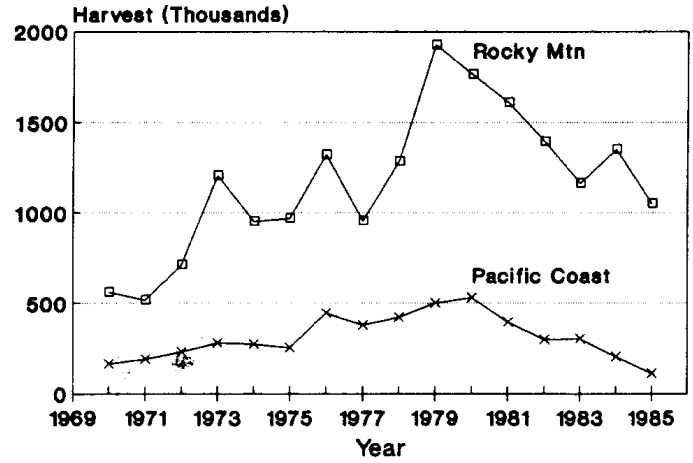
Harvest trends for the five most commonly harvested furbearers show only minor deviations from the total harvest trend (fig. 28). The greatest relative declines since the late 1970's have occurred with muskrat, nutria, and opossum—all declining by over 60%. Raccoon harvests have declined at a more moderate rate while beaver harvests have actually increased since 1983.

Prices that trappers have received per pelt are a strong determinant of harvest. From 1978 to 1985 the average price per pelt dropped by nearly 40% (fig. 29). In constant (accounting for inflation) 1974 dollars, the gross return realized by trappers has declined by 61% over the same period. Unless consumer demand for natural fur garments increases, or new foreign markets are found, these trends will not likely reverse in the near future.

Fish

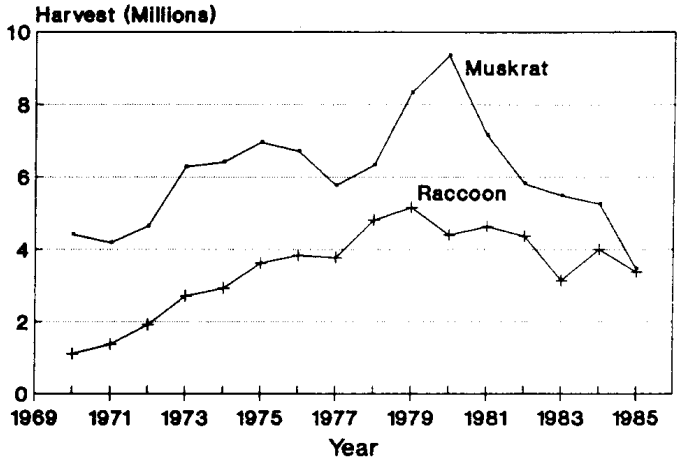
Fish species in the United States are found in a variety of aquatic habitats from inland rivers, streams, lakes, pond and reservoirs, to estuaries and open marine environments. Both the freshwater and marine fishery resource have extremely important economic, recreational, and environmental value. Maintenance and improvement of the nation's fisheries benefit human health and nutrition, economic prosperity, and leisure enjoyment (Gordon 1988). In 1986 alone, the 239,000 people who engaged in commercial fishing took approximately 6 billion pounds valued at $2.8 billion (USDC

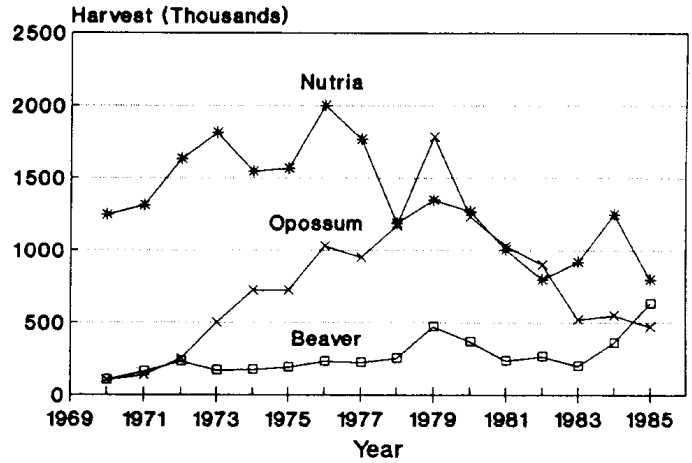




Source: Linscombe (1988)

Figure 27.—Trends in total fur harvest for the nation and by assessment region from 1970–1985.





Source: Linscombe (1988)

Figure 28.—Harvest trends for the five most commonly harvested furbearers (1970–1985).

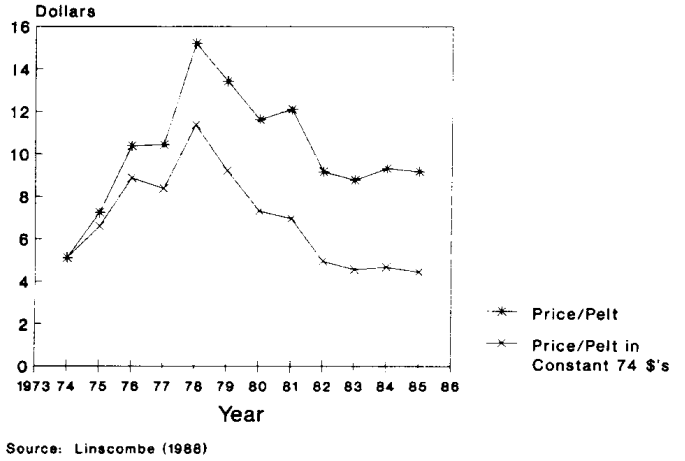
National Oceanic and Atmospheric Administration, National Marine Fisheries Service 1987). In addition, the Fish and Wildlife Service (1988b) found that more than one out of every four persons in the United States fished in 1985.

Despite the importance of the nation's fisheries as sources of recreation and livelihood, little information exists that can be used to identify or evaluate changes in fish species distribution and abundance. Information on trends in the number of users and commercial harvest are more complete. Recreational use is monitored by the Fish and Wildlife Service and commercial users and harvests are monitored by the National Marine Fishery Service. This report focuses on that portion of the fishery resource that is potentially impacted by land management activities. Consequently, emphasis is placed on inland and anadromous fish species with less consideration of marine species.

Populations.—The numbers of fish in the nation's lakes, streams, reservoirs, and estuaries are rarely inventoried except at specific locales. Although many population surveys have been completed, generally it is not possible to extrapolate beyond the specific area sampled. Only one known study provides estimates of the nation's fishery population resources. The distribution and abundance of the nation's fish resources were considered as a part of the 1982 National Fisheries Survey (Judy et al. 1984). Fish were categorized as sport and nonsport species and related to the number of miles of streams in which they occurred.

Sport fish species occurred in 73% of the nation's streams while nonsport species were found in 68%. Twenty-one percent of all streams sampled contained no fish largely due to lack of water in intermittent streams. Anadromous sport fish species were present in 11% and commercial fish species were found in 17% of the stream miles sampled. Defined in terms of stream miles occupied, largemouth bass and carp were the most widely distributed sport and nonsport species, respectively (table 17).

Given the distribution of the fisheries resource described above, Judy et al. (1984) went on to classify sport and nonsport fish into five abundance categories: abundant, common, uncommon, rare, and expected. The survey found 64% of the stream miles sampled to be suitable (i.e., support an abundance class of abundant



Source: Linscombe (1988)

Figure 29.—Trends in average price per pelt from 1974–1985.

or common) for sport fish while sport fish were uncommon or rare in only 7% of the stream miles sampled (table 18). Sport fish were found to occupy the greatest number of stream miles in the common category (41%) while nonsport fish occupy the most miles of stream in the abundant category.

Evaluating these statements is difficult without a second point of reference either in terms of data from a previous time or an explanation of the factors that produced the results. Attempting to address recent trends in the condition of the freshwater fishery resource, Judy et al. (1984) asked biologists to rate the ability of the nation's waters to support fish communities over a 5-year period. The results indicated little change—4% of the streams improved, 5% were diminished, and 91% of the streams remained unchanged in their ability to support fish communities.

Longer trends in the distribution and abundance of some fish species are available only from specific regional studies. In New England, the plight of the Atlantic salmon is, in many respects, indicative of trends in other anadromous salmonids. Beland (1984) estimated that in precolonial times, as many as 500,000 returning adult Atlantic salmon migrated up 34 river systems. The USDI Fish and Wildlife Service (1984) estimated that 7,000 adult salmon now enter only 16 New England river systems. Of the total returning adult spawners, only about 1,000 are from natural reproduction—the remainder being from hatchery stock.

The factors responsible for the Atlantic salmon decline are varied. Commercial harvests have been cited in the species' early decline (New England Fishery Management Council 1987), and harvest continues to limit recovery. Boreman et al. (1984) estimated that for every adult salmon returning to New England rivers, one to five are caught in the ocean fishery. Despite the mortality associated with commercial harvests, probably the most limiting factor has been inaccessible spawning and nursery habitat caused by dams lacking fish-passage structures. Beland (1984), Oatis et al. (1985), and Stolte (1982) estimated that on the six major river systems under restoration, less that 50% of the potential

Table 17.—Ten most prevalent sport and nonsport fish species occurring in the nation's waters.

Species	Stream miles where species occurred	Percentage of total stream miles
Sport fish species		
Largemouth bass	263,859	27.3
Rainbow trout	213,461	22.1
Bluegill	188,495	19.5
Channel catfish	148,343	15.4
Smallmouth bass	142,142	14.7
Green sunfish	126,074	13.1
Brook trout	103,507	10.7
Black crappie	98,190	10.2
Spotted bass	98,129	10.2
Rock bass	94,682	9.8
Nonsport fish species		
Common carp	187,417	19.4
Creek chub	176,709	18.3
White sucker	166,823	17.3
Gizzard shad	131,730	13.6
Bluntnose minnow	126,665	13.1
Stoneroller	122,337	12.7
Green sunfish	115,234	11.9
Common shiner	112,112	11.6
Fathead minnow	110,531	11.4
Golden shiner	106,602	11.0

Source: Judy et al. (1984).

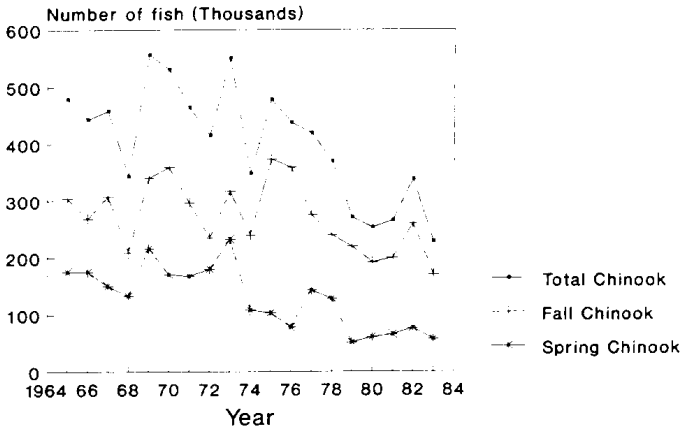
Table 18.—National estimates of fish class abundance for "all streams."

Fish class abundance	Stream miles in class	Percentage of total stream miles
Sport fish		
Abundant	221,694	23.0
Common	391,757	40.6
Uncommon	52,582	5.5
Rare	12,228	1.3
Expected	65,619	6.8
Nonsport fish		
Abundant	334,700	35.1
Common	303,713	31.9
Uncommon	22,344	2.3
Rare	4,727	0.5
Expected	60,414	6.3

Source: Judy et al. (1984).

spawning and nursery habitat is accessible to returning adults.

Similar factors have been implicated in the decline of chinook salmon in the Columbia River basin. Although many salmonid species inhabit the Columbia River basin, the chinook is perhaps the most economically, culturally, and politically important (Phinney 1986). Examination of commercial and recreational catches, dam counts, and hatchery returns provides minimum estimate of in-river runs of salmon. Trends since 1965 indicate that lower-river chinook runs have shown significant improvement because of increased hatchery production. Conversely, upper-river runs have declined sharply (fig. 30). The cumulative impact of hydroelectric



Source: Phinney (1986)

Figure 30.—Trends in upper-river chinook salmon returns in the Columbia River Basin, 1965–1983.

projects is certainly a major obstacle to chinook runs; however, excessive ocean and in-river fishing rates have also contributed to the decline (Phinney 1986).

Some resident salmonids have also suffered range restrictions and population declines. In the Appalachian region of Tennessee, brook trout only occupy 20% to 30% of their estimated range at the turn of the century (Bivens et al. 1985). Severe range restrictions and population declines have also been noted in many native western trout species (Behnke and Zarn 1976). Hybridization and competition with nonnative salmonids have contributed to the decline in both the eastern and western trout populations. Habitat degradation resulting from irrigation projects, mining, logging, road construction, and overgrazing has also been an important factor in the demise of these native trout populations.

The negative impacts on the nation's fishery resources associated with human development are not restricted to coldwater species. In the agriculturally dominated landscapes of the Midwest, warmwater fish communities have deteriorated significantly. Karr et al. (1985) documented that since the mid-1800's 67% of Illinois River fish species and 44% of Maumee River species have experienced population declines or have been eliminated. Human activities that have had the greatest impact on these warmwater fish communities include: lowered water tables and nutrient enrichment associated with agricultural development; construction of navigational locks, channels, levees, milldams, and other impoundments; discharge of oxygen-demanding wastes and toxic chemicals; excessive water consumption; and introduction of exotic species (Karr et al. 1985).

Recreational and commercial fishers.—The number of people pursuing recreational fishing has been increasing over the last 20 years, although the trend varies by type of fishing (table 19). Freshwater fishing represented 86% of the total number of anglers in the United States in 1985, and the number of freshwater anglers has increased consistently since 1965. The number of saltwater anglers has recently increased after a decline in participation in 1980.

There are some regional differences in the trends of sport anglers (table 20). The number of anglers has consistently increased in all regions except the North where a decline of nearly 1 million anglers occurred between 1975 and 1980. Since 1980, however, fishing participation in the North has increased back to levels observed in 1975. In the South and Rocky Mountain regions, a higher percentage of the population fishes than in the North and Pacific Coast regions. It might be expected that outdoor recreationists in the East would be increasingly attracted to fishing over hunting because of less restrictive regulations and greater accessibility.

The number of commercial fishers is largely governed by the availability of fish stocks and markets for the catch. The demand for edible fish products has increased significantly. From 1965 to 1985, the per capita consumption of fish increased by nearly 35% (Bunch 1985). Accompanying this noted increase in demand has been a significant influx of commercial fishers. In 1985, there were 80% more commercial fishers in the United States than 20 years earlier (fig. 31).

Commercial fish harvest.—State agencies estimate recreational harvest through creel census methods which tend to be site specific. There are no known national or regional summaries of creel-census information although there are now individual states that are developing standardized data summaries for their fisheries. The National Recreational Fisheries Policy (USDI Fish and

Table 19.—Total freshwater and saltwater anglers and days of fishing (1965–1985).

Year	Freshwater anglers			Saltwater anglers			All anglers		
	Number (thousands)	% of U.S. population	Days of fishing (thousands)	Number (thousands)	% of U.S. population	Days of fishing (thousands)	Number (thousands)	% of U.S. population	Days of fishing (thousands)
1965	23,962	16.9	426,922	8,305	5.9	95,837	28,348	20.0	522,759
1970	29,363	18.9	592,494	9,460	6.1	113,694	33,158	21.4	706,187
1975	36,599	21.3	890,576	13,738	8.0	167,499	41,299	24.0	1,058,075
1980	35,782	19.4	788,392	11,972	6.5	164,040	41,873	22.7	952,420
1985	39,122	20.0	895,027	12,893	6.6	171,055	45,345	23.2	1,064,486

NOTE: Total participants based on people 12 years old and older. For the purposes of trend analysis the figures reported for 1965–1985 have been adjusted to permit comparison across years, as explained in appendix C of USDI Fish and Wildlife Service (1988b).

Source: USDI Fish and Wildlife Service (1988b).

Table 20.—Number and percent of the U.S. population sport fishing by assessment region (1965–1985).

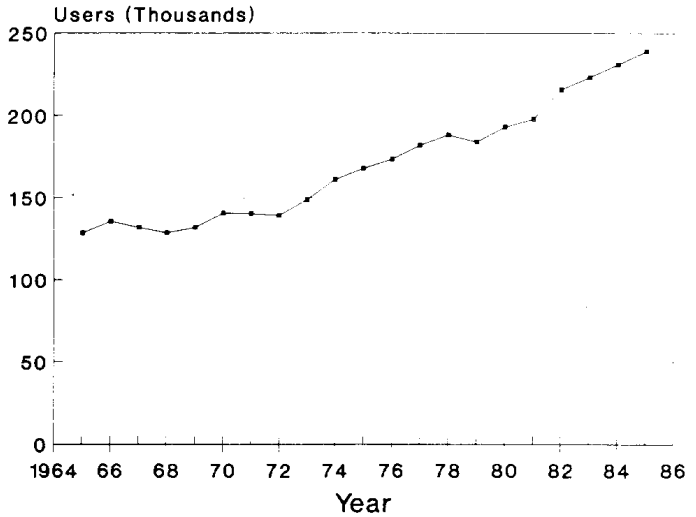
Year	North[1]		South[2]		Rocky Mountain[3]		Pacific Coast	
	Number (thousands)	% of U.S. population	Number (thousands)	% of U.S. population	Number (thousands)	% of U.S. population	Number (thousands)	% of U.S. population
1965	12,810	16.8	10,533	24.5	1,261	25.1	3,744	21.4
1970	16,212	20.2	11,599	22.8	1,769	31.3	4,030	20.0
1975	19,228	22.2	14,435	26.5	2,252	29.7	5,386	23.4
1980	18,231	20.7	15,395	25.1	2,500	27.3	5,747	21.9
1985	19,685	22.0	17,068	25.4	2,765	27.1	5,829	20.3

[1]*Includes the states of ND, SD, NE, KS and excludes MD, WV, and DE.*
[2]*Includes the states of MD, WV, and DE.*
[3]*Excludes the states of ND, SD, NE, and KS.*
NOTE: Total participants based on people 12 years old and older. For the purposes of trend analysis the figures reported for 1965–1985 have been adjusted to permit comparison across years, as explained in appendix C of USDI Fish and Wildlife Service (1988b).
Source: USDI Fish and Wildlife Service (1988b).

Wildlife Service 1988c) recommends developing a consistent and comprehensive system for collecting, storing, and retrieving recreational fisheries harvest information. Implementation of this policy would significantly improve the capability to monitor the status of the nation's fishery resource. In the absence of a consistent regional or national information base, little can be said about the amount of fish harvested by recreational anglers.

Commercial fish harvest is reported annually by the National Marine Fisheries Service. Several species or species groups of commercial fish live in the nation's lakes, streams, and estuaries and are influenced by land-management practices. The discussion that follows will emphasize these species.

Domestic harvests of salmon vary in relation to a number of complex and interacting factors including the quality of the run (determined by weather, survival, etc); subsistence fishing pressure from Native Americans; regulations on species, gear, and particular fishing grounds; and finally, pelagic harvests from foreign-flag vessels. Commercial harvest of salmon for the nation averaged approximately 300 million pounds during the late 1960's, dropped to about 200 million pounds in 1975, and increased to a high of around 730 million pounds in 1985 (fig. 32), valued at nearly $440 million.



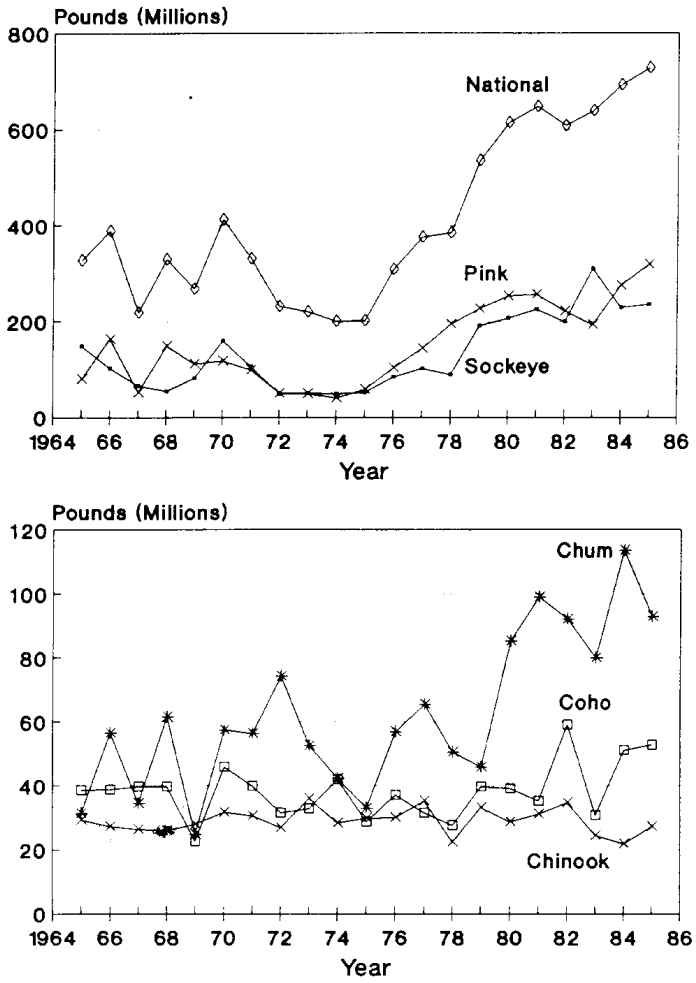
Source: USDI, Bureau of Commercial Fisheries (1967-1969); USDC, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (1971-1975, 1976a, 1976b, 1977, 1978,1979, 1980a, 1980b, 1981-1983, 1984a, 1984b, 1985-1987)

Figure 31.—National trends in numbers of commercial fishers, 1965–1985.

The 1966 harvest represented a record high for the previous 20 years indicating that recent historical trends in harvest have increased substantially. The increasing harvest was, in part, a response to escalated domestic and foreign demand. Between 1975 and 1985, domestic per capita consumption of canned salmon products doubled from 0.3 pounds to 0.6 pounds (Bunch 1985); and exports of salmon increased nearly five-fold from 71,000 pounds to 338,000 pounds (USDC National Oceanic and Atmospheric Administration, National Marine Fisheries Service 1976b, 1986). Despite increasing demands, the average value per pound since the last assessment has declined by 43% (57.7 cents/pound in 1975 to 32.8 cents/pound in 1985, in constant 1975 dollars).

The salmon harvest comes almost exclusively from the Pacific Northwest and Alaska. The national contribution of the Great Lakes commercial salmon fishery is minor, and the Atlantic salmon fishery is still recovering from a long history of overharvest and blocked access to breeding habitats by waterway projects (Stolte 1986).

The trends of individual salmon species are important because of the differences that exist in their life histories, harvest, and habitat situations. Pink and sockeye salmon are the most heavily harvested species followed by chum, and then considerably smaller amounts of chinook and coho (fig. 32). Harvests of pink, sockeye, and to a lesser extent chum, salmon have increased over the recent historical period while chinook and coho salmon have remained at a relatively stable harvest level. Poor runs of pink and sockeye salmon in the early 1970's probably resulted from severe winters in 1970–1972 and



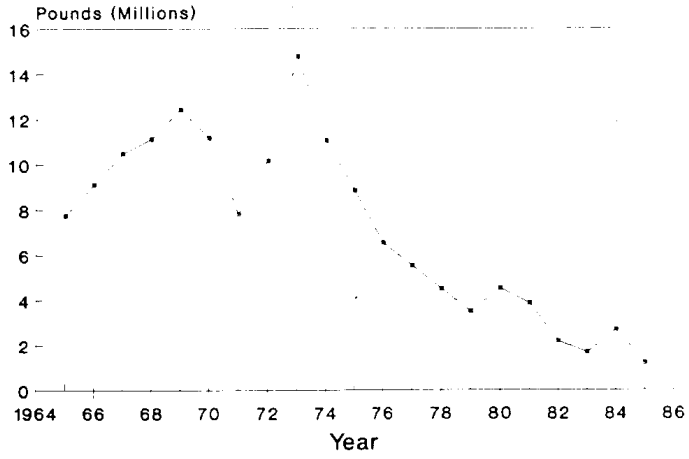
Source: USDI, Bureau of Commercial Fisheries (1967-1969); USDC, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (1971-1975, 1976a, 1976b, 1977, 1978, 1979, 1980a, 1980b, 1981-1983, 1984a 1984b, 1985-1987);

Figure 32.—Commercial harvest of salmon by species nationwide, 1965–1985.

heavy pelagic harvests; however, improved weather conditions in subsequent years improved the runs and the harvest for these species.

In addition to the salmon, steelhead trout are commercially harvested in the Pacific Northwest. The record of commercial landings of steelhead during the 1965–1977 period is one of considerable variation with the number of pounds varying between 250,000 and 700,000 from one year to the next.

The striped bass, historically a species of the North American Atlantic coast, has been transplanted to the Pacific Coast plus many freshwater lakes and streams. In its original range, overharvest, chemical contamination, declining pH levels, and dams have combined to significantly reduce population levels (Fosburgh 1985a). The commercial harvests of striped bass have dropped dramatically since the early 1970's. Attempts to institute a moratorium on commercial harvests have been unsuccessful and the commercial harvest shown in figure 33 primarily represents the remaining Atlantic Coast use.



Source: USDI, Bureau of Commercial Fisheries (1967-1969); USDC, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (1971-1975, 1976a, 1976b, 1977, 1978, 1979, 1980a, 1980b, 1981-1983, 1984a, 1984b, 1985-1987)

Figure 33.—Commercial harvest of striped bass nationwide, 1965–1985.

A large number of freshwater finfish are commercially harvested in various lakes and streams and include bullhead, catfish, yellow perch, crappie, walleye, sauger, and pike. During the late 1970's, freshwater finfish harvests fluctuated between 80 and 90 million pounds. In 1980, freshwater commercial harvests increased dramatically to about 130 million pounds, after which harvests have stabilized near 120 million pounds. The amount of freshwater finfish harvested commercially depends largely on the demand for fish which expanded in recent years with a stabilized per capita demand for red meat (Joyce in press).

Other commercial fisheries associated with large rivers and estuarine environments include the shellfish. These species are critically influenced by land and water management practices. Shellfish harvests have fluctuated around 1 billion pounds over the last 15 years (fig. 34). The total commercial crab harvest nearly doubled between 1971 and 1980, falling back to earlier levels by 1985. Blue crabs were at their lowest harvest levels in the late 1960's and early 1970's but increased during the mid-1980's. The higher harvest of shellfish in the late 1970's and early 1980's was primarily the result of increases in the shrimp harvest. Blue, snow, and king crabs were largely responsible for the increase in crab harvests observed in the late 1970's.

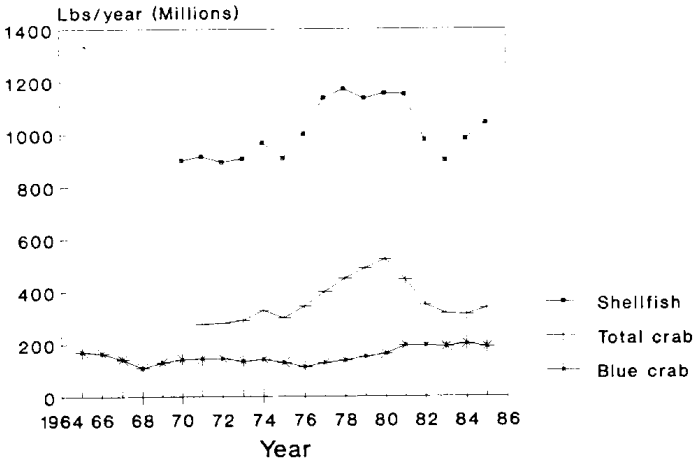
Threatened and Endangered Species

Individual species are a tentative signature on the genetic composition of the earth. Over the last 20 years, however, the rate at which species are now being lost has generated much concern. In a review of global extinctions, Flesness (1986) conservatively estimated a six-fold increase (0.124 species/year to 0.767 species/year) in the vertebrate species extinction rate occurred in the periods 1600–1825 and 1826–1975.

Since the turn of the century, a determined effort has been made to reduce the impact that man has on the rate of animal species extinctions. Early treaties between the United States and other nations such as Canada, Mexico, England, and Russia attempted to reduce excessive exploitation of animal populations. However, not until 1966, under the Endangered Species Preservation Act, did the United States adopt legislation specifically addressing the protection of endangered species. New legislation that improved on the identified flaws in the earlier statute was enacted in 1969 (the Endangered Species Conservation Act) and in 1973 (the Endangered Species Act), the latter being amended in 1978, 1982, and 1988. Two status categories are recognized: *endangered*, which covers species in danger of extinction throughout all or significant parts of their ranges; and *threatened*, which includes species likely to become endangered within the foreseeable future throughout all or significant parts of their ranges.

Many states have comparable endangered species programs directed at preserving species within state boundaries. Under current federal legislation, state programs are eligible for federal matching dollars of up to 75% of program costs. This series of federal and state laws established the requirement for all federal and participating state agencies to conserve endangered wildlife and fish through restrictions on activities that jeopardize continued existence, or the implementation of management programs that are directed ultimately at population restoration.

Number and distribution.—The number of species officially considered threatened and endangered is monitored by the Fish and Wildlife Service and reported monthly in the Endangered Species Technical Bulletin. Since the last national assessment of wildlife and fish, the number of listed species has increased in every animal class (table 21). Interpretation of this increase is difficult since there is a continual process of adding and deleting species from the list. New information regarding the status of listed and unlisted species is continually being evaluated. While more listed species may mean more species have become endangered, it may also mean evaluation has been completed for candidate species. Currently, the Fish and Wildlife Service has sufficient information to initiate formal listing procedures for approximately 1,000 candidate plant and animal species (Bean 1986).



Source: USDI, Bureau of Commercial Fisheries (1967-1969); USDC, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (1971-1975, 1976a, 1976b, 1977, 1978, 1979, 1980a, 1980b, 1981-1983, 1984a, 1984b, 1985-1987)

Figure 34.—Commercial harvest of shellfish nationwide, 1965-1985.

Table 21.—Number of threatened and endangered animal species.

Category	Endangered 1988	Threatened 1988	Total 1988	Total 1980
Mammals	50	7	57	25
Birds	76	10	86	70
Reptiles	15	18	33	18
Amphibians	5	4	9	7
Fish	47	30	77	41
Invertebrates	55	13	68	39
Total	248	82	330	200

Source: USDA Forest Service (1981); USDI Fish and Wildlife Service (1988a).

Although the number of species listed and the rate with which listing has taken place is difficult to interpret from an ecological standpoint, the distribution of these species by county is valuable for interpreting how threatened and endangered species relate to the major biomes of the United States (fig. 35). Areas with major modification of natural environments have greater concentrations of threatened and endangered species, such as in the sun belt and coastal counties. Also, areas with sensitive desert environments have high numbers of threatened and endangered species. This is explained, in part, by the number of animals that live within refugia (primarily unique aquatic habitats) in otherwise harsh environments.

By definition, the populations of threatened and endangered species are low; however, very little information on the population levels of most endangered species exists. For this reason, we chose to consider the status of endangered species in two categories: those that are recovering, and those that have not improved since they were listed. Examples of species that have been recovering include the American alligator, peregrine falcon, southern sea otter, and Puerto Rican parrot; species such as the California condor, black-footed ferret, and the red-cockaded woodpecker have not been increasing.

Recovering species.—The fact that there have been few complete recoveries is not surprising given the short existence of protective legislation. However, even in the 20-year period of endangered species legislation some species have responded favorably to protection. The American alligator was in danger primarily because of overharvesting. Since its listing, the alligator has recovered sufficiently to be removed from the federal threatened and endangered list (USDI Fish and Wildlife Service 1987b), and in many areas, strictly regulated annual harvests for economic purposes continue to increase.