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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

**Curtis H. Flather
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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.

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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

Curtis H. Flather and Thomas W. Hoekstra

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).

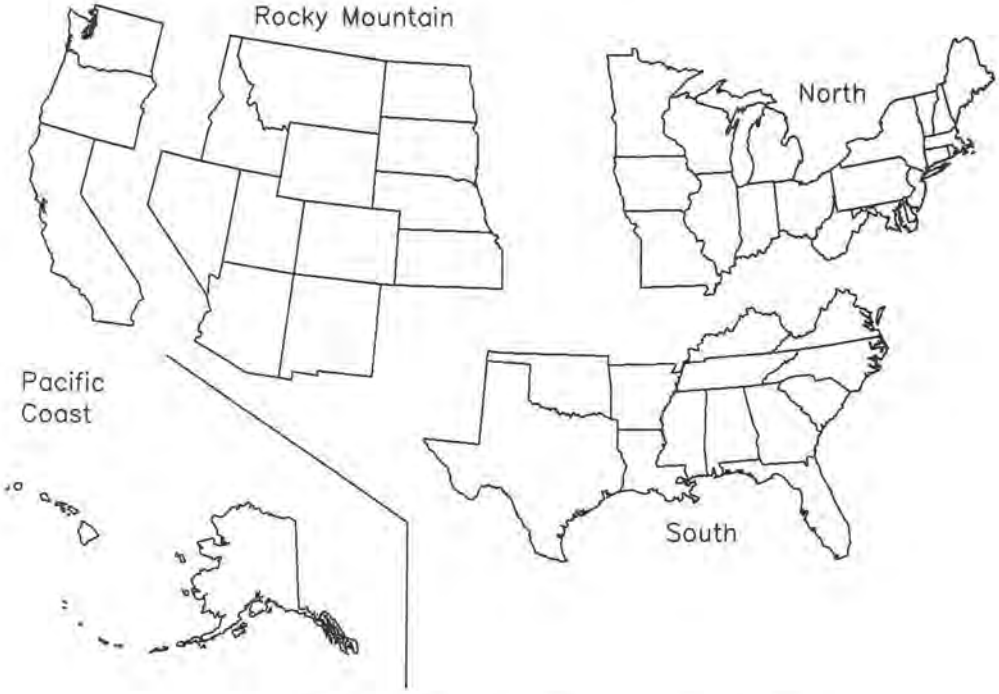


Figure 1.—Forest Service assessment regions.

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.

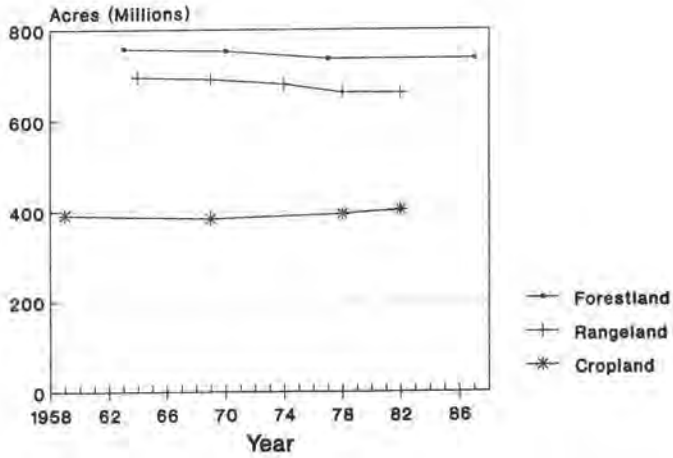
The majority of the forestland acres recently lost occurred in the eastern half of the country, particularly in the South where forest has declined by 20 million acres over the last decade (table 1). This was expected because of the higher population and economic activity in the East (USDA Forest Service 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 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).



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).

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).

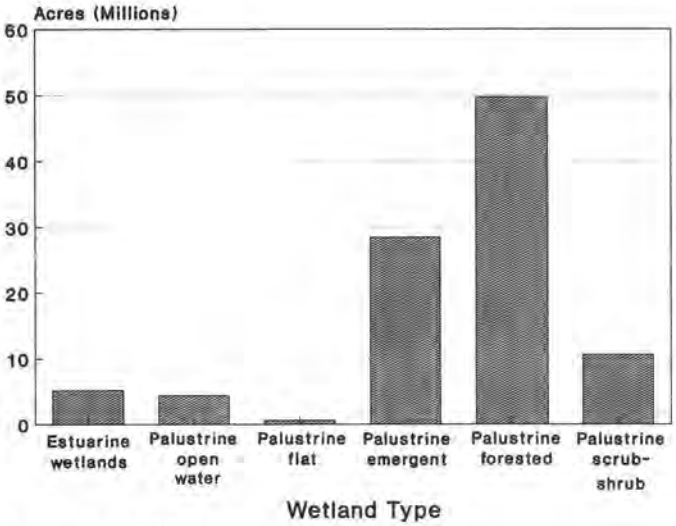
The ecological, economic, and recreational values of this habitat type cannot be overemphasized. Wetland systems are critical to flood and erosion control, recharging aquifers, and water purification. They are among the most productive ecological systems (Weller 1986). This inherent productivity supports 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).

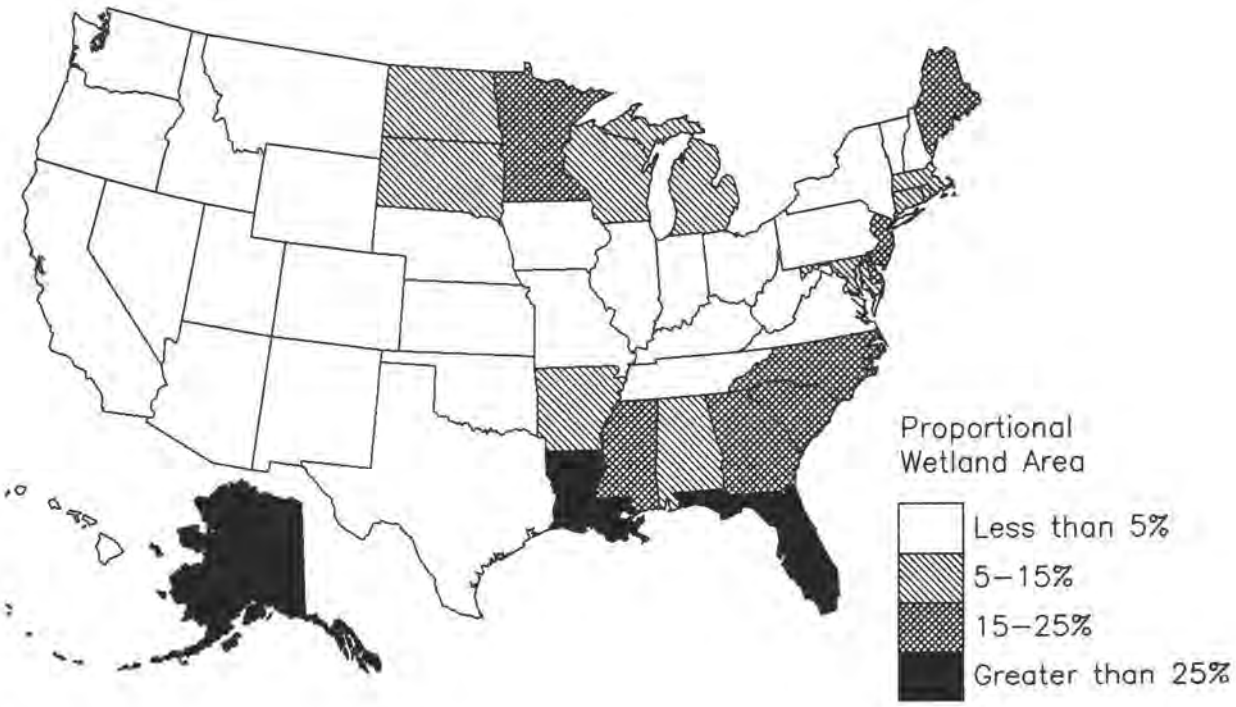
Noted loss rates at the national level are magnified when examined at the regional or state level. Recently published statistics on the amount of wetland habitat lost show that declines ranged from 99% for Iowa natural marshes to 32% for Wisconsin wetlands (Tiner 1984).

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).

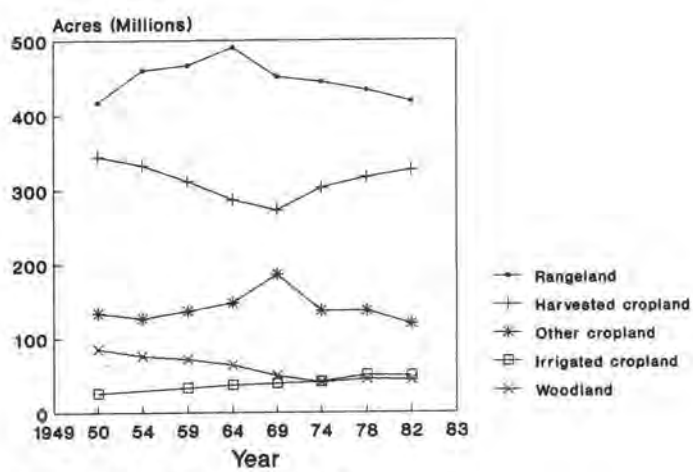
Collectively, these changes in farming technique and practices have encouraged the elimination of wildlife and fish habitat. The removal of hedgerows, field border strips, wetlands, and woodlots to maximize crop production has reduced the amount of vertical and horizontal habitat diversity and with it 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).



Source: USDC, Bureau of Census (1984a)

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.

	Assessment region where status is of concern				Primary reason for listing		
Species	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.

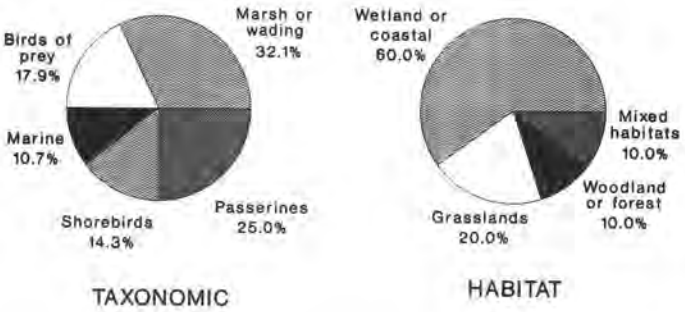
One additional characteristic associated with habitat loss is that over half (57%) of the species listed are Neotropical migrants. Not only is there concern for the loss of wetlands and deforestation in the tropics, but other factors including unregulated hunting, pesticide use, and pollution probably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

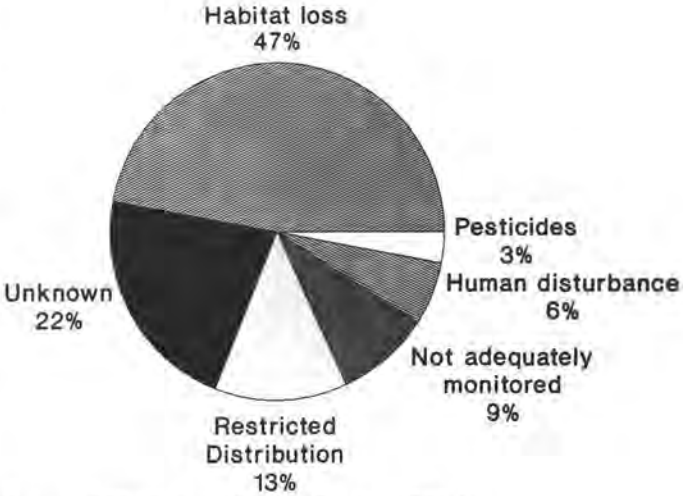
Nonconsumptive recreational use.—Nonconsumptive uses of wildlife and fish resources has been defined as those activities that do not result in the death or attempted death of an individual animal (More 1979). This definition is necessarily broad to accomodate nonconsumptive uses of both game and nongame. 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.

	Total nonconsumptive users		Primary						Secondary					
			Total		Nonresidential		Residential		Total		Nonresidential		Residential	
Year	# 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.

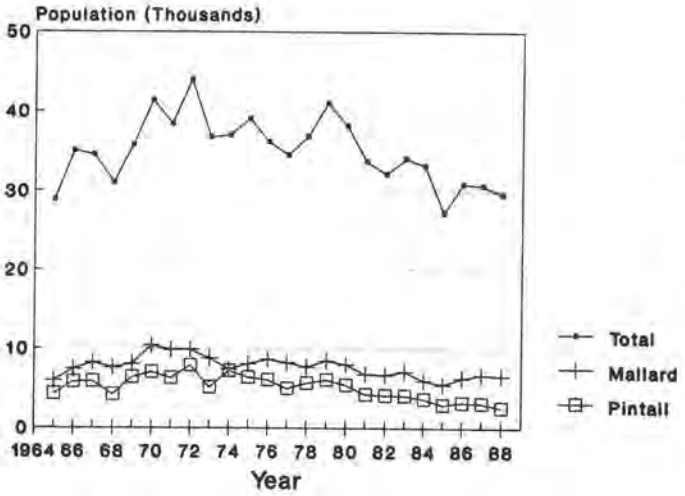
The regional trends in nonconsumptive wildlife-related recreation are generally consistent with the national trends (table 13). The Fish and Wildlife Service uses human census regions to describe regional use patterns. These regions can be aggregated to approximate the assessment region boundaries used 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.

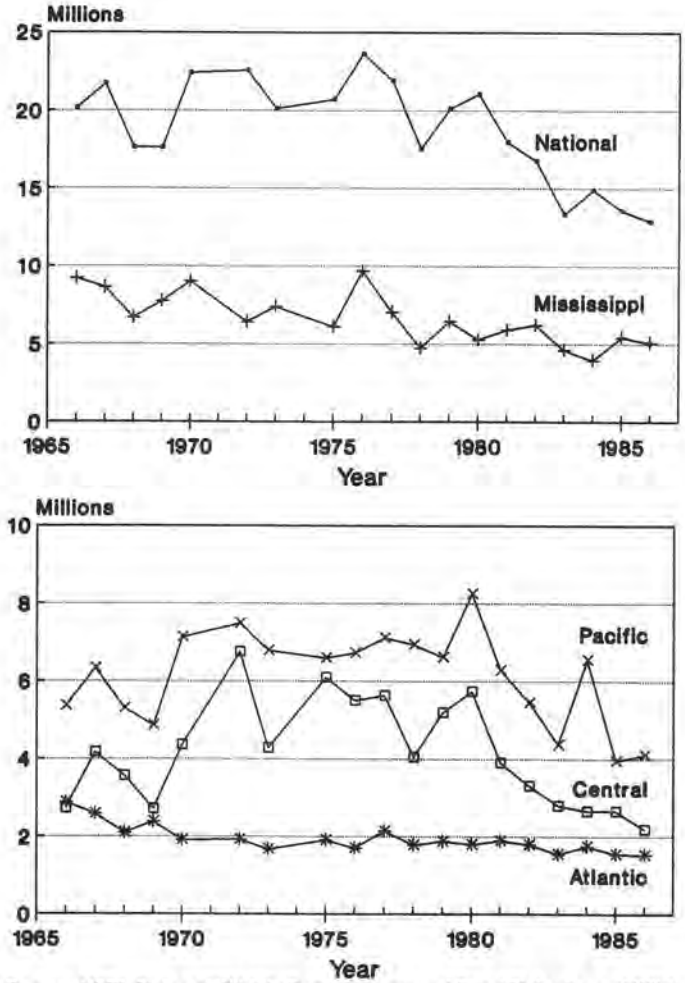
of ducks, the mallard and northern pintail, also have shown significant historical declines (fig 8). The decline has continued as the 1988 breeding populations were 20% and 54% below the 1955–1987 average, respectively. Other species that have also declined over this time period include the blue-winged 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.

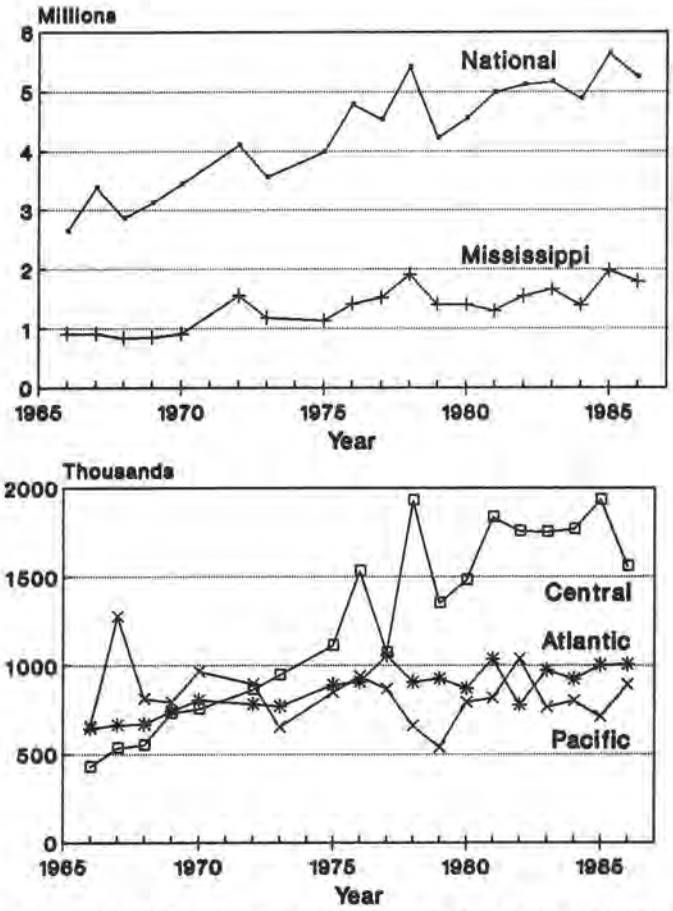
Populations of ducks found in winter flyway surveys are the product of several factors. The process begins with the number of breeding birds that flew north the previous spring, the weather during breeding, suitability of the breeding habitat, breeding success, and losses from natural and hunting mortality 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).

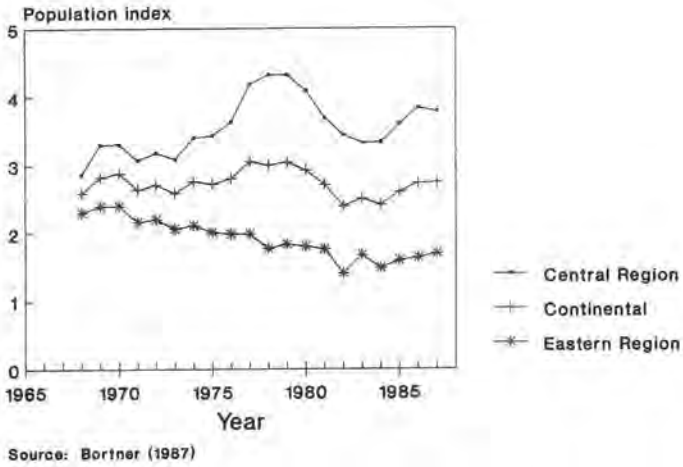


Figure 12.—Woodcock breeding population indices (singing males per route) by management region.

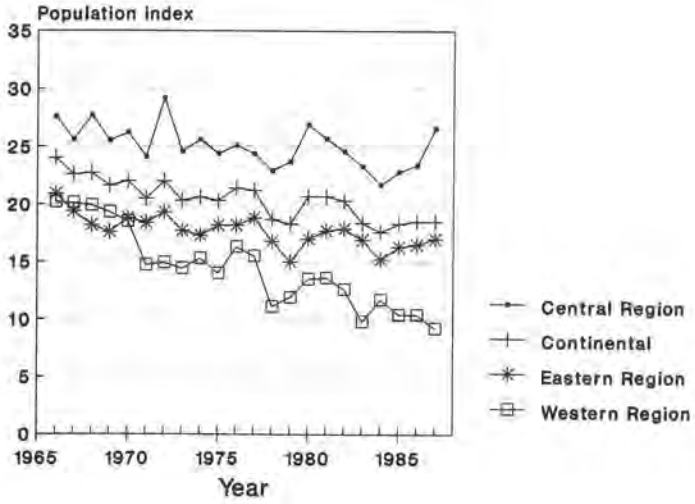
Mourning dove.—With populations estimated at about 500 million, the mourning dove is one of the most abundant birds in North America (Dolton 1986, USDI Fish and Wildlife Service 1987a). The Fish and Wildlife Service surveys breeding dove populations throughout three management regions of the nation with 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).

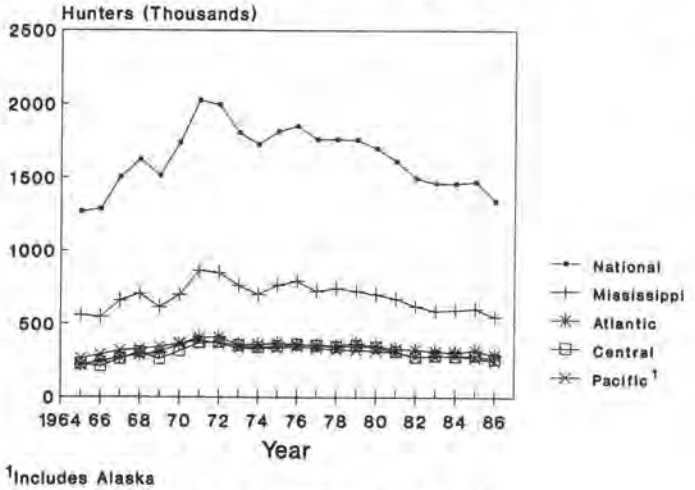
Migratory game bird hunters.—Hunting activity associated with migratory game birds is influenced by hunting regulations that combine ducks and geese on one licence, and the webless migratory game birds (doves, woodcock, snipe, and other shorebirds) on another.

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: Eastern management region (7 states)	Woodcock: Central management region (7 states)	Mourning Dove: Eastern management region (12 states)	Mourning Dove: 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).

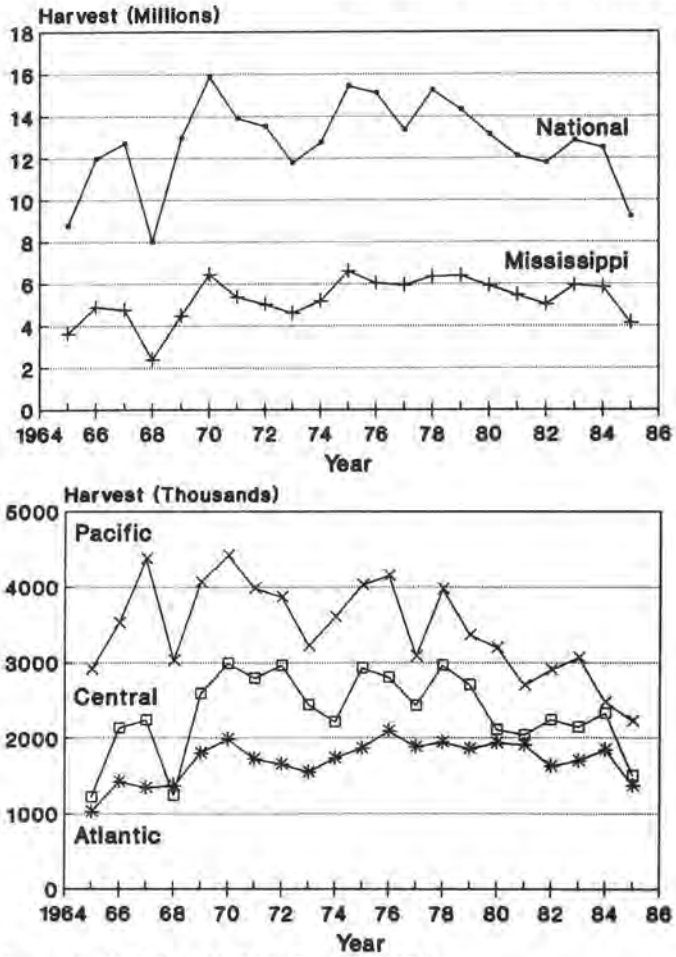
the Eastern region with the Central region being represented by four states. The trend in number of hunters pursuing mourning dove for the period 1980–1986 was stable in the East (table 14). The trend for four states in the southeastern part of the Central region increased during the period 1981–1984, 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.

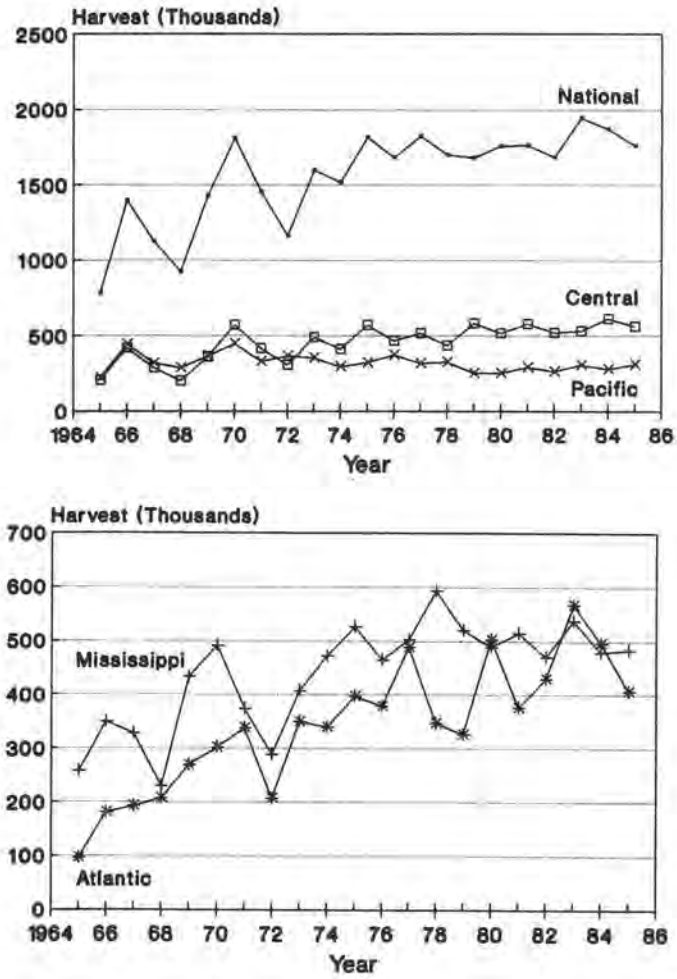
Duck harvests by flyway show little deviation from the noted national trends. Since the early 1970's, the Atlantic and Mississippi flyways have shown generally stable duck harvests, Central flyway harvests have fluctuated, and the Pacific flyway has shown a downward harvest trend. The Atlantic flyway 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



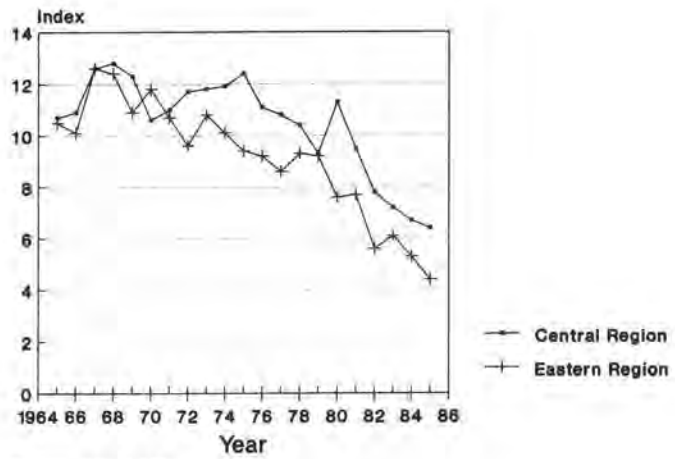
Source: USDI, Fish and Wildlife Service (1987a)

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.

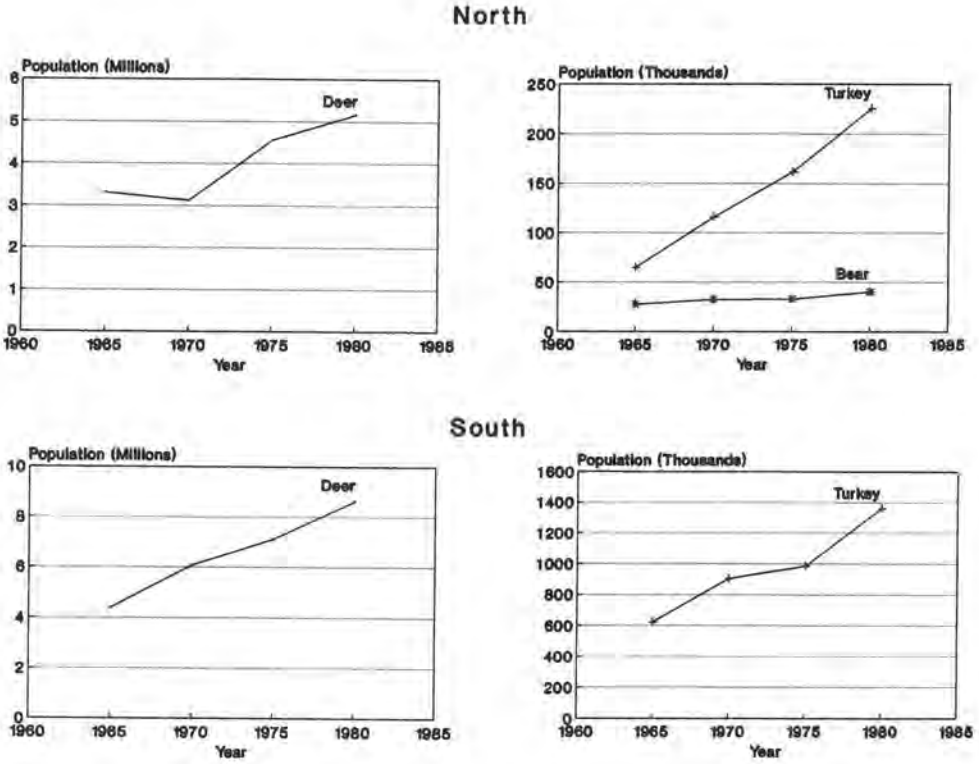
North.—The big game species in the Northern region include white-tailed deer, black bear, and wild turkey. White-tailed deer is by far the most abundant. Of the 20 states comprising the region, 19 reported trend information since 1965. Eighty percent of the states reported increased deer populations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

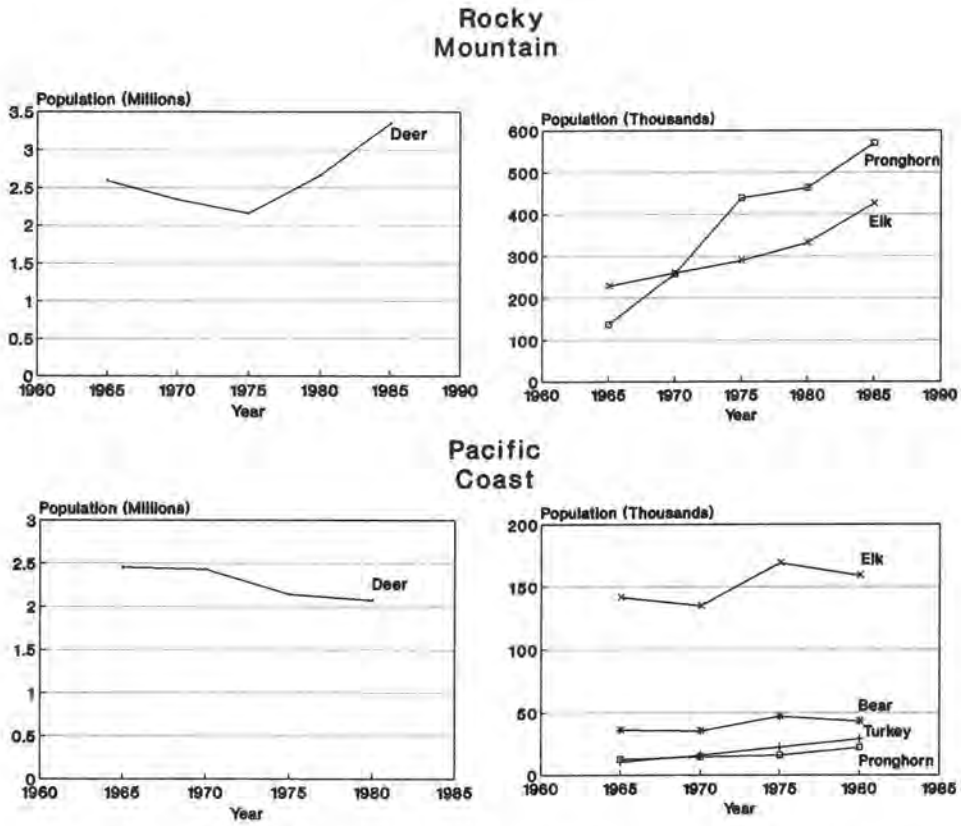
1.4 million turkeys, levels 29 and 47 times the national population estimates for these species in the early 1900's, respectively. The recovery of these populations since the turn of the century has continued over the last 20 years. Deer populations have increased 96% (70,000 animals/ year), while turkeys 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



Source: Data supplied from state fish and wildlife agencies

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.

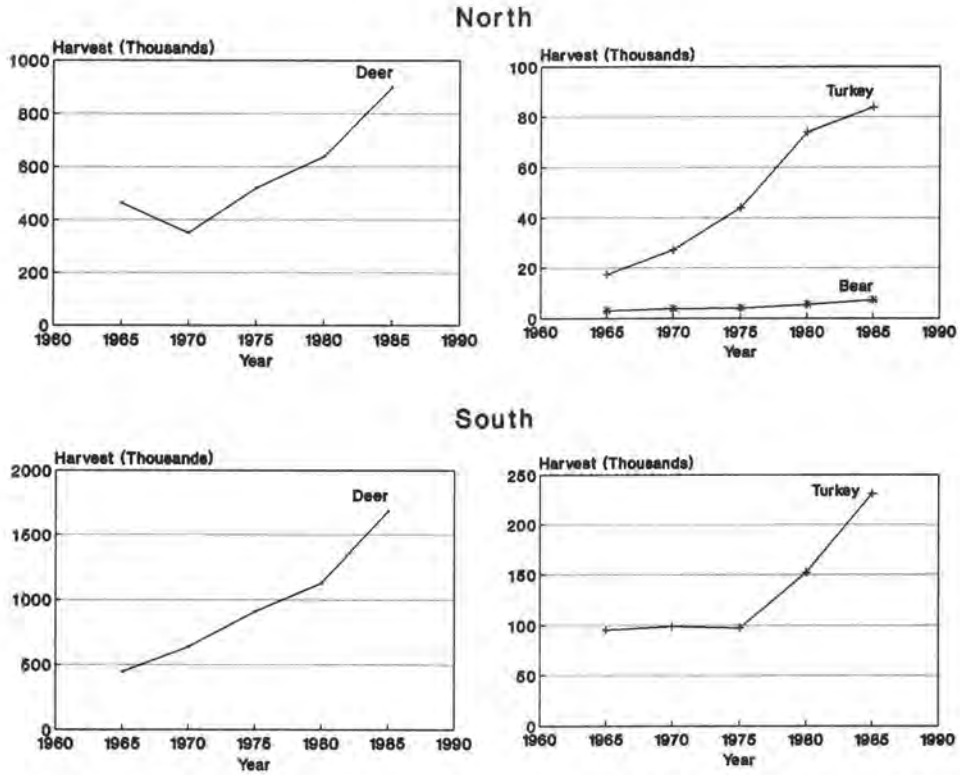
Big game harvest.—One of the major tools available to states for managing big game species is harvest regulation. This is particularly true where natural predators of big game are no longer present and some form of removal helps balance animal numbers with habitat resources. Much of the research recently 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.

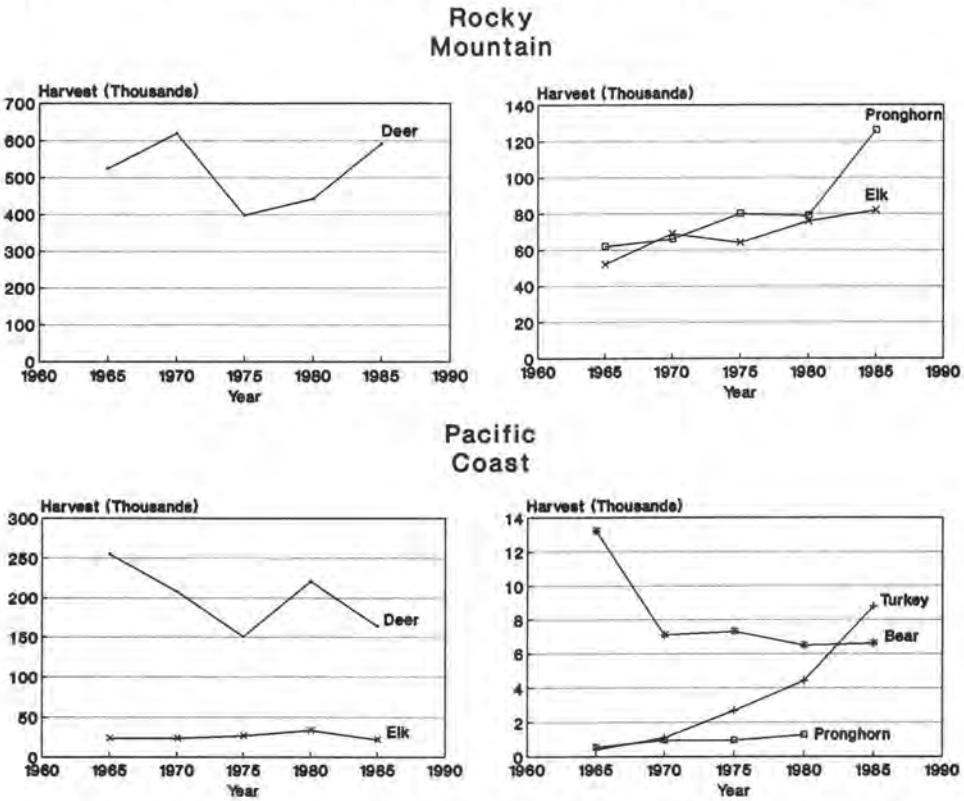
Rocky Mountain.—Big game harvest trend data were available from all states in the Rocky Mountain region. Elk and pronghorn harvests have increased by 58% and 104%, respectively, over the last two decades (fig. 21). Elk harvest increases appear to be consistent across reporting states. Conversely, pronghorn 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).

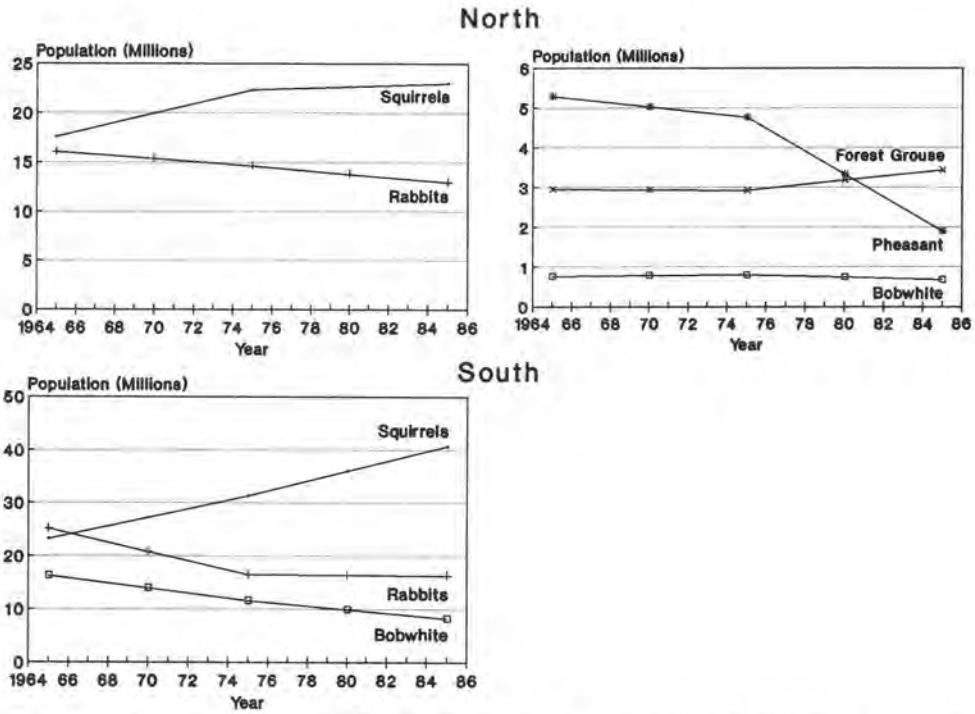
In contrast to the small game species associated with agricultural and shrubland habitats, squirrel populations have increased by over 30% in the forested Northeast, yet have declined slightly in the more agricultural Midwest. These trends follow the changes in land-use patterns—small farm woodlots are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

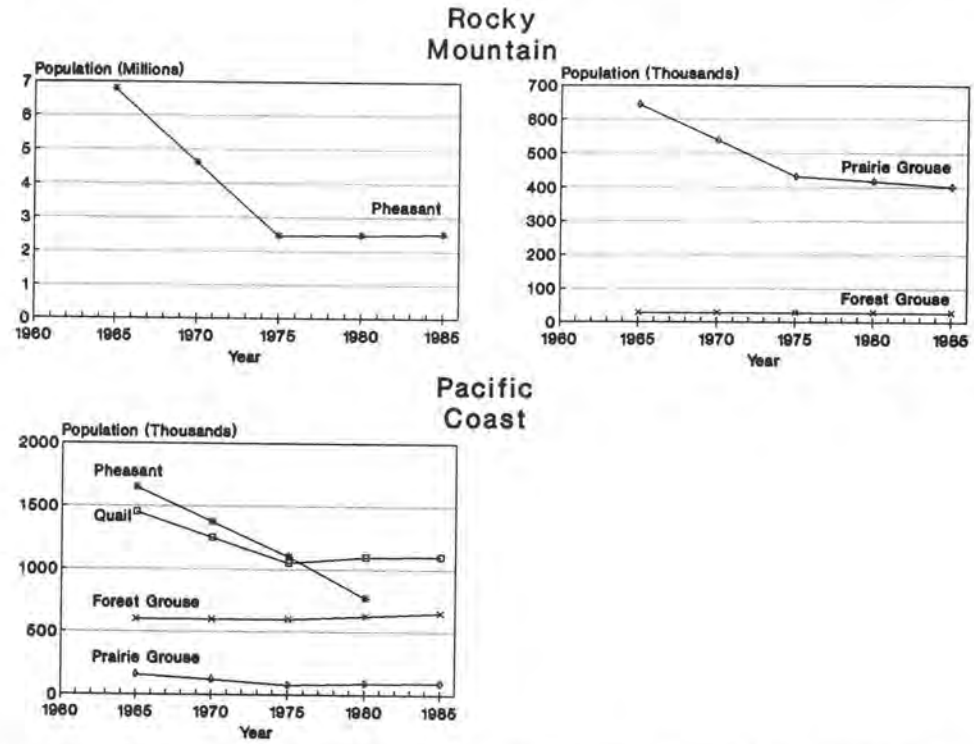
Grouse populations have varied by species. Composite population trends for prairie grouse species have shown consistent declines over the recent historical period, while forest grouse species have shown relatively



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.

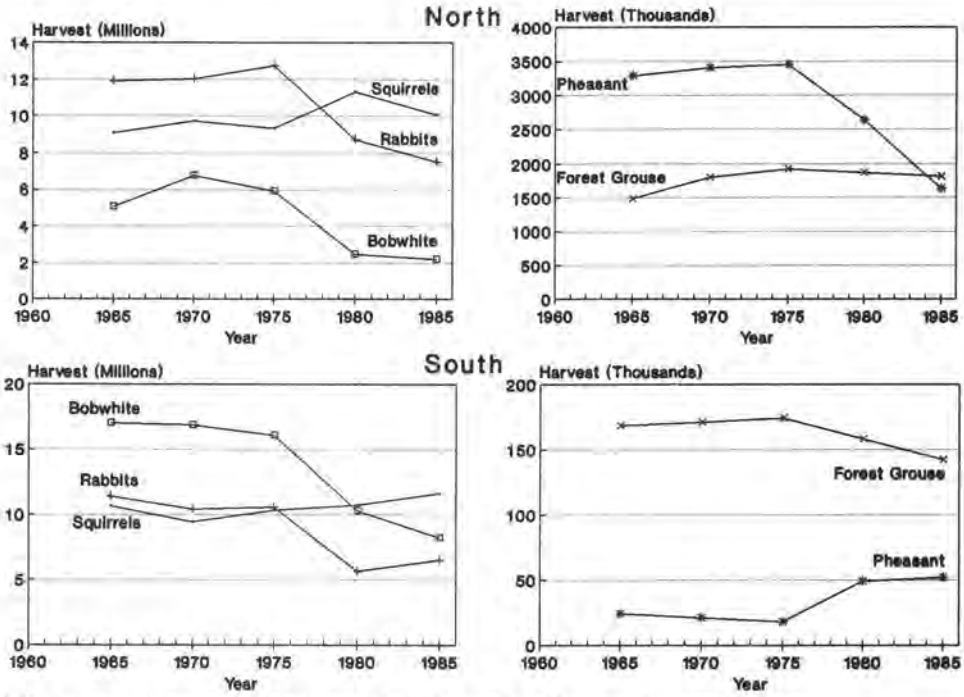
Table 16.—National and regional participation trends in small game hunting.[1]

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.

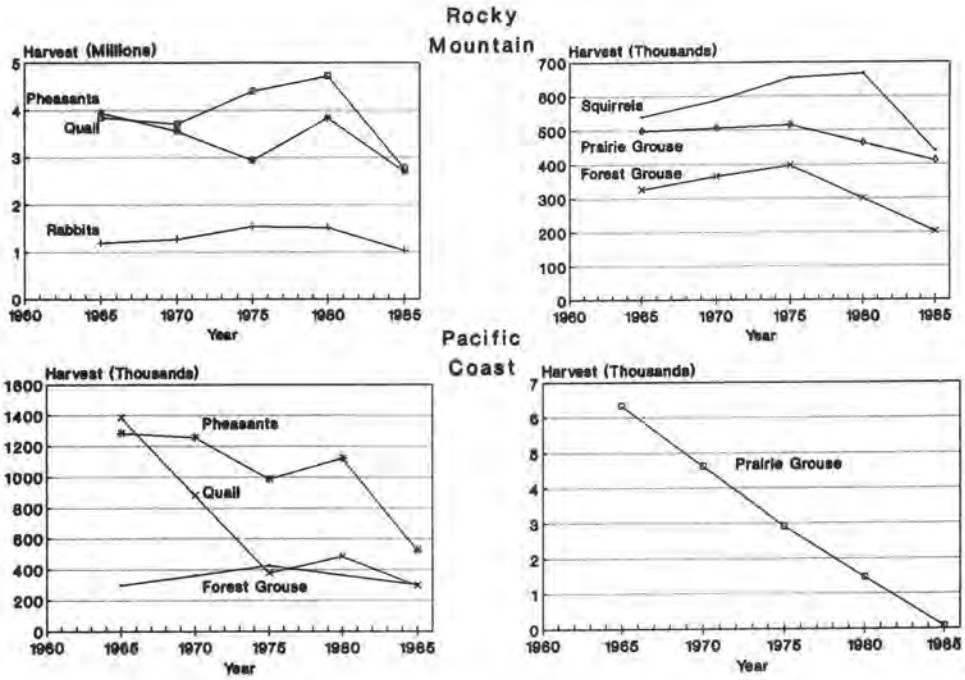
Rocky Mountain.—In general, small game harvests in the Rocky Mountain region have shown a convex pattern—increases through the mid-1970's and early 1980's followed by declines (fig. 25). Quail-harvest gains through 1980 have recently been lost. More recent harvests have dropped well below levels observed 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

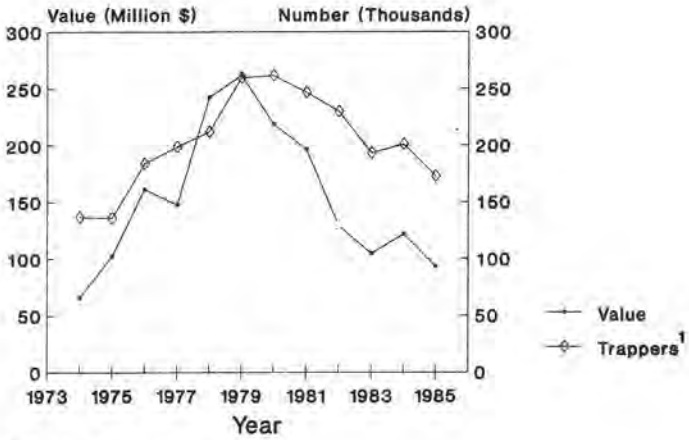
and mink were the fourth and fifth most valuable species in 1985, behind raccoon, muskrat, and beaver (Linscombe 1988). Recent trends for fox and mink are less favorable than for the more commonly harvested furbearers. Sisson-Lopez (1979) found evidence that both species had declining trends in some 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).

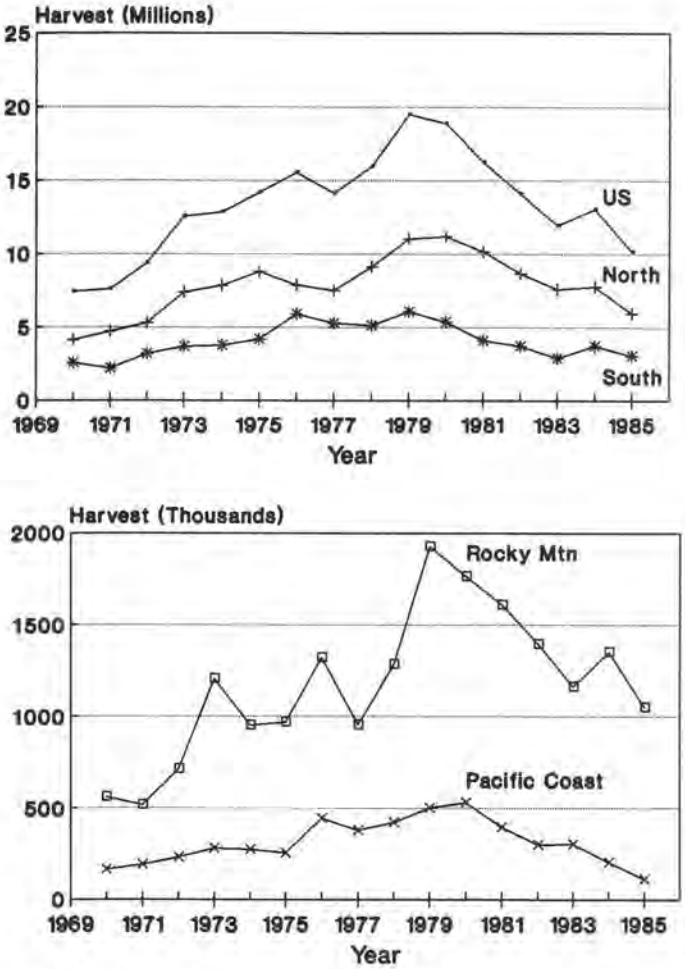
Furbearer Harvest.—Data on furbearer harvest trends are more complete than data on population levels or number of trappers. National harvest trends since 1970 correspond to the expected pattern given the value and trapper trends reviewed above. Number of furbearers harvested showed nearly a three-fold 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.

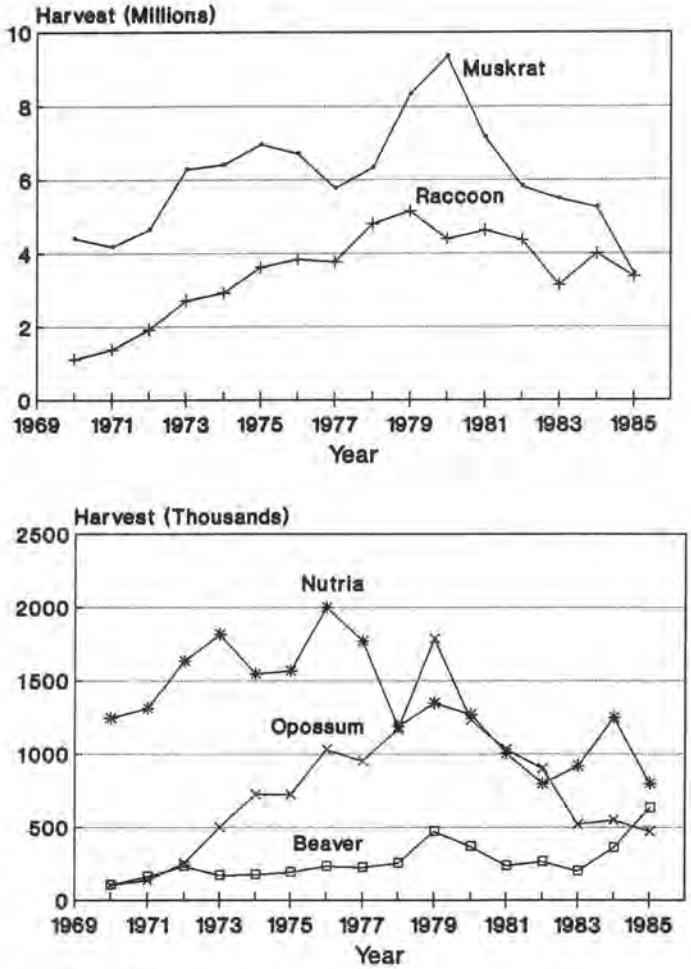
Fish

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).

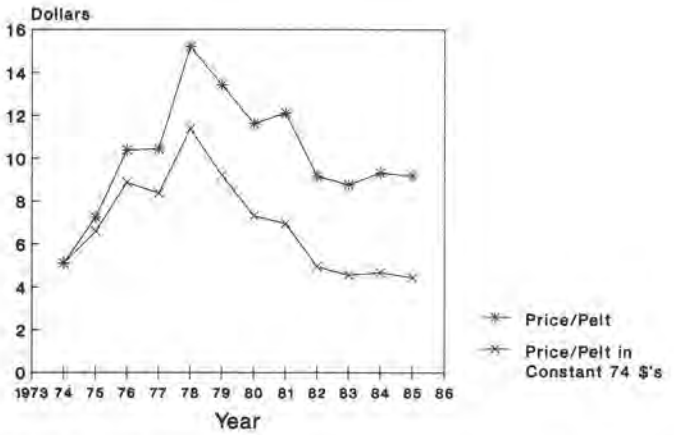
National Oceanic and Atmospheric Administration, National Marine Fisheries Service 1987). In addition, the Fish and Wildlife Service (1988b) found that more than one out of every four persons in the United States fished in 1985.

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 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

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

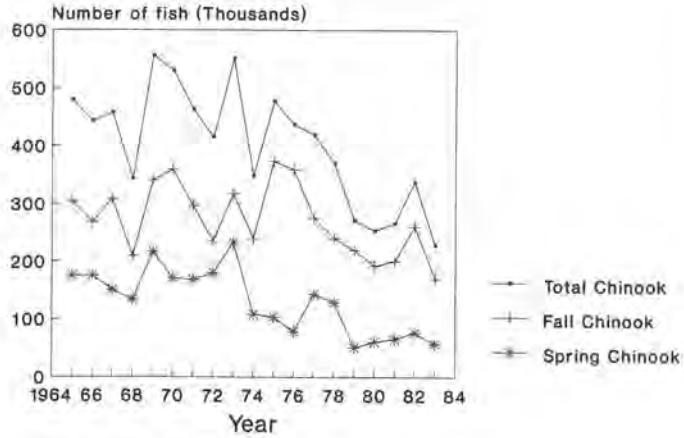
Species	Stream miles where species occurred	Percentage of total stream miles
Sport fish species		
Largemouth bass	263,859	27.3
Rainbow trout	213,461	22.1
Bluegill	188,495	19.5
Channel catfish	148,343	15.4
Smallmouth bass	142,142	14.7
Green sunfish	126,074	13.1
Brook trout	103,507	10.7
Black crappie	98,190	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).



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).

	Freshwater anglers			Saltwater anglers			All anglers		
Year	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).

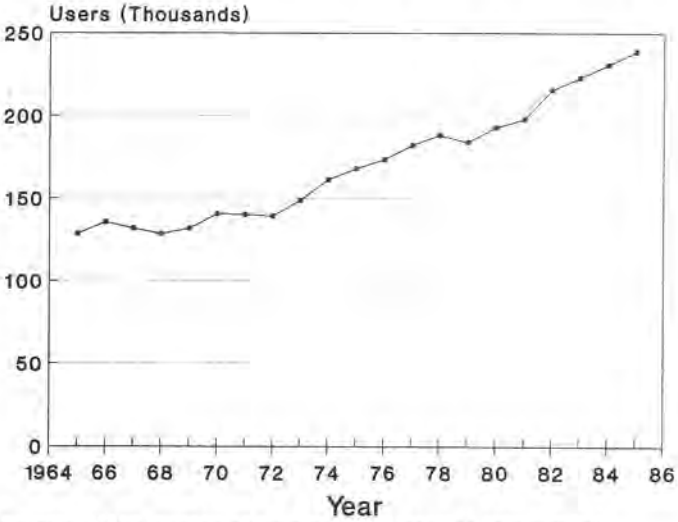
Year	North[1]		South[2]		Rocky Mountain[3]		Pacific Coast	
	Number (thousands)	% of U.S. population	Number (thousands)	% of U.S. population	Number (thousands)	% of U.S. population	Number (thousands)	% of U.S. population
1965	12,810	16.8	10,533	24.5	1,261	25.1	3,744	21.4
1970	16,212	20.2	11,599	22.8	1,769	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.



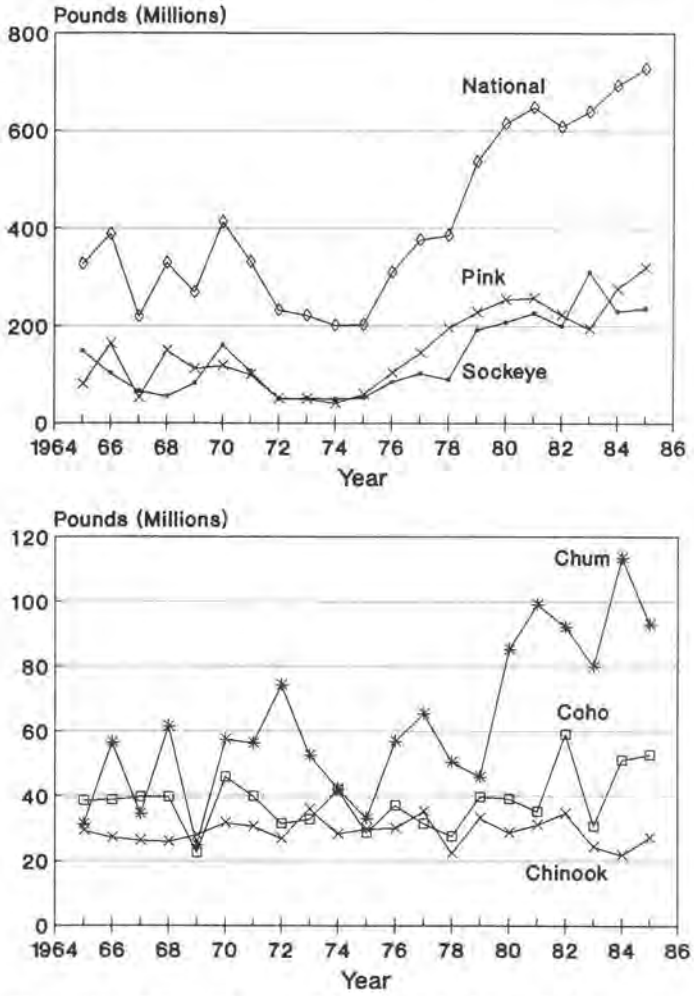
Source: USDI, Bureau of Commercial Fisheries (1967-1969); USDC, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (1971-1975, 1976a, 1976b, 1977, 1978,1979, 1980a, 1980b, 1981-1983, 1984a, 1984b, 1985-1987)

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



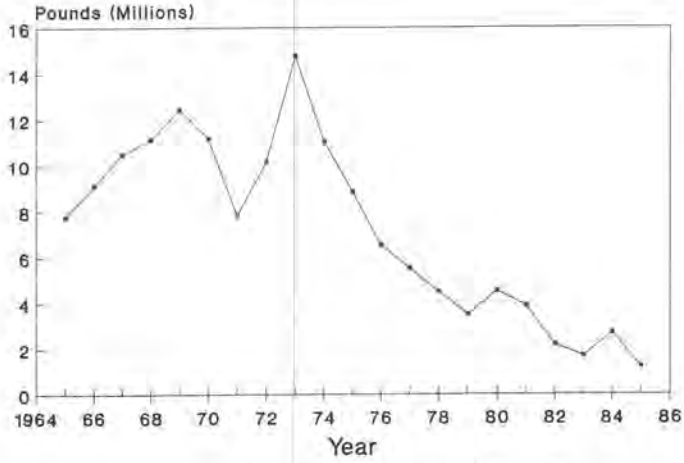
Source: USDI, Bureau of Commercial Fisheries (1967-1969); USDC, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (1971-1975, 1976a, 1976b, 1977, 1978, 1979, 1980a, 1980b, 1981-1983, 1984a 1984b, 1985-1987);

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.

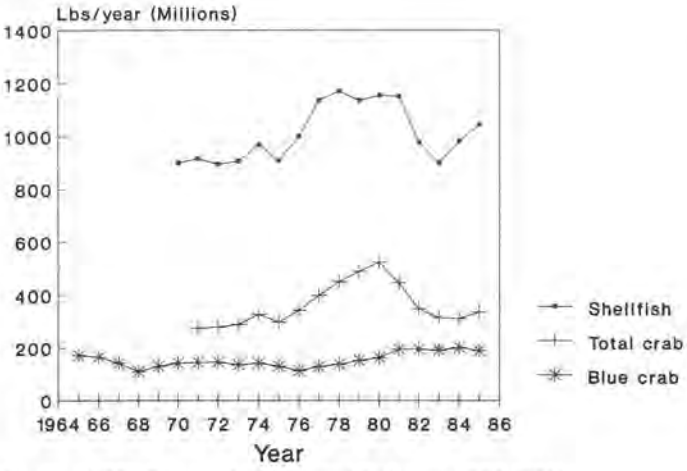
Threatened and Endangered Species

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.

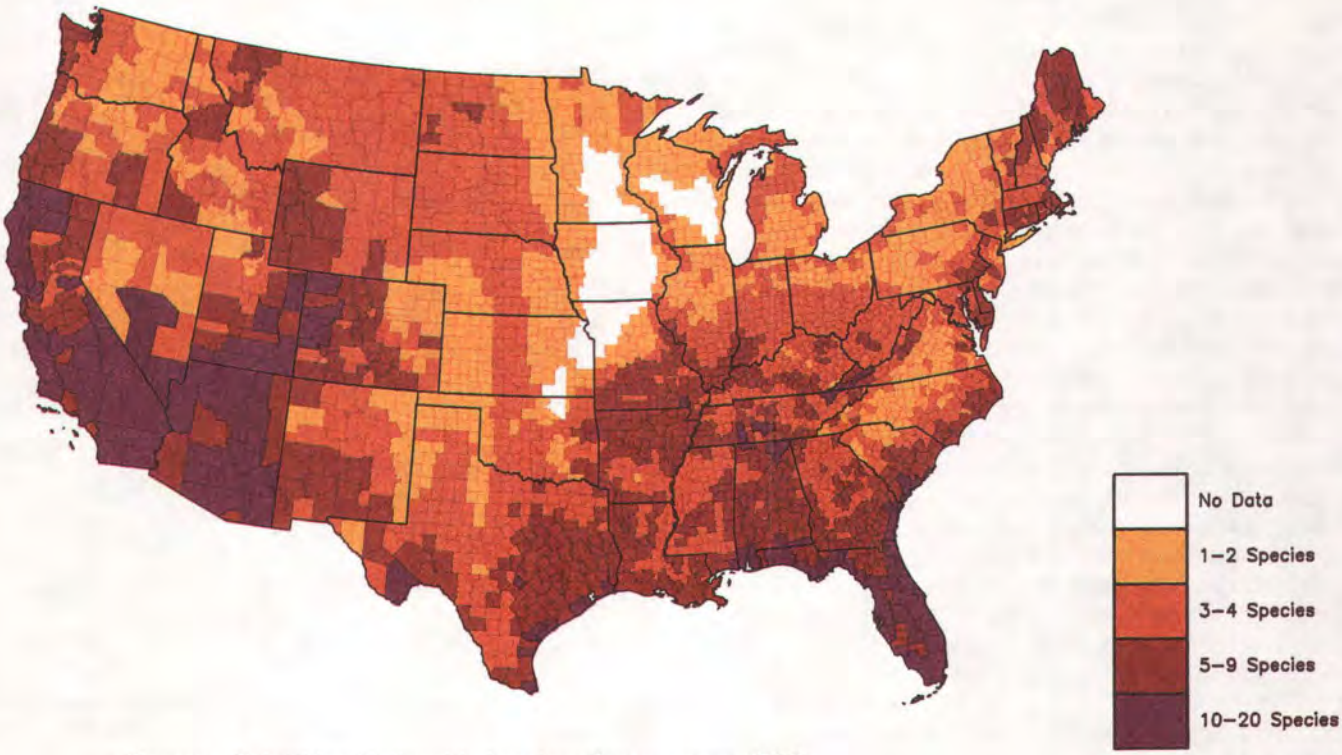
Category	Endangered 1988	Threatened 1988	Total 1988	Total 1980
Mammals	50	7	57	25
Birds	76	10	86	70
Reptiles	15	18	33	18
Amphibians	5	4	9	7
Fish	47	30	77	41
Invertebrates	55	13	68	39
Total	248	82	330	200

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.



Source: Oak Ridge National Laboratory (pers. comm. 1981)

Figure 35.—Distribution of federal threatened and endangered species by counties in the United States.

The peregrine falcon was placed on the threatened and endangered list because organochlorine pesticides inhibited its reproductive success. The pesticides caused thin egg shells which broke during incubation or, in dry climates, allowed embryos to desiccate before hatching. The banning of pesticides such as DDT in conjunction with a captive breeding program was instrumental in recovery success. The tundra peregrine has recovered to the point where it was "downlisted" to threatened status in 1983 (USDI Fish and Wildlife Service 1983). Despite such success, however, the peregrine will probably remain on the threatened and endangered list until organochlorine pesticides are completely eliminated from the peregrine's range, including Latin America (Craig 1986).

The southern sea otter, like the alligator, was an overexploited species. Protection afforded the species by its listing as endangered increased the probability of successful reintroduction aimed at establishing viable populations along the coasts of California and Oregon (USDI Fish and Wildlife Service 1986a). Implementation of several important recovery tasks has given researchers reason to believe that annual population increases on the order of 4% to 5% can be expected (Ladd and Riedman 1987).

The Puerto Rican parrot was listed because of habitat reductions and exploitation of the bird as a pet (MacPherson 1987). Listing has controlled exploitation and provided the impetus for habitat improvements needed for the species to attain viability. From a low of 13 individuals in 1975, the population has grown to 41 individuals today (MacPherson 1987).

Declining species.—The California condor has frustrated the attempts of those involved in its recovery because of habitat degradation and low breeding potential. The condor population has declined in spite of breeding programs and research efforts to learn more about the bird's habitat requirements. As of 1984, only 15 birds were known to exist in the wild (Bean 1986), and in a final effort to retain what little genetic variability existed, all known individuals were captured and placed in a captive breeding program.

The black-footed ferret was listed largely because of its low population resulting from habitat degradation including a declining prey base (prairie dogs). The secretive habits of the species, low population, and failures associated with captive breeding have disappointed researchers trying to assist the species' recovery. The dramatic reduction of a recently located breeding population in Wyoming from 128 to 16 individuals caused by an outbreak of distemper (Williams et al. 1988), emphasized the vulnerability of isolated populations.

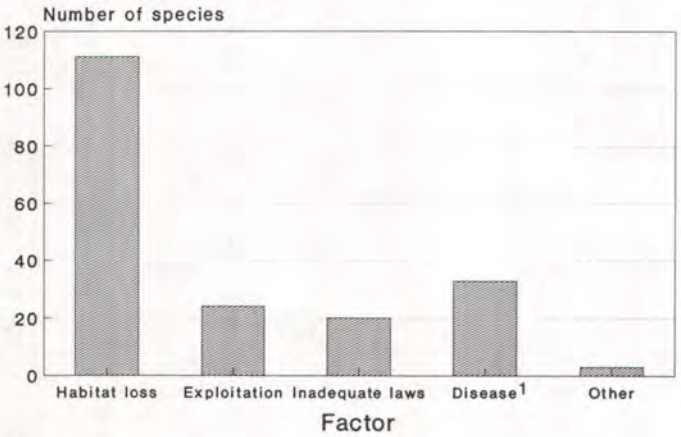
The red-cockaded woodpecker is on the threatened and endangered species list primarily because its habitat has been deteriorating through loss of older loblolly/shortleaf and longleaf/slash pine forests under which fires frequently burn to reduce the hardwood understory (Lennartz and McClure 1979). The woodpecker continues to decline because the amount of habitat that meets its specialized habitat requirements continues to

decline. No known subpopulation of red-cockaded woodpeckers is increasing or stable, and its long-term survival seems heavily dependent on public land ownerships (Jackson 1987).

Relationship between population declines and land types.—Early on, scientists concerned about threatened and endangered species identified the major factors contributing to species endangerment. A consistent factor for many species was man-induced loss or degradation of habitat. Other major causes include disease, excessive harvest, and inadequate protection from human disturbance. Figure 36 indicates the relative importance of the factors contributing to animal species becoming threatened or endangered based on data in the Fish and Wildlife Service's Endangered Species Information System (USDI Fish and Wildlife Service 1987c).

An attempt to compare threatened and endangered species with habitat yields figure 37. Though such a chart may help a person visualize how species status relates to habitat status (as described in earlier sections), interpretation must be done with caution. Simple associations do not convey full natural history or ecological processes. The utility of this information, like so much of the material presented in this assessment, is to provide a broad perspective for organizing policies and management decisions rather than for recommending specific land management actions. Understanding these constraints should assist in obtaining useful insight from figure 37.

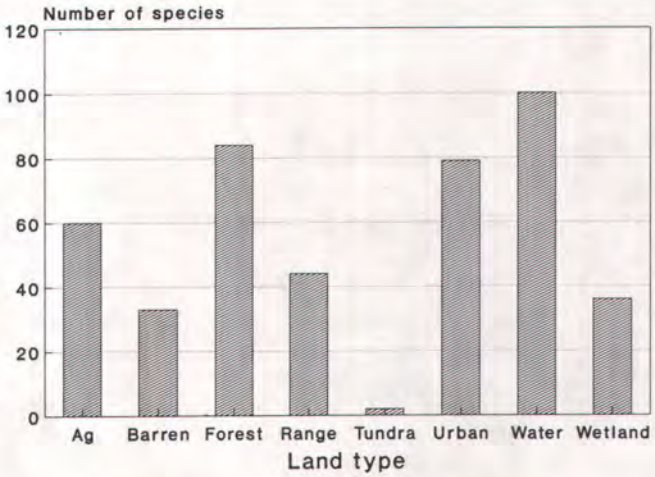
For example, a high number of threatened or endangered species associate with urbanland, primarily because urbanland uses superimpose other land types and represent a drastic modification of the original habitats. For some species, urbanland represent a significant mortality factor attributable to the nation's extensive transportation network. But many threatened and endangered species are also associated with agricultural land types which have disturbed and fragmented forest and range ecosystems.



[1]Includes predation
NOTE.--Based on 116 animal species

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

Figure 36.—Factors contributing to animal species being threatened or endangered.



NOTE.--Based on 116 animal species. Number of species across land types do not sum to 116 because species are represented in more than one land type

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

Figure 37.—Number of threatened and endangered animal species associated with land types for the United States.

In the case of natural habitats, the number of endangered species comes from the original and potential diversity of the land type. Hence, forest and water/ wetland types contain the greatest numbers of endangered species because they also contain the largest number of species. Tundra on the other hand is a harsh, less diverse environment with a relatively small list of endangered and associated species.

Summary

The current status of and recent historical trends in populations and uses of wildlife and fish resources are related to trends in their habitats. Species associated with agricultural, mature and old-growth forest, native grassland, and wetland environments have had declining or unstable populations in the last 20 years. Breeding birds that have shown recent population declines are more numerous in the East than in the West. Breeding birds that have increased tend to be those adapted to more intensive land uses, particularly urban/suburban environments. Population trends in game species have varied. With the exception of geese, migratory game bird populations have declined. Big game species across all regions have shown recent population increases with the exception of deer in the Pacific Coast region. Small game population trends differ between agriculture and forestland. Those small game species associated with agricultural lands have shown significant declines over the last 20 years, while most forest small game populations have remained stable or increased. Trends in furbearer populations have varied—the most commonly harvested species have stable or increasing populations, while other species such as red fox and mink have shown

regional declines. While there is limited quantitative information on how the nation's fish communities have changed, specific regional studies help. Generally, the capacity of the nation's waters to support healthy warmwater and coldwater fisheries has declined in response to anthropogenic degradation of aquatic habitats and introductions of competing fish species.

Recent trends in the recreational use of wildlife and fish are a function of the availability of wildlife and fish resources 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 of the increase in nonconsumptive recreation occurs with activities in and around people's residences or in association with their other outdoor activities. The number of persons that actually took trips for the sole purpose of viewing wildlife has not kept pace with the increase in U.S. human population. Though the number of big game hunters has generally increased during the last 20 years, the number of small game and migratory game bird hunters has declined, a probable response to lower game populations, reduced access, and crowded hunting conditions. The number of trappers has recently declined in apparent response to low prices, but fewer trappers may also reflect public and legislative pressure to restrict this activity. Both recreational and commercial fishers' numbers have consistently increased during the last 20 years.

Recent historical trends in game harvests reflect a combination of animal population levels and hunter effort, and in the case of furbearers, price. Consequently, the harvest trends noted are consistent with the population and user characteristics summarized above. Notable exceptions to this expected relationship concerns ducks in the Mississippi and Atlantic flyways which have shown stable harvests despite a declining number of hunters and duck populations.

The recent historical trends summarized reflect the wildlife and fish resource situation on all lands. No distinction has been made regarding resource trends within specific ownership categories. To evaluate the potential effectiveness of future Forest Service programs in managing natural resources, a review of the recent resource situation on public lands is required.

WILDLIFE AND FISH RESOURCES ON PUBLIC LANDS

The public generally perceives that public lands have attained the stature that the early conservationists such as Roosevelt, Pinchot and others had in mind when they began establishing the National Forest System, the National Park System, and the National Wildlife Refuge System. Some conservation and management success on public land is evident: large ungulate populations, critical habitat for threatened and endangered species, large predator populations, and a general uniqueness of local faunas. Partially as a result of federal laws, federal agencies have greatly improved inventory data, analytical methods, management policies, and management practices. Using all these, managers attempt to maintain viable populations, habitat diversity, and species diversity in concert with the full complement of other values associated with managed forest and range ecosystems.

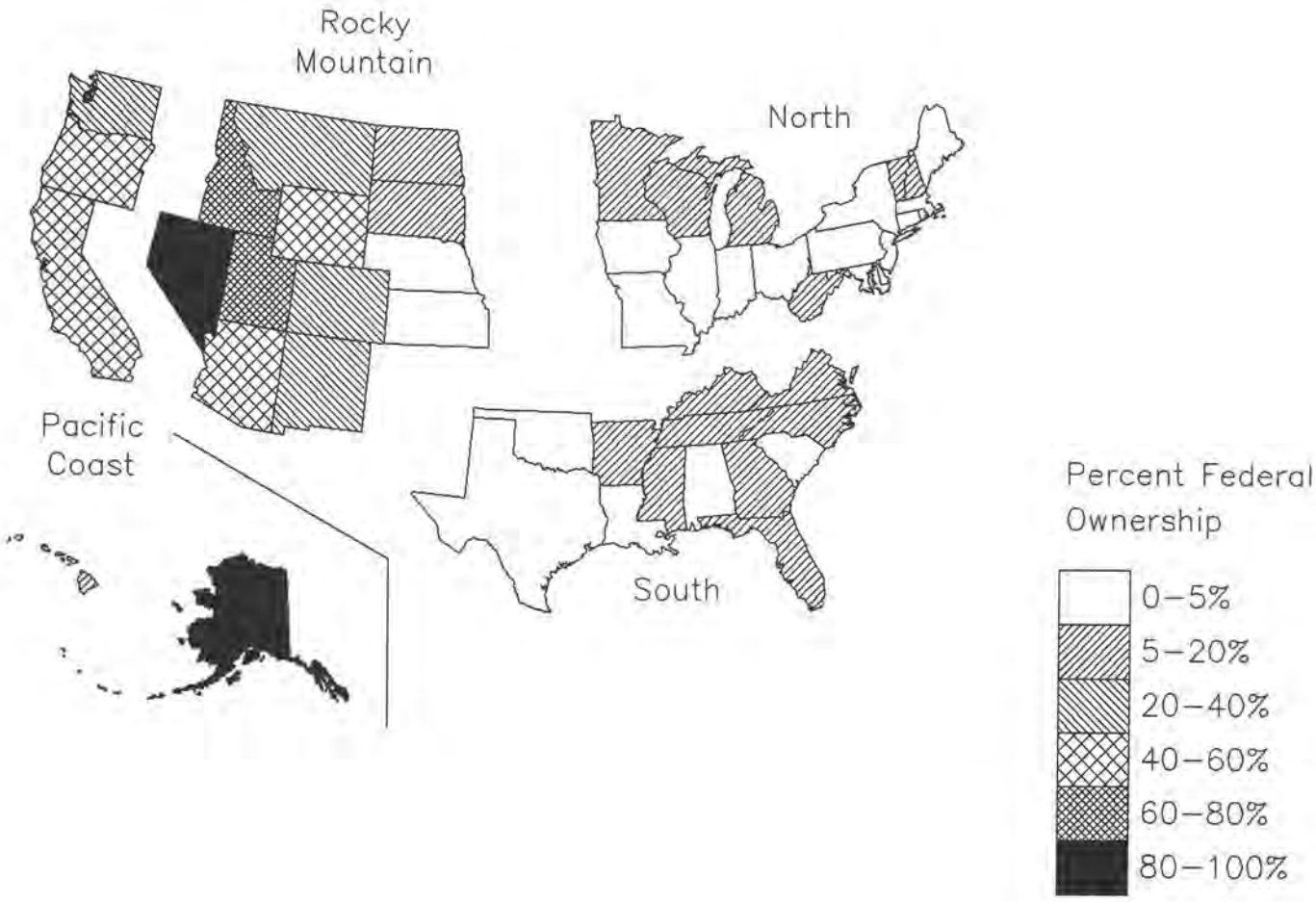
The following discussion documents the recent history of wildlife and fish on public lands in general, and specifically on Forest Service (FS) and Bureau of Land Management (BLM) lands. These two agencies are emphasized because they administer the majority of federal lands and because they are directed by legislation to monitor and manage wildlife and fish resources in a multiple resource context. Because public land distribution varies considerably across each assessment region (fig. 38), the recent trends in wildlife and fish resources on the agencies' lands differ accordingly.

The National Forest System (NFS) comprises 191 million acres on 156 national forests (186.4 million acres), 19 national grasslands (3.8 million acres), and a number of other land units associated with land-utilization projects, research and experimental areas, and purchase units. These lands are primarily in the West, which contains 87% of NFS lands. Apart from comprising a much smaller proportion of the land base, eastern NFS lands are further distinguished from those in the West by the significant amount of private inholdings that often occur within a national forest's promulgated boundary—a characteristic requiring careful consideration in managing natural resources, particularly mobile resources such as wildlife and fish.

The NFS is one of the most valuable public land networks for the nation's wildlife and fish resources (Barton and Fosburgh 1986). This value is reflected in habitat diversity, the number and variety of wildlife and fish species, and the number of recreationists that use the NFS. National forests contain approximately 128,000 miles of streams, 2.2 million acres of lakes, and more than half the nation's big game habitat. These aquatic and terrestrial habitats are used by over 3,000 species of wildlife and fish, and support 41% of the recreational use that occurs on all federal lands (Barton and Fosburgh 1986), of which 14% is devoted to wildlife and fish-related recreation including birdwatching, fishing, and hunting (USDA Forest Service 1985b).

The BLM has exclusive management jurisdiction on approximately 334 million acres (USDI Bureau of Land Management 1986). The BLM manages 46% of all federal lands—more than any other federal agency. These lands are primarily distributed west of the Mississippi River with only 0.7% of the land administered by the BLM occurring in the East.

Within its boundaries, the BLM manages a variety of ecosystems including Alaskan tundra, old-growth forest of the Pacific Northwest, and the deserts of the Southwest. Associated with these ecosystems is a variety of wildlife and fish species that are enjoyed by consumptive and nonconsumptive users. These lands not only provide essential habitat for game species, they are also critical to the survival of rare and endangered wildlife and fish. The BLM has management responsibility for over 80% of the desert bighorn sheep habitat as well as 130 plant and animal species listed as threatened and endangered (USDI Bureau of Land Management 1988).



Source: The Conservation Foundation (1984)

Figure 38.—Federal lands as percentage of total area, by state, 1980.

The lands administered by the FS and BLM constitute a vast land area that supports many renewable natural resources. Under a multiple resource management philosophy, the current status of and recent trends in wildlife and fish resources on FS and BLM lands have been, in general, more auspicious than those observed on private lands.

Wildlife and Fish Habitat on Public Lands

Forestland Habitats

Most forestland is privately owned. Nearly 71% of the total forestland in the United States was in nonfederal ownership in 1987 (Bones in press). Of the forestland under federal management (29%), the majority is managed by the FS (67%); the BLM manages an additional 13%; and the remaining 20% falls under the jurisdiction of the Fish and Wildlife Service, the National Park Service, or the Department of Defense. Most federal forestland is found in the Rocky Mountain and Pacific Coast regions, with federal lands in the East only constituting about 9% of the regional forestland area.

One indication of forest habitat status on public lands is the trend in timber removals. The annual removals of growing stock indicate that since 1962 removal rates across all ownerships have increased (table 22). Proportionately, the increase has been the greatest on forest industry lands. Comparison of average removals for the 1962–1970 and the 1976–1986 periods indicates that timber removals have increased 43% on forest industry lands, 36% on other public lands, 12% on other private lands, and 3% on NFS lands.

The regional pattern in timber harvests varies in relation to the predominance of public land within each region. The South and Pacific Coast regions supply the majority of the harvested timber volume. In the South the majority (over 90% in 1986) of the harvested volume comes from private lands, whereas in the Pacific Coast 42% comes from public lands. Of these two major timber producing regions, the South has had the most significant increases in timber removals since 1962 (table 22).

The timber harvesting that has occurred on national forests, and public lands in general, required an extensive network of roads. Road construction has resulted in a number of outcomes including: (1) increased access

Table 22.—Trends in timber removals by ownership and assessment region (1962–1987).

Region	Year	NFS	Other public	Forest industry	Other private
			Million cubic feet		
All regions	1962	1,873	723	2,958	6,406
	1970	2,322	966	3,765	7,041
	1976	2,121	1,077	4,229	6,802
	1987	2,209	1,216	5,380	8,235
North[1]	1962	84	137	213	1,643
	1970	100	173	323	1,876
	1976	124	184	406	1,945
	[4]1987	119	155	582	1,895
South[2]	1962	186	130	1,133	4,075
	1970	272	184	1,497	4,548
	1976	286	213	1,791	4,279
	[5]1987	314	291	2,425	5,668
Rocky Mountain[3]	1962	414	86	130	111
	1970	527	86	186	94
	1976	465	93	177	110
	1987	455	74	161	139
Pacific Coast	1962	1,188	369	1,481	577
	1970	1,423	523	1,759	523
	1976	1,244	586	1,855	468
	1987	1,321	696	2,212	534

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

for fire, insect, and disease protection; (2) increased access for wildlife and fish recreation; (3) potential increased disturbance of sensitive wildlife species including elk and grizzly bears; and (4) increased stream sedimentation resulting in degraded fish habitat (Council on Environmental Quality 1985, Fosburgh 1985b).

In addition to road development impacts, other forest habitat issues are emerging about public lands. Old-growth habitats are becoming increasingly rare, particularly on private lands. In 1977, more than half of the remaining old-growth in the Pacific Coast occurred on national forests; most of the old-growth in the Rocky Mountains occurs on NFS lands; and in the South, current trends indicate that much of the old-growth pine forests will only be found on national forests or other public lands (Lennartz et al. 1983).

With increasing management intensity on private timberlands, public forestlands will become increasingly unique when compared to private ownerships. This is of primary concern in the East for two reasons: (1) national forests could become isolated habitat islands which could threaten the maintenance of biological diversity (Harris 1984, Lennartz et al. 1983, Norse et al. 1986); and (2) public preferences are modifying the objectives for managing national forests to include increased consideration of the unique environments found there.

Rangeland Habitats

The majority (64.1%) of the nation's rangeland acres are in private ownership (Bones in press). Of the 276 million acres of rangeland in public ownerships, the BLM and FS administer 54% and 15%, respectively.

The condition of federally owned rangelands is difficult to evaluate for wildlife and fish resources. If we assume that range in good condition for certain domestic species will also be in good condition for similar wildlife species (Wagner 1978), then rangeland habitats on BLM and NFS lands appear to be improving (Joyce in press). Reduced use and improved management have contributed to range rehabilitation, although the recovery appears slow on BLM lands due to the long history of uncontrolled free range use and the longer vegetation recovery periods characteristic of arid climates (Council on Environmental Quality 1985).

Public lands only provide about 7% of the total grazed forages consumed by livestock (Joyce in press). Recent trends in grazing use of federal rangelands, as measured by animal unit months (AUM's), indicate that total grazing use of NFS and BLM lands declined through the mid-1970's (table 23). From 1980 to 1985, however, there was a slight (about 6%) increase in the grazing use of NFS and BLM lands—despite a nationwide decline in cattle herd size across all ownerships. This short-term trend

likely is due to a redistribution of the industry from East to West where public lands are the predominant ownership (Joyce in press).

On NFS lands, grazing use declined approximately 4% from 1965 to 1975, after which use increased to levels exceeding those reported in 1965 (table 23). The low use level reported for 1975 reflects, in part, the state of the cattle industry at a time when much of the nation's livestock went to market and grazing declined. Trends in NFS grazing use by assessment region are similar to the nationwide trend with all regions showing gains in the last 5 years.

Bureau of Land Management rangelands have witnessed a general reduction in grazing use. During the 1970–1980 decade, BLM lands experienced a total decline in grazing use of 21% (table 23). The majority of the decline occurred in the Rocky Mountain region with use in the Pacific Coast remaining relatively constant. Subsequent grazing use on BLM lands (1980–1985) increased 9%.

The overall impact of these grazing trends on rangeland habitats for wildlife and fish is difficult to determine. Obviously, livestock grazing can cause numerous conflicts with wildlife and fish resources; however, the extent of the conflicts cannot be easily quantified.

One of the most important wildlife and fish issues related to rangeland grazing concerns the impacts of livestock on riparian areas. Barton and Fosburgh (1986) characterize cattle damage to riparian zones on public lands as the most serious conflict between livestock and wildlife and fish. Heavy use of riparian areas by livestock results in a direct and significant impact on both terrestrial and aquatic habitats (Ohmart and Anderson 1986), and these habitats are particularly important in the arid environments that characterize much of the western rangelands. Nearly 76% of the breeding birds in the Southwest depend on water-related habitats (Johnson et al. 1977); in Oregon's southeastern Great Basin country, nearly 80% of terrestrial wildlife species depend on riparian zones or use these areas more than other habitats (Thomas et al. 1979); and 40% of the vertebrate wildlife species in Colorado associate with riparian areas which comprise only 3% of the land base (Melton et al. 1984). Besides the importance of riparian areas to livestock and wildlife, riparian areas are also valued for their recreational opportunities and are prime sites for road construction (Thomas et al. 1979).

The concern for riparian management on NFS and BLM lands is heightened when one considers only 3 million acres of riparian habitat are managed by these agencies (Prouty 1987). The varied demands concentrated on riparian areas make this habitat type a focal point for resource conflict (Platts 1979). Unfortunately, inventory information on riparian habitats is inadequate to evaluate recent trends in the condition of this important habitat type.

Wetlands

Nearly 74% of the remaining wetland habitats are privately owned, leaving about 25% under either federal or state ownership and 2% under the jurisdiction of local governments (USDI Fish and Wildlife Service n.d.a) With increasing human populations, and the proximity of population centers to coastal wetlands, the pressure to develop private wetlands will remain intense (Tiner 1984). As private wetland habitat continues to be lost, the importance and value attributed to those acres protected under federal and state ownerships will continue to escalate.

Within the federal ownership category, 40% of the lands classified as wetlands are managed by the Fish and Wildlife Service (fig. 39). The FS has management responsibility for 23% and the National Park Service, BLM, Corps of Engineers, Bureau of Reclamation, and Air Force manage the remaining 37%.

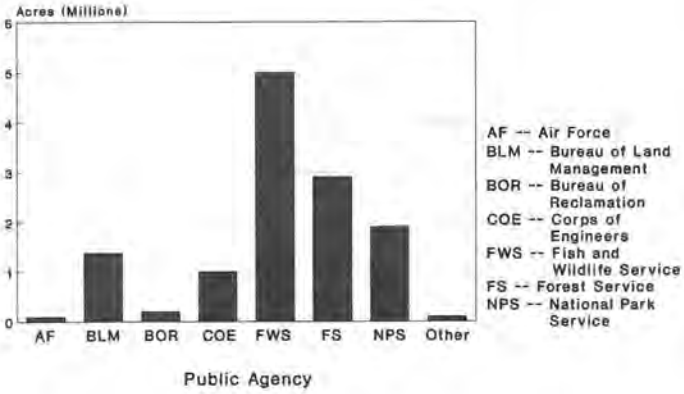
No standard national inventory permits an assessment of wetland trends in the FS. However, the Public Land Statistics published by the BLM do report wetland acreage. The number of wetland acres under the BLM's jurisdiction have declined since 1979 (table 24). This trend is not a reflection of actual degradation or destruction of wetland habitats but a reflection of recent Alaskan land transfers from the BLM to the State and Native Americans. Alaska accounted for 97% of the total BLM wetland acres in 1986.

The trends in BLM wetlands by assessment region are more indicative of the management emphasis that wetland types are receiving. In the Pacific Coast region, the dynamics are again dominated by the land transfer

Table 23.—Trends in grazing use on NFS and BLM lands.

Year	Total		North	South	Rocky Mountain		Pacific Coast	
	NFS	BLM[1]	NFS	NFS	NFS	BLM[1]	NFS	BLM[1]
				Thousand AUM's				
1965	9,339		108	184	8,004		1,043	
1970	9,284	13,039	40	354	7,910	11,651	980	1,388
1975	8,971	11,935	54	316	7,492	10,550	1,109	1,386
1980	9,757	10,308	67	225	8,202	8,929	1,263	1,380
1985	10,124	11,218	78	248	8,431	9,812	1,366	1,406

[1]*Multiply by 1.2 to be comparable to NFS, see Joyce (in press) for explanation.*
Source: Joyce (in press).



Source: USDI, Fish and Wildlife Service [n.d.]a

Figure 39.—Distribution of federally-owned wetland habitats.

Table 24.—Trends in wetland acres on lands administered by the BLM.

Year	National	Pacific Coast	Rocky Mountain	Eastern
		Thousand acres		
1979	46,951	46,797	154	
1980	48,960	46,794	151	35
1981	23,189	23,018	171	33
1982	27,474	27,289	185	35
1983	17,235	16,043	192	35
1984	16,246	16,043	203	35
1985	16,248	16,041	207	35
1986	16,248	16,041	207	37

Source: USDI Bureau of Land Management (1981–1987).

pattern in Alaska. This masks the general increase in BLM wetland habitat reported in California, Washington, and Oregon. Similar increasing trends in wetland area are also observed in the Rocky Mountain region where wetland acres have increased by over 35% since 1979. These increases are attributed to a number of factors including more intensive wetland improvement programs, a wet weather cycle during 1983–1985, and more intensive inventories and more precise definitions that have resulted in more acres being classified as wetland.

Wildlife and Fish Populations on Public Lands

Big Game and Other Large Mammals

Wildlife population statistics on public lands are compiled in cooperation with state wildlife agencies. Historical trends are published by the FS and BLM in their annual reports concerning wildlife and fish management on lands under their jurisdiction (USDA Forest Service 1965–1977, 1978–1985; USDI Bureau of Land Management 1966–1988). The populations reported by these two agencies are not mutually exclusive estimates and therefore cannot be added to estimate total populations on public lands. The migratory habits of many large mammal species can result in the use of FS and BLM lands at different times of the year. In addition, the lands managed by these agencies are occasionally "checkerboarded" with private lands preventing a definitive censusing.

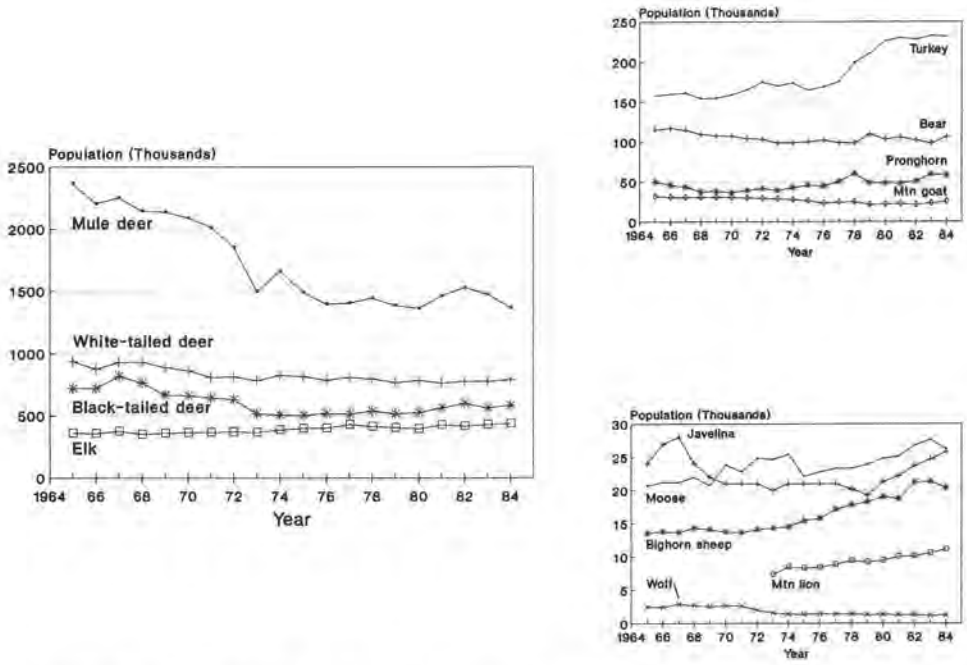
Big game populations in the NFS have, in general, remained stable or increased over the recent historical period of this report (fig. 40). The mule deer, including the black-tailed deer subspecies, is an exception. It declined during the late 1960's through the mid-1970's. This decline was range-wide and not specific to NFS lands. No single factor has been identified as being responsible for the decline (Connolly 1981). The only other large mammal that has shown a significant decline is the gray wolf. Wolf numbers have declined by 50% since the 1970's. Factors contributing to this decline include forest successional changes in the north-central portion of the U.S. that support less prey (The Conservation Foundation 1984) and wolf reduction efforts in Alaska aimed at increasing ungulate populations for sport and subsistence use (Peterson 1986). The most notable increases in big game abundance have occurred with wild turkey, moose, elk, bighorn sheep, and mountain lion.

Within assessment regions, population trends vary from the nationwide trends. In the North (appendix C, table C-1), bear and turkey populations have remained fairly stable, while moose populations have increased by nearly 70% since 1965. White-tailed deer declined through the early 1970's, after which numbers appear to have stabilized at about 300,000 animals. The decline in northern deer abundance may be related, in part, to declining forestland acreage in the early successional stages that provide higher carrying capacity.

Southern big game abundance trends have either been increasing or stable since 1965 (appendix C, table C-2). White-tailed deer numbers have remained between 250,000 to 300,000 while black bears have fluctuated around 3,000 animals. Wild (feral) pig populations have gradually increased in the last 20 years; in some areas, populations have increased to levels where competition with native fauna and damage to flora is a concern. Wild turkeys are a success story in the South. Numbering around 40,000 birds in 1965, turkeys increased threefold by 1984.

Big game and other large mammal species inhabiting the Rocky Mountains have had varying population trends (appendix C, table C-3). While moose, pronghorn, elk, mountain lion, and bighorn sheep have all gradually increased over the last 20 years, black bear and collared peccary populations have remained relatively stable. Species that have tended to decline include deer, turkey, mountain goat, and woodland caribou although it now appears that turkey and deer numbers are recovering.

In the Pacific Coast region, several species have increased significantly. Wild turkey and pronghorn populations have increased by 200% and 79%, respectively (appendix C, table C-4). Declining species include the gray wolf, deer, mountain goat, and bear.



Source: USDA, Forest Service (1965-1977, 1978-1985)

Figure 40.—Trends in big game populations on NFS lands.

Trends in big game populations on BLM lands generally are consistent with the trends observed on NFS lands. However, for Alaskan big game species, the trends are heavily influenced by the conveyance of land to the State and Native Americans. Of the species that were minimally affected by the land transfer, pronghorn and elk have shown increasing numbers while deer have declined (table 25). Of the Alaskan species, trends prior to and after the land transfer appear to be either stable or upward. The only exception to this pattern is with caribou, the population of which declined from the late 1960's through the early 1970's.

The eastern-states BLM office reported stable big game trends since 1980. Because of small BLM acreage in the east, these lands do not make a significant contribution to national big game production. In 1985, 100 moose, 1,200 deer, and 100 black bears used eastern BLM lands during part of the year.

In the Rocky Mountain region, the BLM showed significant increases for all species except deer (table 26). The most significant gains over the 1966–1985 period were observed with bear (378%), elk (227%), and moose (135%) populations. Deer numbers have declined by 27%.

Trends reported for the Pacific Coast region are influenced by the conveyance of BLM land in Alaska making interpretation of long-term trends difficult. Qualitative evaluations are possible by examining trends prior to and after the mid-1970's estimates. Deer and caribou were the only species showing downward trends (table 27). The deer decline is attributed to a drop in mule deer abundance in California, Oregon, and Washington. A presumed cause for the caribou decline is heavy harvest of adults and high calf predation from gray wolves and grizzly bears (Bergerud 1978).

Threatened and Endangered Species

Since federal land managing agencies have a legal responsibility to improve the status of threatened and endangered species, the association that exists between endangered species and federally administered habitat is important to understand. The association is due, in part, to land management actions that have maintained or enhanced endangered species habitats to the point where public lands are frequently the only place where these species still exist. In addition, the criteria that were used to justify the acquisition or retention of federal land frequently meant that public lands were unique with respect to animal species occurrence. For example, the Fish and Wildlife Service actively acquires land as a means of protecting threatened and endangered species as authorized under the Land and Water Conservation Fund, and the National Park Service has continually acquired some of the most unique lands in the United States. As a result, a high proportion of endangered species inhabit public lands.

The FS's threatened and endangered species program includes habitat management for endangered, threatened, proposed, and candidate (category 1 or category 2) species. The "proposed" category includes those species officially proposed for listing by the Fish and Wildlife Service or the National Marine Fisheries Service. "Candidate" species comprises taxa for which the Fish and Wildlife Service currently has substantial biological information to support a proposal to list the species

Table 25.—Trends in selected big game populations on BLM lands.

Year	Moose	Pronghorn	Elk	Deer	Sheep	Caribou	Bear
				Thousands			
1966	91	175	42	1,689	45	600	21
1970	101	183	67	1,462	44	600	25
1975	152	191	96	1,499	41	450	74
1980	88	241	101	1,260	45	250	37
1985	89	266	130	1,209	21	260	38

Source: USDI Bureau of Land Management (1966, 1970, 1975, 1981, 1986).

Table 26.—Trends in selected big game populations on BLM lands in the Rocky Mountain Region.

Year	Moose	Pronghorn	Elk	Deer	Sheep	Bear
			Thousands			
1966	1	162	35	1,176	7	1
1970	1	168	61	945	7	2
1975	2	147	86	968	9	2
1980	3	223	96	843	9	3
1985	3	246	114	855	13	4

Source: USDI Bureau of Land Management (1966, 1970, 1975, 1981, 1986).

Table 27.—Trends in selected big game populations on BLM lands in the Pacific Coast.

Year	Moose	Pronghorn	Elk	Deer	Sheep	Caribou	Bear
				Thousands			
1966	90	13	8	513	38	600	20
1970	100	14	6	517	38	600	23
1975	150	14	11	530	32	450	72
1980	85	17	13	414	36	250	34
1985	85	20	16	353	8	260	35

Source: USDI Bureau of Land Management (1966, 1970, 1975, 1981, 1986).

as endangered or threatened (category 1), or taxa for which current information indicates that listing species may be appropriate but conclusive biological data are not available to support the development of proposed rules (category 2).

Currently, 109 endangered species, 42 threatened species, 4 species either endangered or threatened depending on location (e.g., grizzly bear), 9 proposed species, plus an additional 90 category 1 species and 737 category 2 species occur on FS lands (Raml, pers. comm., 1988). Consequently, the FS manages habitat that directly affects approximately 30% of the U.S. plant and animal species which have been listed by the Fish and Wildlife Service. The Southern, Southwestern, and Eastern Forest Service Regions had the greatest number of proposed, threatened, or endangered species; the Northern and Alaska Regions had the least (Raml, pers. comm., 1988). The number of listed species occurring on NFS lands is expected to increase as new species are listed and as new information on species distributions becomes available.

The BLM currently has responsibility for habitat used by 82 threatened and endangered animal species, of which 77 have approved recovery plans (USDI Bureau of Land Management 1988). The largest species concentration occurs in Nevada, with 21 threatened or endangered animal species occurring on BLM lands (table 28). BLM personnel have also estimated that they have land management responsibility for approximately 6.5 million acres of terrestrial and 1,850 miles of aquatic habitat used by threatened and endangered species. In addition to officially listed species, the BLM also provides habitat for 870 candidate species, some 620 of which are plants (see Joyce in press).

Table 28.—Number of threatened and endangered species and habitat occurring on BLM lands by state.

State	Animal species	Habitat acres (thousands)	Aquatic habitat miles
Alaska	5	100	
Arizona	17	454	304
California	19	350	6
Colorado	8	938	200
Idaho	6	81	302
Montana	8	400	250
Nevada	21	36	339
New Mexico	7	50	10
Oregon	7	97	12
Utah	13	2,160	446
Wyoming	5	1,846	
Eastern U.S.	13	50	

Source: USDI Bureau of Land Management (1988).

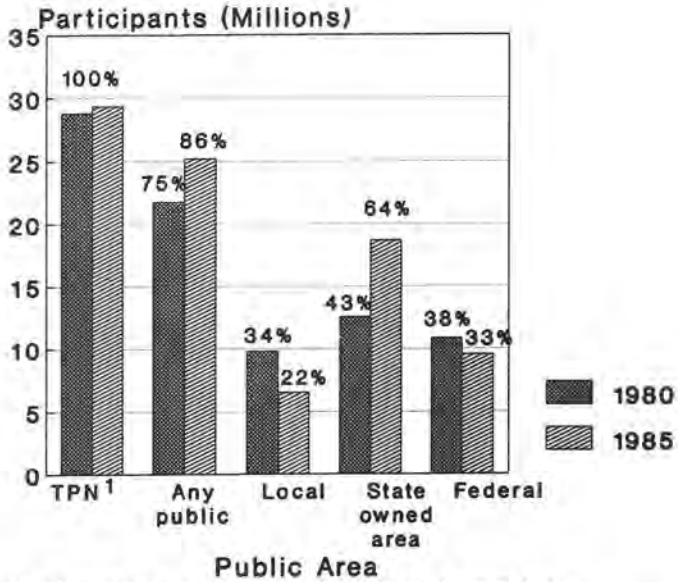
Recreational Use of Wildlife and Fish on Public Lands

Proportionate Use Patterns of Public Lands

Ownership patterns in wildlife-related recreation, measured as the proportion participants or days spent recreating within various land ownerships, were obtained from the Fish and Wildlife Service's National Surveys of Fishing, Hunting, and Wildlife-Associated Recreation. These surveys represent the only standard inventory of users that permits a national and regional comparison of where hunters and nonconsumptive recreationists chose to participate with respect to land ownership categories. These surveys have been conducted every 5 years since 1965; however, because of changes in survey design, historical trends are difficult to interpret. As opposed to earlier years, the 1980 and 1985 surveys were similar enough in their reporting of ownership use pattern to permit an evaluation of recent trends in public land use by the outdoor recreating public.

Nonconsumptive wildlife related recreation on public lands.—Within the nonconsumptive-use categories defined by the Fish and Wildlife Service, only primary nonresidential recreational participation was described in terms of land ownership. Results of the 1980 (USDI Fish and Wildlife Service, and USDC Bureau of Census 1982) and 1985 (USDI Fish and Wildlife Service 1988b) surveys indicate that public land areas are critical to primary nonresidential nonconsumptive recreation, and they are becoming more important (fig. 41). In 1980, 75% of the total nonconsumptive users participated on public lands, and that figure increased to 86% in 1985. The majority of the increase is associated with state-owned areas which witnessed a 20% increase in proportional participation. Participation declined significantly on local areas and declined slightly on federal lands.

Hunting on public lands.—The trends in proportionate hunting use by ownerships showed minor shifts during the period of 1980 to 1985 (table 30). The days



[1]Total primary nonresidential participation on all ownerships
NOTE.—Percentages reflect the proportion of total primary nonresidential participation for a given year. Percentages across land ownerships will not sum to 100 since persons may participate in several ownership categories.

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

Figure 41.—Participation on public areas by primary nonresidential participants.

spent hunting on public lands for all types of hunting activities declined by 3.4%. This was the result of a significant drop in the days spent on the "other" public land category. The proportionate number of days spent on federal and state-owned areas actually increased by 2% between 1980 and 1985. The increased use of federal and state lands is explained by less habitat being available from private land due to more intensive land use and reduced accessibility.

The patterns observed for all hunting activities are generally maintained across each hunting type with the exception of big game. The proportionate number of days that big game hunters spent on public lands declined to a much greater degree than was observed for small game or migratory bird hunting. In addition, the proportion of days spent big game hunting on federal lands declined slightly between 1980 and 1985—the only type of hunting where this was observed.

Trends in the Number of Participants on Public Lands

Proportionate use, as discussed above, only provides information on the relative importance of different land ownerships to hunting and nonconsumptive activities. The results of that analysis showed that public lands, in general, are receiving a greater share of the nonconsumptive and consumptive wildlife-related recreation. However, these figures do not provide information on the magnitude of use on these ownerships; such data were obtained from annual reports published by the FS.

Nonconsumptive recreation.—Within the NFS, statistics on nonconsumptive activities (recorded as total nature study) were not collected until 1980. Since 1980,

Table 29.—Regional distribution of primary nonresidential participation on public lands in 1980.

Region of residence	Total primary nonresidential participants	Any public area		Local or regional park or natural area		State-owned area		National wildlife refuge		Other federal area	
		Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
					Numbers in thousands						
National	28,822	21,731	75.4	9,820	34.1	12,545	43.5	4,561	15.8	6,283	21.8
North[1]	14,867	11,049	74.3	5,262	35.4	6,912	46.5	2,144	14.4	1,802	12.2
South[2]	6,754	4,604	68.2	1,791	26.5	2,414	35.7	966	14.3	1,281	19.0
Rocky Mountain[3]	2,125	1,725	81.2	577	27.2	735	34.6	264	12.4	970	45.7
Pacific Coast	5,076	4,353	85.7	2,192	43.2	2,484	48.9	1,068	21.0	2,228	43.9

[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.*
NOTE: Detail does not add to total because of multiple responses.
Source: USDI Fish and Wildlife Service, and USDC Bureau of Census (1982).

Table 30.—Percentage of total days spent hunting on public land by type of hunting and ownership.

	1980				1985			
	All hunting	Big game	Small game	Migra. birds	All hunting	Big game	Small game	Migra. birds
				Percent				
All Public	31.6	40.7	25.9	28.7	28.6	34.2	22.9	28.4
Federal	9.3	15.4	5.9	6.0	10.4	15.1	6.3	8.3
State	10.4	13.2	8.8	10.1	11.6	13.2	10.1	11.6
Other[1]	11.9	12.0	11.1	12.5	6.6	5.9	6.5	8.5

[1]*Other public land includes locally managed areas and unclassified public land use.*
Source: USDI Fish and Wildlife Service (1988b); USDI Fish and Wildlife Service, and USDC Bureau of Census (1982).

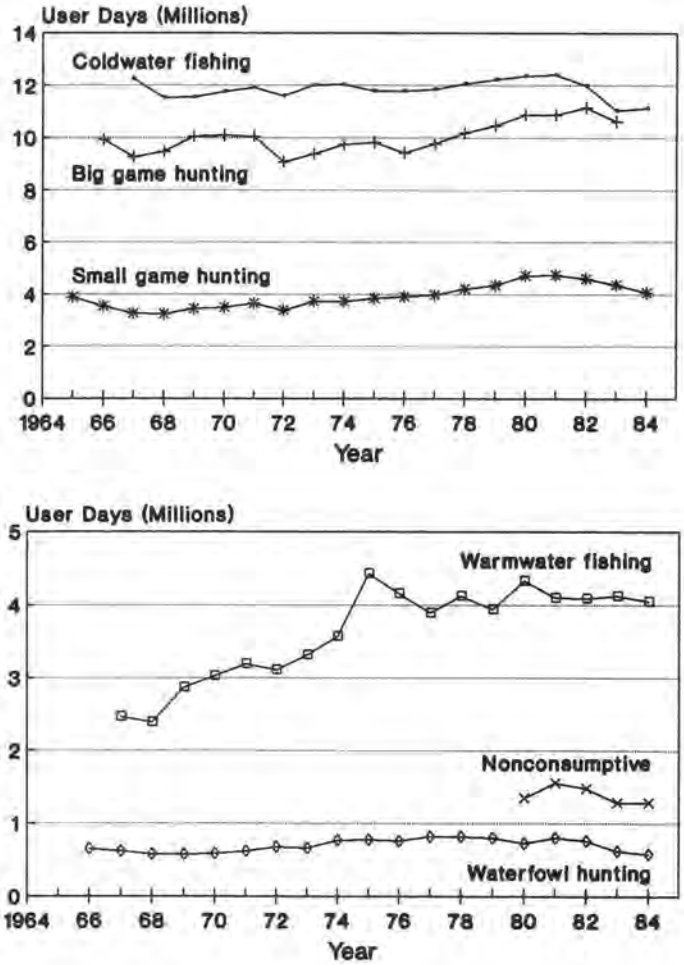
total nonconsumptive user-days on NFS lands peaked in 1981 at 1.55 million user-days and declined to approximately 1.27 million user-days in 1984 (fig. 42). Although this trend is surprising given increased public interest in nonconsumptive recreational activities, participation in primary nonresidential nonconsumptive activities may be leveling off. Over the period from 1980 to 1985, the Fish and Wildlife Service noted a general decline in the proportion of the population participating in primary nonresidential nonconsumptive activities and actual declines in the number of participants in some regions of the country (USDI, Fish and Wildlife Service 1988b; USDI Fish and Wildlife Service, and USDC Bureau of Census 1982).

Regional trends in nonconsumptive use on NFS lands, in general, follow the national trends within this ownership (appendix C, table C-5). Nonconsumptive user-days declined in every region from 1980 through 1984 except in the South. This regional pattern is consistent with the regional trends across all land ownerships. The South experienced the most significant gains in primary nonresidential participants while participation declined in the North and Pacific Coast regions (see table 13).

Migratory game bird hunting.—The only available statistics on trends in migratory bird use were for waterfowl hunting and therefore do not include the webless migratory species. Waterfowl use on FS lands peaked in 1978 at approximately 800,000 user-days. By 1984, use was 25% below peak levels (fig. 42).

Although the waterfowl use pattern on NFS lands within each assessment region is consistent with that observed on all land (appendix C, table C-6), the magnitude of the decline varies greatly by region. The Pacific Coast region has had the greatest decline from peak use (approximately 50%) while use has remained relatively stable in the Rocky Mountains (10% decline from peak period). The trend in waterfowl use on eastern national forests has ranged from a 32% decline in the North to an 18% decline in the South.

The downward trend in waterfowl use on FS lands is not specific to these lands as waterfowl use has consistently declined across all ownerships. The decline is likely a function of many interacting factors including declining waterfowl populations, regulations, and changes in recreational preferences.



Source: USDA, Forest Service (1965-1977, 1978-1985)

Figure 42.—Trends in wildlife-related recreation user-days on NFS lands.

Big game hunting.—The number of user-days that the recreating public has devoted to big game hunting on national forests has been increasing nationwide (fig. 42). From 1966 through 1977, big game user-days fluctuated around 9.5 million, after which a gradual increase was observed, peaking in 1983 at 11.1 million user-days. This trend is generally maintained within each assessment region although the magnitude of changes varies by region (appendix C, table C-7). The North has witnessed over a 55% increase in big game hunting use since the early 1970's. Big game hunting use in the South has increased consistently since 1967 and appears to be related to the previously noted deer and turkey population increases. Trends in big game hunting use within the Rocky Mountain region lagged a few years behind the dynamics of mule deer populations. The decline in deer numbers during the early 1970's is followed by declining use in the mid to late 1970's. Since 1978, the number of big game user-days has increased to record levels in the Rocky Mountains. Pacific Coast big game hunting use on NFS lands has remained relatively stable over the last 20 years, fluctuating around 2.9 million user-days.

Although the number of days spent pursuing big game on FS lands has increased or remained stable, the importance of each region in terms of its relative contribution to the national total is shifting. The West has always accounted for the majority of big game use on FS lands (approximately 70% of the national total). However, between the 1966–1968 and 1982–1984 periods, the average contribution of each region to the national total showed that the South has had the greatest percentage gain (16.8% to 19.2%), followed by the Rocky Mountains (40.4% to 42.2%) and North (10.8% to 11.8%). The Pacific Coast's relative contribution to the total number of big game user-days has declined by over 5% between the two time periods.

Small game hunting.—National forest personnel have reported the number of small game mammal and upland game bird user-days as a part of the annual wildlife report from 1965 through 1984. The trend for combined small game mammal and upland game bird users was upward for the first 15 years followed by a noticeable decline (fig. 42). In 1984, the South accounted for the greatest proportion of national forest small game use (42%); the North and Rocky Mountains accounted for a similar proportion of small game user-days (24% and 22%, respectively); and the Pacific Region had the smallest proportion of small game use at 12% (appendix C, table C-8). Small game species occupying national forests are generally not associated with agricultural lands. Therefore, small game recreational use on NFS lands has not been influenced by the general national decline in agriculture-associated small game populations.

Fishing.—Following a decline of 4 million fishing user-days in the late 1960's, fishing has steadily increased on national forests through 1980. The level of coldwater angling use on national forests was consistent at nearly 12 million user-days between 1967 and 1981, after which use dropped to about 11 million by 1984 (fig. 42). Warmwater fishing user-days nearly doubled between 1967 and 1975, after which numbers stabilized at about 4 million user-days (fig. 42).

Important regional differences exist in the distribution of angling use on national forests (appendix C, table C-9). In the North, fishing has stabilized around 2 million fishing user-days. Warmwater fishing participation increased from less than 900,000 user-days in 1967 to about 1.4 million by 1984. Coldwater fishing has maintained a relatively stable level of use at about 650,000 user-days.

The amount of fishing use on Southern national forests increased from less than 2 million to about 3 million user-days over the 1965–1984 reporting period. These trends are influenced by the amount of warmwater fishing which makes up over two-thirds of the fishing use in the region.

In the Rocky Mountain region, coldwater fishing accounts for nearly 95% of the total number of recreational fishing days on NFS lands. After averaging about 5 million user-days through 1975, coldwater fishing use increased to 6 million user-days by the early 1980's. No trend is apparent in warmwater fishing with use fluctuating around 300,000 user-days.

The total number of fish user-days on Pacific Coast national forests has fluctuated in the recent past. However, the general trend is one of declining use, particularly over the 5-year period from 1979 to 1984. As in the Rocky Mountains, coldwater fishing is dominant, accounting for over 90% of the total fishing use. The decline in coldwater fishing participation is probably a function of many factors including declining anadromous fish numbers during the late 1970's and early 1980's and regulations (Lee, pers. comm., 1987).

Harvests of Wildlife and Fish on Public Lands

Big Game and Other Large Mammal Harvests

Harvest statistics for big game species (including gray wolf) on public lands were available for FS lands only. National trends in total big game harvest can be explained, in part, by trends in animal populations and users. Regression analysis showed that 88% of historical harvest variations is explained by changes in big game populations and hunter effort (as measured by user-days). Other factors that influence observed harvest levels include hunting season regulations and weather.

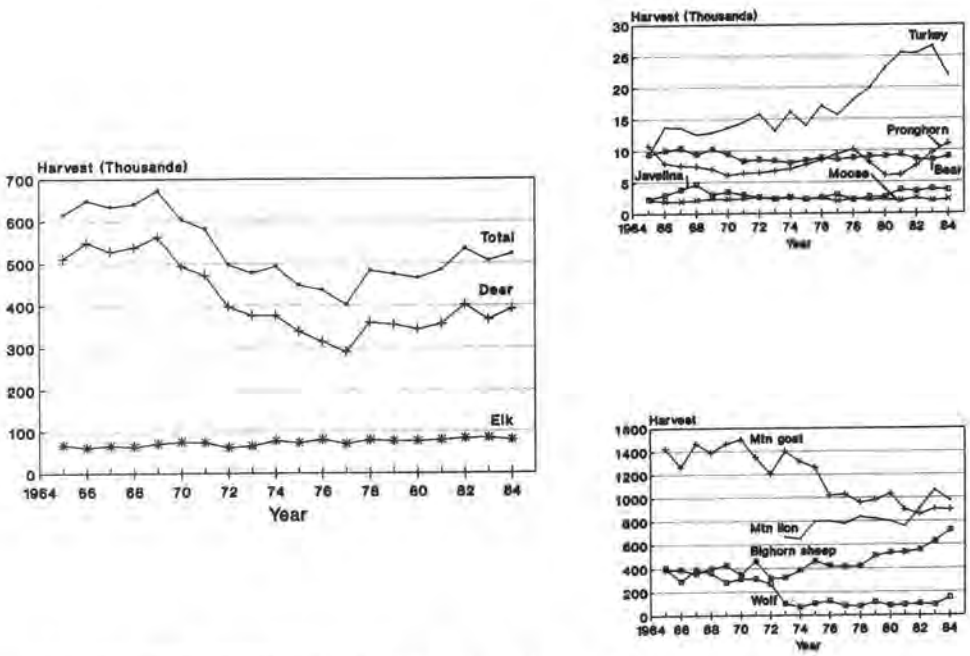
Total big game harvests on FS lands declined from 1965 through 1977, followed by a gradual increase through 1984. This observed trend is dominated by the historical harvest of deer which account for approximately 75% of the total number of big game animals harvested (fig. 43). Harvests of elk, turkey, mountain lion, and bighorn sheep have also increased while mountain goat and wolf harvests have declined.

In the Northern region, both turkey and black bear harvests increased on FS lands. Deer harvests reached a record low in the early 1970's, after which harvest increased to levels approaching those observed in the mid-1960's (appendix C, table C-10).

All species of big game showed increased harvests on Southern national forests. Turkeys showed a 350% increase in harvest since 1965 while deer and black bear harvests increased by 145% and 95%, respectively (appendix C, table C-11).

Rocky Mountain big game harvest trends are variable owing to the diversity of big game species found on national forests in this region (appendix C, table C-12). Deer have accounted for the majority of the big game harvest in this region. During the mid-1960's, deer accounted for at least 80% of the total big game harvest. During periods of lower populations (mid to late 1970's), deer harvests accounted for only 60% of the big game total. Species that have shown consistent increases in harvest include elk, pronghorn, bighorn sheep, and mountain lion. The only species with a consistently declining harvest trend is mountain goat.

Big game harvests from FS lands in the Pacific Coast Region appear more variable than the other regions (appendix C, table C-13). Fall weather patterns, particularly in Alaska, have a significant influence on observed big game harvests of moose, mountain goat, sheep, and caribou. Species showing consistently increasing harvests are those found on national forests in California, Oregon, and Washington and include pronghorn and wild turkey. Regional wolf and bear harvests have declined by 50% and 25%, respectively.



Source: USDA, Forest Service (1965-1977, 1978-1985)

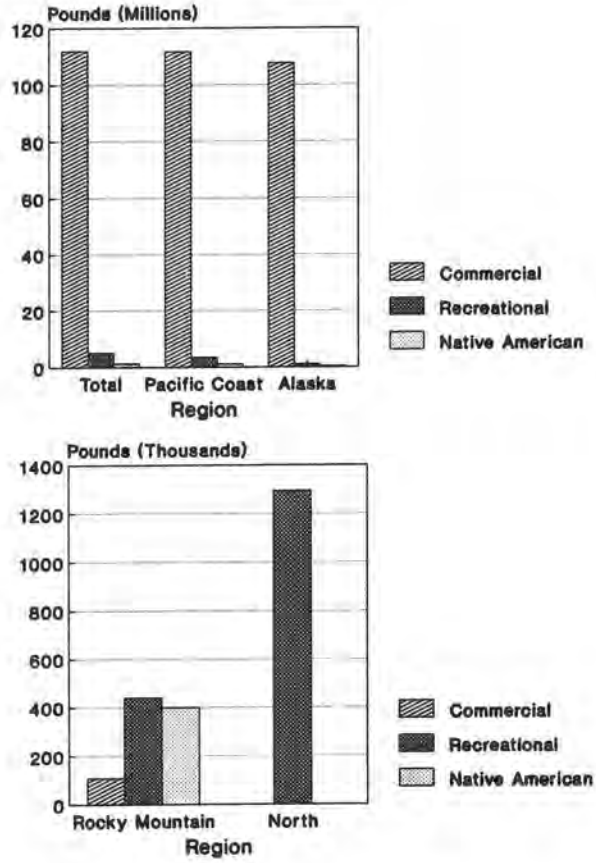
Figure 43.—Trends in harvest of selected big game species on NFS lands.

Fish Harvests

The FS and BLM have annually reported the harvest of anadromous salmon and steelhead but not the harvest of other fish species. Anadromous fish harvests from FS and BLM lands are based on the estimated contribution that these lands make to the annual production of these species, rather than the harvest that actually occurs on NFS lands.

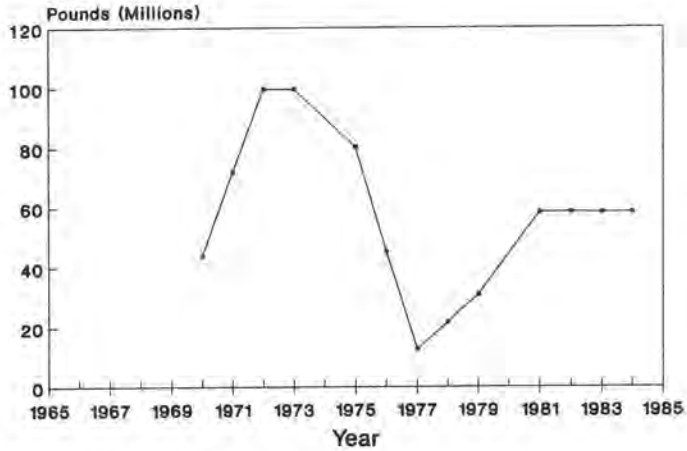
For national forests, information on fish harvests are categorized as commercial, recreational, and Native American. The largest segment of the harvest is taken by commercial fishing. The total salmon harvest for the nation was about 700 million pounds, of which 15% (112 million pounds) was attributable to the NFS (fig. 44). Considering the 5 million pounds of salmon and steelhead harvested by recreational users and 2 million pounds taken by Native Americans, national forest contributed nearly 120 million pounds of salmon and steelhead in 1984. The majority of the recreational (40%) and Native American (50%) harvest of salmon and steelhead occurs in the Pacific Coast region.

The trend in commercial fish harvested on BLM lands has been highly variable during the last 20 years. A high of 100 million pounds was harvested in 1972 and 1973 followed by a low of only 12 million pounds in 1977 (fig. 45). In recent years, the commercial harvest of anadromous fish produced on BLM lands has been around 60 million pounds.



Source: Dombeck (pers. comm. 1987)

Figure 44.—Salmon and steelhead harvested from national forest production.



Source: USDI, Bureau of Land Management (1970-1985)

Figure 45.—Trend in commercial fish harvest from BLM public land production.

Summary

Public lands constitute a vast area that supports many renewable natural resources of which wildlife and fish are an important component. The NFS together with the Bureau of Land Management are responsible for the management of 525 million acres of forest and rangeland ecosystems. As multiple-use land managing agencies, the FS and BLM give wildlife and fish prominent consideration in resource management activities. Consequently, forest and rangeland ecosystems on public lands provide habitat for a diversity of wildlife and fish species. However, indications are that important wildlife and fish habitat will be lost or diminished in quality unless wildlife and fish concerns continue to be acknowledged in future resource planning.

Within forest environments, important habitat issues on public lands are ultimately tied to trends in timber removals. Harvest of timber is dependent on roads, and recent construction trends have heightened concern for the potential impacts on species sensitive to human disturbance and increased sedimentation of stream habitats. Timber harvesting also alters the mix of forest successional stages. As demands for timber increases, old-growth forest environments are becoming increasingly rare on private lands, leaving public agencies with the responsibility for managing these unique habitat types.

In a way analogous to forest environments, forage removals on public lands are the ultimate source of wildlife and fish management issues within rangeland environments. However, rangeland habitat problems appear also to be related to the historical overgrazing of range ecosystems. Attendant with recent declining trends in public-land grazing has been improvement in

range condition. However, because of the slow recovery of vegetation in arid climates, rangeland habitats could still see significant improvements with time and implementation of appropriate management practices. A particularly important wildlife and fish habitat issue associated with range ecosystems is grazing use of riparian habitat. Failure to manage livestock use of riparian areas severely degrades this habitat for both terrestrial and aquatic species.

The majority of big game species have been increasing on national forests and BLM lands in response to the joint habitat and population management between state and federal agencies. Threatened and endangered species are a special responsibility of public agencies, and considerable effort has been exerted to improve the status of these species on public lands through habitat management and the implementation of approved recovery plans.

Recreational use patterns associated with federal lands showed some unexpected trends given the increasing uniqueness of these lands with respect to wildlife and fish habitats and populations. The proportionate number of days spent on federal ownerships has declined slightly for nonconsumptive recreation and big game hunting, and increased for small game and migratory game bird hunting. In the case of national forests, trends in the number of user-days since the last assessment showed declines in nonconsumptive recreation, waterfowl hunting, and small game hunting; increases in big game hunting and warmwater fishing; and stable levels of coldwater fishing.

As land-use intensifies on private lands in response to increasing human populations and increased demand for commodity goods, public lands will probably become more unique with respect to the distribution of native vegetation, wildlife and fish communities, and recreation opportunities. Evaluating the relative importance of public lands to future wildlife and fish recreation and populations requires recreational use and inventory projections.

CHAPTER 2: PROJECTIONS OF WILDLIFE AND FISH RESOURCE USE

Resource-demand projections are an integral part of national resource assessments, and when compared against future trends in resource supplies, they provide insights into possible imbalances between the demand for and supply of natural resources. For wildlife and fish, demand analysis is interpreted to involve projections of resource use (Hoekstra and Hof 1985). This modification on the traditional economic analysis framework is necessary since true demand analysis requires a conventional market structure that generally does not exist for wildlife and fish.

Wildlife and fish use can be categorized into three classes according to the common values held for wildlife and fish resources. These categories are commercial, existence, and recreational values (Hoekstra et al. 1983). The capability to project future trends in wildlife and fish use varies across these categories because data requirements and analysis methods differ.

For commercial fisheries and furbearers, a traditional competitive market exists. However, analyses to project commercial use at scales appropriate for national assessments have not, as yet, been completed.

Existence value represents a category of wildlife and fish use acknowledging that some people derive satisfaction from just knowing that certain species or fauna exist. People hold these values even though they may never use (consumptively or nonconsumptively) the resource directly. Consequently, existence values are independent of current use and expected future use and therefore must be derived from altruistic motives (Randall and Peterson 1984). Passage of such laws as the Endangered Species Act provides evidence for the extent to which existence values are held by the public. Although a general description of existence values is widely accepted, a precise and common definition of the concept does not exist (Bishop 1987). Such a definition is required before future trends in this use category can be analyzed.

In the case of recreational use, standard national surveys addressing wildlife and fish related recreation have been conducted by the Fish and Wildlife Service (USDI Fish and Wildlife Service, and USDC Bureau of Census 1982). These data have been used to examine the correlation between participation levels in recreational activities and socioeconomic factors presumed to be important in explaining why persons choose to participate in certain recreational activities. Projected changes in the socioeconomic factors explaining participation permit an estimation of future users. Because of the analytical constraints associated with commercial use, and because of the need for future theoretical development to address existence value, this chapter only discusses projections of recreational use.

Two aspects of recreational use will be addressed. First, participation in six recreational activities related to wildlife and fish are projected for the nation and each of the four assessment regions. These projections are compared to expected future trends in wildlife and fish recreation on national forests. Second, the growing interest in fee-hunting on private lands is examined as an emerging issue of wildlife and fish recreation. Future trends in the number of hunters participating in fee-hunting are reviewed.

PROJECTION OF WILDLIFE AND FISH RECREATION

Projecting the number of people engaging in wildlife and fish recreational activities provides important information that can be used to anticipate future changes in participation levels and their relative preference for specific recreational activities. The last national assessment of wildlife and fish projected increases for all recreational activities examined (USDA Forest Service 1981). The magnitude of envisioned increases ranged from 90% for freshwater fishing to 24% for small game hunting over a 50-year projection period from 1980 to 2030. These projections were based on linear extrapolations of historical participation rates by age group over the previous 30 years. During this historical period, the number of licensed hunters doubled and the number of licensed anglers more than tripled.

The Fish and Wildlife Service has completed two national surveys on wildlife and fish associated recreation since the 1979 wildlife and fish assessment (USDI Fish and Wildlife Service 1988b; USDI Fish and Wildlife Service, and USDC Bureau of Census 1982). These surveys indicate participation patterns have recently changed. They show declining number of hunters, increasing anglers, and increasing nonconsumptive users. This pattern has been observed by others. Gilbert and Dodds (1987) noted that increasing nonconsumptive interests and a potentially declining number of hunters will change the clientele of the future wildlife manager; in New York, Brown et al. (1987) showed that lower participation in hunting can be expected given sociodemographic trends; and in Colorado, the Executive Task Force on the Future of Wildlife (1987) noted that the number of big game hunters may be expected to decline while participation in fishing and nonconsumptive uses is expected to increase.

Attempting to explain these perceived changes, empirical relationships between participation and hypothesized factors affecting participation were estimated. The projection method reported here was developed by Walsh et al. (1987) and used to analyze nonconsumptive use, coldwater fishing, warmwater fishing, big game hunting, small game hunting, and migratory bird hunting. These activities are defined in table 31.

Projection Approach

Several studies have attempted to project recreational activity at scales appropriate for national assessments (Adams et al. 1973, Cicchetti et al. 1969, Hay and McConnell 1979, Hof and Kaiser 1983). It must be emphasized that these past projections of wildlife and fish use, and the projections reviewed here, do not represent true demand in the economic sense, but rather an estimate of the actual expected consumption. As argued by Hof and Kaiser (1983), if the objective is to identify future over-use problems, then the relevant quantity to project is actual expected consumption not quantity demanded.

For nonmarket goods, such as wildlife and fish, Hof and Kaiser (1983) recommended the following theoretical form for recreation projections:

$$Q_c = f(P, X_i, Q_p)$$

where

Q_c = the quantity of resources actually consumed;
P = a price surrogate, e.g., travel cost or time costs;
X_i = traditional "demand shifters" such as income, age, and education; and
Q_p = the quantity of resource provided or available.

Walsh et al. (1987) followed this theoretical form and examined the relationship between participation in wildlife and fish recreational activities and 20 hypothesized explanatory variables, including two price variables, nine demand shifters, and nine resource availability variables that tended to be activity specific (table 32). Their approach to project Qc (defined as the number of participants) can be summarized in three steps. First, empirical relationships between explanatory variables and the probability that an individual will participate in a given recreational activity were estimated from available data. The data for this study were obtained from the 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (USDI Fish and Wildlife Service, and USDC Bureau of Census 1982). Logistic regression analysis was used to estimate the projection model coefficients.

The second step involved projection of the explanatory variables from the 1980 base year to 2040. To develop a reasonable range of forecasts that acknowledges the uncertainty about future conditions, three alternative future scenarios were completed. The scenarios resulted in high, medium, and low forecasts of the factors affecting participation in wildlife and fish recreational activities (table 33). The projections of explanatory variables were based on various sources including Darr (in press), USDC Bureau of Census (1984b), Wharton Econometric Forecasting Associates (1985), USDC Bureau of Economic Analysis (1985), and Hof and Kaiser (1983). In general, the medium scenario represented a projection of the recent historical situation. The high and low scenarios assumed an accelerated and slower rate of change, respectively (Walsh et al. 1987). The resource quantity and quality variables were unchanged through the projection period. Consequently, resource availability is not a factor in the projected recreation trends. The impact of changing resource availability (as measured by habitat or animal populations) on recreational use will be addressed in chapter 4.

The third step in the projection methodology was to apply the projected changes in the explanatory variables to the logistic regression equations. The result was an estimated change in the probability of participating in various recreational activities. Total number of participants was calculated by multiplying participation probabilities by the projected human population. To facilitate comparison among recreational activities, relative change from a 1980 base year is shown.

These projections are based on two important assumptions:

1. The relationships between participation in wildlife and fish recreation and socioeconomic factors remain constant over time.
2. Programs are not implemented in the future that either restrict or promote participation in these activities.

Consequently, the trends depicted represent what may occur with the continuation of current management levels and public preferences. Of course, resource management agencies may implement programs to influence or change the course of these trends.

Table 31.—Definitions of the types of fishing, hunting, and nonconsumptive wildlife recreation.

Type of activity	Census survey definition
Nonconsumptive trips	Trips or outings of at least 1 mile from home for the primary purpose of observing, photographing, or feeding wildlife, without which the trip or activity would not have been undertaken. Trips to zoos, circuses, aquariums, and museums, and trips to fish or hunt are not included.
Fishing, total	The sport of catching or attempting to catch fish with hook and line or by archery, spearing, gigging or shooting frogs, seining and netting (but not for bait). Related pursuits that are not considered fishing in the survey include commercial fishing and catching or gathering shellfish (crabs, clams, oysters, etc.).
Coldwater	Includes freshwater trout, kokanee, and anadromous fishes such as salmon and steelhead.
Warmwater	Includes smallmouth and largemouth bass, panfish such as bluegill and crappie, walleye, northern pike, muskellunge, catfish, bullheads, etc.
Hunting, total	The act of searching for wildlife with the intent to take individuals by using firearms or archery. Only hunting for pleasure or recreation is included. Excluded are trapping animals, commercial hunting, searching for animals to photograph, capturing animals live (e.g., to put in a zoo or for biological research), and hunting for frogs. Excluded are those who did not have a weapon but may have accompanied others in the field.
Big game	Large wild animals hunted for sport or food, such as, but not limited to, deer, elk, bear, antelope, and wild turkey.
Small game	Smaller wild animals, such as rabbits, quail, grouse and pheasant, which are hunted for sport or for food; waterfowl, other migratory birds, and animals generally considered to be pests or varmints are excluded.
Migratory birds	Birds regularly moving seasonally from one region or climate to another for feeding or breeding; for example, ducks, geese, doves, and woodcock.

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

Results

Empirical Relationships

The effect of each explanatory variable on participation levels varies by recreational activity. Walsh et al. (1987) found:

- Price was a significant variable in all recreation activities; as travel cost, licence fees, access fees, and other expenses increase, participation would decline.
- The cross-price variable indicated that nonconsumptive activities and fishing are substitutes for hunting. As a result, if costs associated with hunting increase, then nonconsumptive participation and fishing can be expected to increase.
- Higher income had a positive relationship to participation in nonconsumptive activities, coldwater fishing, and migratory bird hunting. Increased income was associated with lower participation rates in big game hunting. Income was not an important determinant of participation in warmwater fishing or small game hunting.
- Age was related to participation in fishing, big game hunting, and nonconsumptive activities in a quadratic fashion. That is, age was positively related to participation up to a point after which it had a negative relationship. Increasing age had a negative relationship to migratory game bird hunting.
- People living in urban environments were less likely to participate in hunting and fishing activities. However, given that a person is a hunter or fisher, urban residents were more likely to participate in coldwater fishing and migratory game bird hunting, and less likely to hunt big game. Area of residence did not affect participation in nonconsumptive activities, warmwater fishing, or small game hunting.
- Males were more likely to participate in most consumptive activities. However, given that a person is a hunter or angler, a person's sex did not appear to be an important factor explaining participation in big game hunting or warmwater fishing. A person's sex was not important in explaining participation in nonconsumptive activities.

Table 32.—Description of explanatory variables used in recreation projections.

Variable type	Variable name	Definition
Price variables	Price	Average variable cost or miles per participant in respondent's region of residence.
	Cross-price	Average variable cost or miles per participant in other fish and wildlife activities in respondent's region of residence.
Demand shifters	Income	Respondent's gross household income.
	Employment	Respondent worked for wages last week.
	Age	Respondent's age.
	Education	Respondent's education level.
	Marital status	Respondent's marital status.
	Household size	Number of persons living in respondent's household.
	Race	Respondent's race.
	Sex	Respondent's sex.
	Residence	Respondent's place of residence.
Resource quantity, quality variables	Success rate	Average number of fish caught or wildlife bagged per day or season in respondent's region of residence.
	Forest	Forestland, public and private, in respondent's state of residence.
	Range	Pasture- and rangeland in respondent's state of residence.
	Water	Total fishable water in respondent's state of residence.
	Coldwater	Fishable cold water in respondent's state of residence.
	Warmwater	Fishable warm water in respondent's state of residence.
	Habitat	Migratory waterfowl habitat in respondent's state of residence.
	Songbirds	Maximum value of number of songbird species per ecological stratum in state of residence.
	Big game	Population of big game in respondent's state of residence.

Source: Walsh et al. (1987).

- Employment was not shown to affect most consumptive and nonconsumptive recreation.
- Household size was positively related to participation in hunting and nonconsumptive activities.
- Education level was positively related to coldwater fishing and migratory bird hunting and negatively related to small game hunting.
- Resource availability showed the expected positive relationship with participation levels. Consequently, with improved resource management programs, involvement in wildlife and fish recreation should increase.

National Projections

Indexed participation projections are depicted in figure 46. The results indicate that under the medium-level assumptions described above, more people will participate in nonconsumptive activities, cold and warmwater fishing, and migratory bird hunting over the 50-year planning horizon. Coldwater fishing and primary nonresidential nonconsumptive activities have projected gains exceeding 150%. Warmwater fishing is also expected to gain more participants but at a slower rate than coldwater fishing. Migratory bird hunting,

Table 33.—Indexed projections of the explanatory variables under high, medium, and low assumptions.

	Year	National population (millions)	Median age (years)	Race (percent white)	Sex (percent male)	Disposable personal income per capita ($1000's 1982)	Employment (percent employed)	Education (years)	Residence (percent urban)	Marital status (percent married)	Family size (number)	Average variable cost/day (dollars)
Initial condition	1980	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
	1990	1.122	1.090	0.979	1.000	1.235	1.069	1.047	0.974	0.998	0.997	1.094
	2000	1.269	1.187	0.959	1.000	1.484	1.107	1.094	0.948	0.980	0.994	1.192
High	2010	1.415	1.227	0.939	1.000	1.773	1.068	1.142	0.923	0.979	0.991	1.266
	2020	1.575	1.223	0.922	1.000	2.052	1.008	1.189	0.897	0.977	0.990	1.326
	2030	1.735	1.243	0.905	1.000	2.461	0.973	1.236	0.871	0.975	0.985	1.402
	2040	1.890	1.237	0.889	1.000	3.016	0.932	1.283	0.845	0.974	0.982	1.479
	1990	1.103	1.100	0.983	1.000	1.213	1.052	1.024	1.001	0.984	0.964	1.077
	2000	1.207	1.210	0.967	1.000	1.432	1.071	1.055	1.003	0.969	0.930	1.153
Medium	2010	1.293	1.283	0.951	1.000	1.721	1.025	1.087	1.004	0.953	0.894	1.230
	2020	1.371	1.310	0.937	1.000	2.022	0.994	1.118	1.005	0.936	0.857	1.306
	2030	1.430	1,360	0.923	0.996	2.420	0.958	1.150	1.007	0.921	0.821	1.383
	2040	1.464	1.387	0.909	0.996	2.961	0.920	1.181	1.008	0.905	0.784	1.459
	1990	1.085	1.107	0.985	1.000	1.181	1.019	1.008	1.026	0.969	0.930	1.042
	2000	1.154	1.233	0.971	1.000	1.361	1.091	1.024	1.052	0.936	0.857	1.097
Low	2010	1.194	1.333	0.957	1.000	1.619	0.972	1.039	1.077	1.905	0.787	1.154
	2020	1.214	1.390	0.943	0.996	1.891	0.932	1.055	1.103	0.872	0.714	1.223
	2030	1.208	1.463	0.929	0.990	2.264	0.895	1.071	1.129	0.841	0.644	1.291
	2040	1.169	1.507	0.915	0.984	2.766	0.858	1.087	1.155	0.809	0.571	1.361

following short-term declines, is the only hunting activity expected to show increased participation by 2040. The number of people participating in big game hunting increases slightly in the short-term but shows a 6% decline over the long-term. Small game hunting is the only activity in which participation consistently declines throughout the projection period with an overall loss of 17%.

The model projections (under the medium-level assumptions) were compared to the preliminary findings from the 1985 survey (USDI Fish and Wildlife Service 1988b). The model was used to predict 1985 participation levels by interpolating between the 1980 base year and the 1990 estimate. The model was consistent in terms of the direction of change (i.e., increases and decreases in participation). However, the model underestimated the change in participation of consumptive activities and overestimated the change in nonconsumptive recreationists (fig. 47).

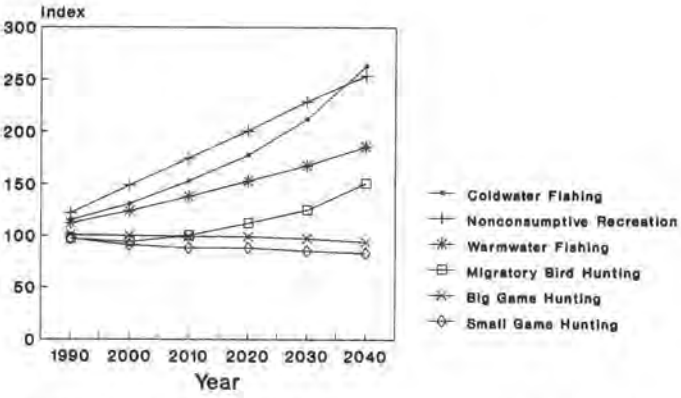
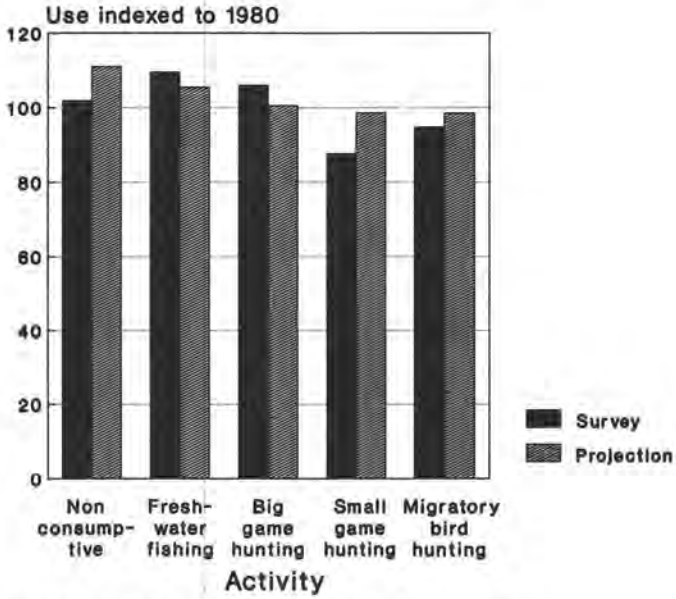


Figure 46.—Projected participation in major wildlife and fish associated recreational activities (Base=1980=100).

The patterns in recreational participation vary under the three alternative future scenarios (table 34). All recreational activities are expected to increase under the high assumption scenario while only nonconsumptive and fishing activities are expected to increase under the low assumption scenario. Despite scenario variation in expected participation levels, all scenarios tend to indicate that hunting, relative to nonconsumptive recreation and fishing, is expected to become less important to the outdoor recreationist.

Regional Projections

Regional wildlife and fish recreation projections were developed by assuming that relative changes in human population levels resulted in an equal percentage change in participation, all other things being equal—a conclusion reached by several studies (Walsh et al. 1987). Regional projections of the price and demand shifting variables were not possible. Consequently, the regional projections of recreation reported here assume no regional variation in the explanatory variables and are



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

Figure 47.—Comparison of 1985 model projections and 1985 Fish and Wildlife Service survey results.

tied only to regional differences in population growth. Based on the projected changes in the distribution of human populations, the Rocky Mountain region is expected to have the largest increases in wildlife and fish recreation with all recreational activities showing an increase in the number of participants over the 1980 base year (table 35). The Pacific Coast and South also are expected to have greater recreational participation than the national average with all activities except small game hunting showing increases over the base year. In the North, where population growth is expected to be the slowest, the indexed change in the number of participants is lower than was predicted for the nation as a whole.

National Forest Projections

Recreational participation rates on national forests have been projected as part of the forest planning process. These projections show the anticipated levels of wildlife and fish recreational activity indexed to a mid-1980 base year (table 36). National forests are expected to receive increased participation in all recreational activities. Nonconsumptive and recreational fishing are

Table 34.—Indexed projections of the number of participants (Base = 1980 = 100) in major wildlife and fish recreation activities under high, medium, and low scenario assumptions.

	Year	Nonconsumptive wildlife-related trips	Fishing		Hunting		
			Cold-water	Warm-water	Big game	Small game	Migratory birds
Base year use (million)	1980	28.8	6.9	29.5	11.8	12.4	5.3
	1990	125	118	115	102	98	100
	2000	160	141	132	105	96	102
High	2010	193	171	152	108	96	112
	2020	227	207	177	114	101	131
	2030	271	261	205	117	103	154
	2040	319	346	241	121	108	199
Compound annual growth rate		1.952	2.090	1.477	0.318	0.128	1.153
	1990	122	115	112	101	97	97
	2000	149	131	124	100	91	94
Medium	2010	175	153	138	99	88	100
	2020	201	178	153	99	88	112
	2030	229	212	168	97	85	125
	2040	254	263	186	94	83	151
Compound annual growth rate		1.566	1.625	1.040	-0.103	-0.310	0.689
	1990	117	111	110	99	95	94
	2000	136	122	118	95	87	87
Low	2010	155	135	126	91	80	87
	2020	171	149	134	87	77	93
	2030	185	167	139	84	71	97
	2040	194	193	145	74	66	110
Compound annual growth rate		1.111	1.102	0.621	-0.501	-0.690	0.159

Table 35.—Indexed projections of recreational activities (Base = 1980 = 100) by assessment region.

Activity and region	1980 users	1990	2000	2010	2020	2030	2040
	Thousands	*Index*					
Nonconsumptive							
North	[1]14,582	116	136	155	176	198	217
South	7,302	125	137	187	217	250	280
Rocky Mountain	2,949	131	169	205	241	281	315
Pacific Coast	4,431	129	165	196	226	259	288
Big game hunting							
North	5,832	96	91	88	87	84	80
South	4,173	104	105	106	107	106	103
Rocky Mountain	1,412	108	113	116	119	119	116
Pacific Coast	969	106	111	111	112	110	106
Small game hunting							
North	5,707	92	83	78	77	74	71
South	4,766	100	96	94	95	93	92
Rocky Mountain	1,534	104	104	103	106	104	103
Pacific Coast	922	102	101	98	99	96	94
Migratory bird hunting							
North	1,576	93	86	89	98	108	129
South	2,544	100	100	107	121	136	166
Rocky Mountain	736	105	107	117	135	153	187
Pacific Coast	632	103	105	112	126	142	171
Warmwater fishing							
North	([2])	107	113	123	134	146	159
South	—	116	131	148	166	184	205
Rocky Mountain	—	121	141	162	184	207	231
Pacific Coast	—	119	138	154	173	191	211
Coldwater fishing							
North	([2])	109	120	136	156	183	225
South	—	118	139	164	193	231	289
Rocky Mountain	—	123	149	179	218	260	326
Pacific Coast	—	122	146	171	201	240	298

[1]*Nonconsumptive use estimates by region were only available for 1985.*
[2]*Breakdown of total freshwater fishing into cold and warmwater fishing was not possible at the regional level.*
Source: Estimates of actual use are from USDI Fish and Wildlife Service, and USDC Bureau of Census (1982).

expected to increase at the greatest rates over the planning period. The Rocky Mountain region shows the greatest gain in nonconsumptive recreation, small game hunting, waterfowl hunting, and total fishing. The South is expected to have the largest increases in big game hunting. Comparison of the relative rates of participation for national forests with those across all ownerships (see tables 35 and 36) shows that national forests are expected to become relatively more significant in providing opportunities to hunt big game and small game species.

PROJECTION OF FEE-HUNTING ON PRIVATE LANDS

Fee-hunting encompasses numerous access and leasing systems, but generally involves charging the hunter for access to the land and may also include charges for taking of animals. The price that is actually charged is dependent on a number of factors including the game species hunted, success, and services offered by the landowner.

Future participation trends in fee-hunting are important because of the implications to wildlife management on private lands (Ruff and Isaac 1987, Wiggers and Rootes 1987). In addition, future studies of fee-hunting could provide previously unavailable transaction-based estimates of wildlife values that are comparable to other natural resources for use in multiple resource planning (Schenck et al. 1987).

Less than one-third of all hunters used public land in 1980 (USDI Fish and Wildlife Service, and USDC Bureau of Census 1982), emphasizing the importance of private land in consumptive wildlife related recreation. However, access is beginning to constrain the opportunity to hunt on private lands. The National Shooting Sports Foundation (1986) found that of the 19 factors that could curtail hunting, access to huntable land was considered

Table 36.—Projections of recreational wildlife and fish user-days (12-hour activity day) by assessment region on national forests (mid-1980 base year).

Activity and region	Mid-1980 user-days	1990	2000	2010	2020	2030	2040
	Thousands	*Index*					
Nonconsumptive							
North	106	100	112	125	140	159	161
South	192	169	182	193	208	224	240
Rocky Mountain	537	124	150	178	206	235	265
Pacific Coast	509	106	136	154	172	190	210
Big game hunting							
North	1,223	106	112	117	125	129	131
South	2,007	119	125	134	137	139	141
Rocky Mountain	4,562	105	108	113	116	122	127
Pacific Coast	2,821	101	107	111	114	118	122
Small game hunting							
North	984	102	108	116	124	128	133
South	1,691	93	98	103	107	113	119
Rocky Mountain	882	104	114	125	136	146	156
Pacific Coast	500	102	108	111	115	119	123
Waterfowl hunting							
North	188	93	106	120	133	146	160
South	107	104	109	116	121	127	133
Rocky Mountain	197	96	109	122	134	148	161
Pacific Coast	94	106	117	126	133	142	150
Total fishing							
North	2,129	98	113	129	149	153	162
South	2,767	84	89	96	101	108	115
Rocky Mountain	5,749	104	119	133	149	165	182
Pacific Coast	4,960	109	131	139	147	155	163

the number one problem facing hunters nationwide. Fee-hunting could change the trend in access to private lands because private landowners who previously denied access may be more willing to exchange permission for remuneration. However, fee-hunting could further compound the access problem. For example, after surveying all 50 states Wiggers and Rootes (1987) found that lease-hunting resulted in more private land opened for hunting in 12 states while four states reported declines.

In 1980, 1.4 million hunters (8% of all hunters) paid either access or lease fees (Langner 1987a). Lease agreements have increased over the last 10 years and are most prevalent in the South and Mid-Atlantic regions according to Wiggers and Rootes (1987), who also speculated that two important factors influencing the prevalence of fee-hunting were a lack of public land and high human populations. Langner (1987a) substantiated these speculated relationships empirically and found that not only did a high percentage of private land increase the probability of participation in fee-hunting, so did hunter experience, education level, and total travel-related hunting expenditures. Income level was also an important factor explaining whether or not a person fee-hunted (Langner, pers. comm., 1987b).

Langner's modeling approach was identical to that of Walsh et al. (1987), and it predicted participation in fee-hunting given that a person was a hunter. Projections of fee-hunting participation thus required projections of explanatory variables and the total number of hunters. Projections of income, education, and travel-related expenditures were taken from table 33 under the medium assumption scenario. Hunter experience and percent land in public ownership were assumed to remain constant. The projected number of total hunters was calculated using the model developed by Walsh et al. (1987).

Application of these assumed changes to the fee-hunting model indicated that the number of hunters participating in some form of fee-hunting could increase more than 150% by 2040 (fig. 48). The proportion of hunters participating in fee-hunting is expected to increase to an even greater degree since the total hunting population is expected to increase only slightly. Based on these results, approximately one in every five hunters may be participating in fee-hunting by 2040.

SUMMARY

Wildlife and fish resource use projections were based on empirical models developed from established national surveys of participation in wildlife and fish recreational activities. These models do not project demand in the economic sense but rather project expected levels of use (measured as number of participants)

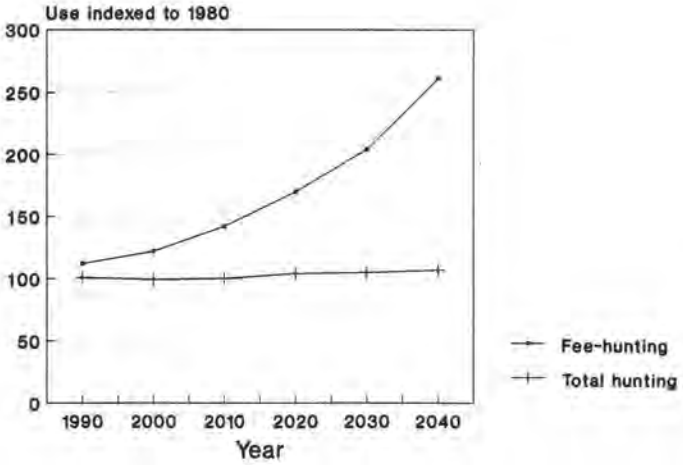


Figure 48.—Projected participation in fee-hunting compared to total hunting.

based on changes in demographic and socioeconomic determinants of participation. The projections assume no direct intervention on the part of resource managing agencies that will either restrict or promote future participation. Rather, the projections reported here examine future trends in wildlife and fish recreation if we assume a continuation of current management levels and public preferences.

The results indicate that the relative importance of various recreation activities related to wildlife and fish will shift. Coldwater fishing and nonconsumptive activities could increase at the greatest rate with the number of participants more than doubling by 2040. In general, hunting could become relatively less important as the number of big game and small game hunters decline. More hunters will probably 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.

Comparing the future trend of wildlife and fish recreation on all ownerships with that expected on national forests, as determined from the forest planning process, indicates that these public lands will become more important in providing outdoor recreation for big game and small game hunters. Mandates requiring multiple resource planning on national forests will help maintain the amounts and quality of future wildlife and fish habitats and also continue to provide the public with opportunities for nonconsumptive and consumptive recreational activities involving wildlife and fish resources.

CHAPTER 3: PROJECTIONS OF WILDLIFE AND FISH RESOURCE INVENTORIES

Projections of wildlife and fish inventories have been difficult to address analytically (Crawford 1984, Hench et al. 1985). This difficulty has limited the incorporation of wildlife and fish objectives into multiple resource planning (Thomas 1986). The data bases and modeling capabilities to support forecasts of wildlife and fish inventories vary depending on the resource attribute of interest. Land-use projection models provide some insights into likely future habitat trends, and regional habitat-based wildlife and fish abundance models have been developed to evaluate land use and land management impacts for a limited number of regions and target species. To present the most complete set of inventory projections covering as many species and as much geography as possible required supplementing conventional analysis with the judgment of resource professionals.

This chapter summarizes the results from the application of these various inventory projection approaches at the national and, where possible, regional level. Inventory projections are discussed for three attributes of wildlife and fish resources. First, habitat is considered by reviewing land use and land cover changes. Second, population is discussed based on information from state and federal agencies and an application of regional habitat-based wildlife and fish abundance models in the South. Third, future wildlife harvest trends are examined.

PROJECTIONS OF HABITAT INVENTORIES

Projected wildlife habitat availability was based on expected changes in land-use and land-cover categories as surrogates for an explicit projection of wildlife and fish habitat. Although land-use and land-cover estimates provide previously unavailable information on future wildlife habitat, they only coarsely indicate how land types and the intensity of land management are expected to change. Explicit statements of wildlife habitat trends will require further research on species-habitat relationships and a commitment to multiple resource considerations at the outset of the analysis.

Overview of Land Use Changes

As part of the resource assessment analysis, the Forest Service recently predicted that the area of major land-use and land-cover categories will change (Bones in press) (table 37). The prediction was based on assumptions about various demographic, social, and economic variables (Darr in press). Forestland is expected to decline slightly over the next 50 years with an overall 4% loss. This represents a continuation of the gradual decline noted during the recent history. Where forestland losses were attributable to cropland conversions during the 1980's, forestland reductions after 1990 are ascribed primarily to urban expansion and reservoir construction (Bones in press).

Rangeland area could increase by approximately 5% as a result of cropland reverting back to rangeland. The increase is expected for two reasons: (1) diminishing surface and subsurface water supplies with an associated rising cost of water could reduce land in irrigated agriculture, and (2) the Conservation Reserve Program is expected to convert substantial acres of highly erodible cropland to permanent grass cover. A more detailed discussion of rangeland area changes and factors explaining these changes can be found in Joyce (in press).

The crop and pasture land projections depicted in table 37 show an overall loss of 94 million acres (an 18% reduction) by 2040. The Conservation Reserve Program has the greatest short-term impact as highly erodible cropland is converted to permanent cover. Other factors also contribute to the decline, such as natural reversion to native vegetation as irrigated acres decline, and conversion to urbanland uses continues. Reduced cropland also has been projected by other resource management agencies. The second appraisal for the Soil and Water Resources Conservation Act (USDA Soil Conservation Service 1987) projected that acres actually planted to crops could decline from 370 million acres to 347 million acres nationwide by 2030.

The increase in "other" land uses will be dominated by the dynamics of urbanland uses. The urbanization of

Table 37.—Major land-use acreage trends for the United States from 1987–2040.

Year	Forest[1]	Range	Crop[2]	Other[3]	Total[4]
			Million acres		
1987	727	770	528	232	2,257
2000	715	809	470	260	2,254
2010	711	809	460	272	2,252
2020	707	809	451	283	2,250
2030	703	810	443	292	2,248
2040	699	810	437	301	2,247

[1]*Includes transition zones, such as areas between heavily forested and nonforested land.*
[2]*Pastureland is included.*
[3]*Includes urban and other land categories.*
[4]*Total area declines due to increased water areas.*
Source: Bones (in press).

rural lands causes particular concern because the conversion is essentially permanent and the associated changes in habitat quality extend beyond urban boundaries. Increased disturbance from humans and domestic animals, conversion of natural vegetation communities, and potential declines in water quality all tend to shift the composition of the animal community to more common native or exotic species that are more adaptable to urban environments (DeGraaf 1986).

The regional shifts in major land uses show the potential for greater land area changes than at the national level (table 38). Regional changes in the commercial timberland acreage portion of the forestland base indicate that all regions could experience acreage reductions over the projection period. The decline in commercial timberland, relative to the acres present in 1982, is expected to be the greatest in the Pacific Coast and the smallest in the Rocky Mountains. The South will probably lose the greatest absolute area (approximately 9 million acres) of commercial timberland as a result of urban expansion and some conversion to cropland (Bones in press).

Regional rangeland area is projected to show significant increases early in the projection period in response to the Conservation Reserve Program (table 38). Acreage increases will be focused in the Rocky Mountain and Southern regions. After the year 2000, rangeland area could decline slightly in the Rocky Mountains and the North but continue to increase slightly in the South and Pacific Coast.

Effects of a Federal Program: The Food Security Act of 1985

The projected changes in the terrestrial land base presented here are based on recent surveys and analyses and suggest a different land base future than has been judged by others in past national reports on wildlife habitat (see Frayer 1987; National Academy of Sciences, National Research Council 1982). Important land-use policy changes are responsible for the new perception of the future. An important policy change with the potential to significantly improve the amounts and condition of wildlife and fish habitat resulted from the Food Security Act of 1985 (also called the 1985 Farm Act). This Act contains several conservation programs directed at reducing soil erosion which may secondarily benefit wildlife and fish habitat.

An important provision of this new policy, the Conservation Reserve Program (CRP), is intended to remove highly erodible cropland from production. The Secretary of Agriculture is authorized to enter into contracts with farmers to take erosion-prone acres out of crop production for a period of at least 10 years. The farmer receives annual rent payments, technical assistance, and cost-sharing payments (up to 50%) to convert these acres into permanent grass or tree cover.

The CRP is anticipated to encourage the conversion of 40 to 45 million acres by 1990. Most of these acres will be converted to grasses. As of the fifth sign-up period (August 1987), about 23 million acres had been

Table 38.—Projection of regional timber and range land uses from 1982–2040.

Land type Region	1982	2000	2010	2020	2030	2040
			Million acres			
Commerical forest						
North	153	152	151	150	149	148
South	194	189	188	187	185	185
Rocky Mountain	61	60	60	60	59	59
Pacific Coast	72	70	69	69	68	67
Range						
North	0.4	0.3	0.3	0.2	0.2	0.2
South	116	128	128	129	130	130
Rocky Mountain	413	440	439	438	437	436
Pacific Coast	241	241	242	242	243	244

Source: Bones (in press).

enrolled with the average size per contract being 110 acres though not necessarily as a continguous land unit. The major crop types that had been affected through the fourth sign-up, in rank order, were wheat (42% of all base acres contracted), corn (23%), sorghum (12%), and barley (11%).

Farmer participation at the regional level has varied. The greatest interest has occurred in the Rocky Mountain region, particularly the Great Plains states where about 10 million acres have been enrolled. The Northern and Southern regions have approximately 5 and 6 million acres under contract, respectively. The Pacific Coast has 1.5 million acres currently enrolled. Based on the projected changes in cropland acres, wildlife and fish habitat will be influenced most significantly in the Rocky Mountains, and next most importantly in the South and North.

Three additional conservation provisions complement CRP objectives: the "Sodbuster," "Swampbuster," and Conservation Compliance programs. The Sodbuster and Swampbuster provisions deny eligibility to receive federal farm subsidies, including price support payments, crop insurance, disaster payments, and low interest loans to those farms that plow new, highly erodible land, or convert wetlands to annual crop production. The Swampbuster provision is particularly important since agricultural development is the major recent cause of wetland drainage and clearing (see chapter 1; Office of Technology Assessment 1984).

The Conservation Compliance provision requires those who produce crops on highly erodible land to comply with an approved conservation plan in order to remain eligible for USDA farm program benefits. Based on the Soil Conservation Service 1982 National Resources Inventory (USDA Soil Conservation Service and Iowa State University Statistical Laboratory 1987), 117.6 million acres of highly erodible cropland existed in 1982. Treatment of these lands through implementation of an approved conservation plan or through enrollment in the CRP could greatly reduce the off-site deposition of sediments to other lands and especially to aquatic ecosystems.

Prior to the passage of this law, perceptions of the amount and quality of future waterfowl and upland game habitat were discouraging. That negative outlook was based on expected increases in cropland acreage, decreased wetland acreage, and increased use of intensive management practices on cropland, forestland, and rangeland (National Academy of Sciences, National Research Council 1982).

Frayer (1987) projected wetland acreage based on a continuation of historical trends between the mid-1950's and the mid-1970's. In that analysis, vegetated palustrine wetlands were estimated to lose 5.5 million acres between 1974 and 2000 (table 39). These changes include 3.8 million acres of forested palustrine wetlands and 1.7 million acres of emergent palustrine wetlands.

Table 39.—Projections of area of wetland types for the conterminous United States 1974–2000.

Wetland type	1974	1986	1990	1995	2000
	Thousand acres				
Estuarine wetland	5,243	4,923	4,850	4,765	4,686
Palustrine open water	4,393	5,599	5,998	6,494	6,987
Palustrine flat	577	641	663	690	717
Palustrine forested	49,713	47,824	47,262	46,584	45,932
Palustrine scrub-shrub	10,611	10,955	11,065	11,200	11,333
Palustrine emergent	28,441	27,559	27,297	26,989	26,701
Total	98,978	97,501	97,135	96,722	96,356

Source: Frayer (1987).

The non-vegetated and open water wetland types were projected to increase in acreage between 1974 and 2000, due to the anticipated creation of pond and reservoir wetland categories.

The wetland projections made by Frayer (1987) exclude expected changes in land use stemming from recent legislation or regulations. The Swampbuster provision of the Food Security Act of 1985, therefore, has the potential to significantly alter Frayer's projections. The possible benefits attributable to this provision can be evaluated by examining recent estimates for the amount of wetland habitat that could be converted to cropland. The Soil Conservation Service 1982 National Resources Inventory identifies nearly 5.2 million acres of nonfederal wetlands classified as having a medium to high potential for conversion to cropland (table 40). Determining those wetlands with potential for drainage was based on the wetland types that were drained in the recent past.

The potential for additional wetland drainage varies by region. The greatest acreage of remaining nonfederal wetland that could be drained occurs in the Northern and Southern regions (table 40). Small amounts of nonfederal wetlands are suitable for drainage in the Rocky Mountain and Pacific Coast regions. However, relative to the total nonfederal wetland area remaining, over 12% could be lost in the Pacific Coast. The Swampbuster provision of the Farm Act was established to stop the incentives paid to private landholders who would convert these forest and range wetlands into cropland.

Table 40.—Nonfederal wetlands with potential for conversion to cropland.

Region	Total wetland acres	Wetland acres with potential conversion to cropland	Percent of total
		Thousand acres	
North	26,183	1,587	6.1
South	38,735	2,518	6.5
Rocky Mountain	8,544	758	8.9
Pacific Coast[1]	2,570	319	12.4
Total	76,032	5,184	6.8

[1]*Excludes Alaska and Hawaii.*
Source: USDA Soil Conservation Service, and Iowa State University Statistical Laboratory (1987).

The potential impact of the Food Security Act on improving wildlife and fish habitat is significant. Substantial increases in upland habitat associated with agricultural lands, maintenance of wetland acres, and sizable reductions in soil erosion could prove beneficial to small game, nesting waterfowl, nongame animals, and fish. Whether this potential is realized depends on several factors. Under Gramm-Rudman-Hollings budget restrictions, future appropriations could be reduced (Cubbage and Gunter 1987) thereby lessening the effectiveness of the conservation programs. Increases in commodity prices could decrease farmers' dependence on federal subsidies. Alternatively, hunter participation in lease agreements which, unlike timber harvesting and grazing, is permitted under the Food Security Act, could provide increased incentive for farmers to manage for wildlife habitat on their lands. Finally, questions arise concerning the long-term implications to wildlife and fish habitat following the 10-year contract period. When all of these considerations are brought together, the future habitat impacts ascribable to the Food Security Act, while providing reason for optimism, are subject to considerable uncertainty.

PROJECTION OF POPULATION INVENTORIES

Information on future wildlife population levels was available from several sources. State wildlife and fish agencies provided both short-term (1995) and long-term (2040) projections of wildlife populations. The National Forest System (NFS) and Fish and Wildlife Service provided additional sources for projections stemming from their management responsibility. A fourth contribution came from regional habitat-based population models. These models were developed and used to predict wildlife and fish abundance changes in response to land use and timber management changes across all land ownerships in the South (Flather et al. in press, Flebbe et al. 1988).

Table 41.—Indexed projections in big game populations by region (Base = 1985 = 100), with number of states contributing to regional mean shown in parentheses.

Region Species	1995		2040	
North				
Wild Turkey	153	(8)	214	(7)
White-Tailed Deer	102	(9)	97	(7)
Black Bear	109	(5)	107	(5)
South				
Wild Turkey	128	(7)	122	(5)
White-Tailed Deer	114	(9)	111	(8)
Black Bear	133	(4)	150	(3)
Rocky Mountain				
Wild Turkey	203	(5)	208	(5)
Deer	114	(11)	115	(10)
Elk	125	(8)	144	(7)
Pronghorn	101	(10)	115	(9)
Black Bear	106	(5)	105	(5)
Pacific Coast				
Wild Turkey	198	(2)	198	(2)
Deer	99	(3)	100	(4)
Elk	110	(1)	107	(2)
Pronghorn	100	(1)	100	(2)
Black Bear	120	(1)	110	(2)

State Agency Population Projections

The projections provided by the state wildlife and fish agencies contributed the most complete geographical information. The short- and long-term percentage change estimates from 1985 represent professional judgement on the likely future condition of selected big game and small game populations. These estimates considered historical population trends, likely future land-use changes, and proposed wildlife management practices. State estimates were summarized as a regional mean of reporting states weighted by the 1985 animal population level within each state. In general, most state agencies are optimistic that populations will increase for both big and small game in the next 10 years, with some exceptions.

Big Game

Eastern big game populations could be generally higher in the future (table 41). Wild turkey is one species for which important increases are forecasted. The substantial historical increase noted in the North (see chapter 1) is expected to continue through 2040. Projected turkey increases in the South, although more moderate than in the North, also represent a continuing historical trend. Several factors influence the expected changes in wild turkey populations. Translocation as a management practice and immigration into suitable habitats could contribute to future population growth.

White-tailed deer in the North could maintain their mid-1980's population with regional estimates ranging within 3% of the 1985 estimates. The maturing forests, lower rates of farm abandonment, and less timber

harvesting contribute to stable deer populations in the North. In the South, white-tailed deer populations are expected to show slight increases through 2040.

Black bear populations in both the North and the South could moderately increase. In the short-term, the expected increase in the North will be slightly more conservative than in the South. In the long-term, both regions could realize less than a 10% increase from 1985 population levels.

The Rocky Mountain states expect, in general, greater short- and long-term gains in big game populations than were reported in the East (table 41). Wild turkey populations are expected to double in the short-term on the Great Plains with little additional increase expected by 2040. As in the East, increased turkey populations will come from translocation practices and natural immigration.

Future population increases for the region's three most abundant ungulates will range from 44% for elk to 15% for deer and pronghorn. Elk populations could gradually and consistently increase over the next 50 years. This growth will result from continuing the favorable habitat conditions and successful population management strategies implemented during the last 20 years. Modest increases in deer (both mule and white-tailed) populations are foreseen with mountain states expected to do better than the plains states. More plains states reported future deer declines, possibly due to anticipated conversion of cropland acres to permanent grass under the Conservation Reserve Program. Pronghorn populations could remain stable over the next 10 years. However, from 1995 to 2040 both mountain and plains states express mixed expectations about pronghorn numbers with the regional average trend being slightly upward.

In the Pacific Coast region, only the wild turkey could show significant changes from the mid-1980's population level. Turkey populations could nearly double over the next 10 years. All other big game species, including deer (mule, black-tailed, and white-tailed), elk, pronghorn, and black bear could remain at 1985 population levels or increase slightly (not exceeding 10%) by 2040. No clear geographic pattern, habitat factor, or management action explains why the states anticipate the changes they have reported with the exception of wild turkey, the expanding populations of which are a product of the nationwide management attention this bird has received and will continue to receive.

Small Game

Most small game species are projected to either remain stable or increase over 1985 population estimates (table 42). Northern bobwhite are a notable exception to this pattern. Over the species' primary range, populations could continue the decline that has occurred over the last 20 years. Although the rate of decline is less than in recent history, the bobwhite is not expected to recover to 1985 population levels.

In the South, all the small game species for which projections were available showed short-term declines or stable population levels. Quail show the greatest decline, followed by squirrels and rabbits. Only rabbits and grouse are expected to exceed the mid-1980's population by 2040.

Table 42.—Indexed projection in small game populations by region (Base = 1985 = 100), with number of states contrib. g to regional mean shown in parentheses.

Region Species	1995		2040	
North				
Forest Grouse	110	(5)	101	(4)
Pheasant	120	(2)	150	(1)
Quail	93	(3)	93	(3)
Rabbit	112	(3)	106	(3)
Squirrel	105	(3)	120	(3)
South				
Forest Grouse	100	(2)	120	(2)
Quail	94	(5)	94	(3)
Rabbit	98	(4)	106	(2)
Squirrel	95	(4)	98	(2)
Rocky Mountain				
Forest Grouse	100	(2)	100	(2)
Prairie Grouse	98	(4)	97	(4)
Pheasant	189	(5)	185	(5)
Quail	123	(5)	115	(5)
Rabbit	154	(2)	208	(2)
Squirrel	117	(3)	117	(3)
Pacific Coast				
Forest Grouse	100	(1)	100	(2)
Prairie Grouse	120	(1)	109	(2)
Pheasant	101	(2)	120	(3)
Quail	([1])		100	(1)
Rabbit	100	(1)	100	(1)

[1]*No data provided.*

In the North, only the bobwhite could decline. Ruffed grouse populations could remain relatively stable over the projection period. Stable grouse populations appear related to the low level of forest regeneration in general, and in particular, the recent loss of the aspen-birch forest type. Anticipated pheasant population gains in the North are attributed to improved upland habitat quality associated with the CRP. Although the CRP's long-term impacts remain unknown, state wildlife agencies expect pheasants to increase consistently through 2040. Rabbit populations could show moderate short-term gains, then dwindle to mid-1980's levels in the long-term. Squirrel populations could grow 5% per decade over the 50-year projection period, mostly because of maturing forests.

The anticipated expansion of intensive management for southern forests, greater human population increases in the South compared to the North, and further maturing of the northern hardwood forests collectively explain the disparate small game projections for these eastern regions. Similarly, differences in the perceived habitat improvement benefits stemming from the CRP explain differences in projected species responses. While the pheasant could respond favorably to the CRP, the bobwhite probably will not because overhead cover requirements provided by woody shrub species is less likely

to develop on CRP acres during the 10-year contract period.

In the Rocky Mountain region, states are optimistic about all upland small game populations except for prairie grouse species (table 42). Most species could experience modest increases over the next 10 years and these gains could either be maintained or increase further in the long-term.

The majority of the small game populations in the Pacific Coast region could remain stable over the projection period. Pheasant and prairie grouse are exceptions to this pattern with regional population gains of 20% for prairie grouse in the short-term, and for pheasant in the long-term.

National Forest System Population Projections

As part of the Forest Planning process, individual national forests are required to project the likely future status of natural resources. For this assessment, a combination of habitat models and professional judgment was used to project big game population. The majority of species could increase in response to proposed management activities (table 43).

Black-tailed deer, a mule deer subspecies typically managed as a distinct group, presents a major exception. Although the combined trend for Forest Service Region 5 (California and Hawaii) and 6 (Oregon and Washington) is slightly upward, combining across regions masked important differences in this case. In Region 6, black-tailed deer populations are expected to decline by nearly 20% over the projection period. Presumably, this trend is owed to changes in forest succession. Early stages of secondary succession following logging develop into midsuccessional stages unfavorable to black-tailed deer. Region 5 populations could increase by approximately 25%, which more than offsets the declines noted in Region 6. All other Pacific Coast big game populations could increase or remain stable over the 50-year planning period.

All other assessment regions anticipate big game increases. The South shows substantial long-term gains in wild turkey, white-tailed deer, and black bear. The population increases on national forests are predicted to be relatively greater than total increases anticipated by state agency personnel. Consequently, NFS lands will tend to support a greater proportion of the South's big game populations. This scenario appears consistent with the expected intensification of timber management on private land in this region.

As in the South, big game populations on northern national forests could consistently increase over the projection period. For all species except wild turkey,

Table 43.—Regional big game population trends for national forests.

Region Species	Mid-1980	1990	2000	2010	2020	2030	2040
				Thousands			
North							
Wild Turkey	34	52	53	54	55	56	56
White-Tailed Deer	327	321	327	334	340	347	354
Moose	6.6	6.5	6.6	6.6	6.7	6.8	6.9
Black Bear	11.8	9.8	10.3	10.9	11.4	11.9	12.5
South							
Wild Turkey	123	253	258	275	283	289	291
White-Tailed Deer	281	392	290	405	436	437	440
Black Bear	3.7	5.4	6.2	6.3	6.5	6.6	6.8
Rocky Mountain							
Wild Turkey[1]	59	134	139	144	148	153	158
Mule Deer	1,055	1,152	1,181	1,196	1,218	1,238	1,260
White-Tailed Deer[2]	284	304	317	320	322	325	327
Elk	408	476	496	511	527	541	556
Bighorn Sheep[2]	16	28	29	31	31	31	32
Pacific Coast[3]							
Wild Turkey	8.3	10.8	12.2	14.3	16.3	18.4	21.5
Mule Deer	336	338	376	382	386	392	398
Black-Tailed Deer	412	407	441	433	425	421	423
White-Tailed Deer	16	16	16	16	16	16	16
Elk	94	95	96	98	99	100	101
Bighorn Sheep	2.0	2.0	2.1	2.2	2.3	2.4	2.5
Black Bear[4]	17	17	17	17	17	17	17

[1]*Data from Forest Service Regions 2 and 3.*
[2]*Data from Forest Service Regions 1, 2, and 3.*
[3]*Data from Forest Service Regions 5 and 6.*
[4]*Data from Forest Service Region 6.*

increases are slight (less than 10%). Wild turkey numbers could increase by 62% on national forests compared to a total 114% increase projected by state personnel.

All big game species on national forest lands in the Rocky Mountain region could show long-term population increases. However, the relative increases may be either equal to or more moderate than those anticipated across all regional ownerships. Deer population projections on national forests, relative to mid-1980's levels, show a gain equal to that anticipated by state agency personnel. Wild turkey and elk show lower relative increases on national forests compared to state agency data.

Fish and Wildlife Service Population Projections

As one of the federal government's lead agencies for fish and wildlife conservation and management, the Fish and Wildlife Service must prepare various resource management plans. One common component of these plans is the specification of future wildlife and fish resource status. Future status is often defined as habitat, population, or harvest objectives to be reached through implementation of management activities. In other cases, future status is described as a continuation of recent trends. This section summarizes the findings from two national plans, one on waterfowl and one on fishing.

The North American Waterfowl Plan (USDI Fish and Wildlife Service and Canadian Wildlife Service 1986a) aims to restore those duck and goose populations which have declined recently (see chapter 1), and it also calls for maintaining current numbers for all other waterfowl species. The plan has a 15-year horizon, to the year 2000, and proposes habitat acquisition, improvement, and restoration to accomplish the population objectives. Under the assumed implementation strategy, the Fish and Wildlife Service projects that breeding population levels for the 10 most common species of ducks will increase from the 27 million birds observed in 1985 to 36 million by 2000. Successful implementation depends, to a large degree, on funding. Since cost estimates for plan implementation exceed anticipated federal appropriations, the private sector and states will play a critical role in meeting funding requirements.

To assess the nation's future hatchery fish requirements, the Fish and Wildlife Service conducted a national survey (USDI Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife 1968b). The findings from this survey indicate that fishable water is expected to increase from 87.1 million acres in 1980 to 104.6 million acres by 2040—an overall increase of approximately 20%. This projection was based on water quality improvements on streams and lakes, accelerated stocking programs, and expected reservoir construction.

Habitat-Based Abundance Projections for the South: A Case Study

Past assessments of natural resources have relied on a limited application of analytical approaches to project resource supplies and inventories. Assessments have also been criticized for not analyzing resource response in a multiple resource context (Schweitzer et al. 1981). In response to such criticism, Joyce et al. (1986) developed a regional modeling framework designed to analyze multiple resource responses to land management activities. The southern United States was chosen as a test area for application because this region was already the focus of a regional study of timber resources. The combining of these two efforts resulted in the first regional evaluation of timber resources that also analyzed multiple resource impacts stemming from timber management actions and changing land use (USDA Forest Service 1988). This case study represents a prototype of how future national assessments may address regional multiple resource analyses.

Linking wildlife and fish resources into the multiple resource framework required the capability to predict resource response to general land management activities. The objective of the wildlife and fish modeling component was to develop regional abundance and occurrence models that were consistent with and responsive to models that projected regional shifts in land use and timber inventory characteristics. Models were developed for white-tailed deer, wild turkey, red-cockaded woodpecker, and trout. A detailed description of the wildlife and fish models can be found in Flather (1988), Flather et al. (1989), and Flebbe et al. (1988).

Projection Approach

The description of a species' habitat depends on the scale of the resource management problem. At a regional scale, patterns in land use and forestland characteristics define a coarse representation of wildlife and fish habitat. For fish, this approach represents an extension of within-stream habitat models to consider changes in the watershed land base where streams occur.

The modeling approach is patterned after Klopatek and Kitchings (1985) and uses discriminant function analysis to establish statistical relationships between land use and forestland descriptors, relative abundance classes of white-tailed deer, wild turkey, and trout, and occurrence of active red-cockaded woodpecker nesting colonies. The wildlife models used counties as the sampling unit while the fish model used watersheds defined by the U.S. Geological Survey.

Land base data were obtained from Forest Service inventories (USDA Forest Service 1985a) for area estimates of commercial timberland for forest cover types (natural pine, planted pine, oak-pine, upland hardwood, and lowland hardwood) and forest age classes. The Soil Conservation Service's 1982 National Resource Inventory (USDA Soil Conservation Service and Iowa State University Statistical Laboratory 1987) was used to estimate area in all other land types including cropland, pastureland, rangeland, and human-related land uses (urbanland, roads, railroads, farm structures, strip mines).

Projected changes in land use and land cover (i.e., forest type, cropland, pastureland, rangeland, and

human-related land uses) were provided by a land area projection model developed by Alig (1984). Changes in forest age classes were provided by the timber resource inventory model (Tedder et al. 1987). Projected changes in the land base were applied to the wildlife and fish models to estimate the impacts on the wildlife and fish species that were modeled. The result is an indexed projection of wildlife and fish abundance or occurrence in future years compared with the 1985 base year. Separate projections for the Southeast (Virginia, North Carolina, South Carolina, Georgia, and Florida) and South-central (Texas, Oklahoma, Arkansas, Louisiana, Mississippi, Tennessee, and Alabama) were made for the wildlife species. Trout projections are reflective of the coldwater fishery area in the southeast.

Results

To accomplish the objective of modeling the possible impacts of changing land use and forest vegetation characteristics on wildlife and fish abundance and occurrence, a number of assumptions were required. These assumptions acknowledge those factors which influence wildlife and fish numbers and habitat relationships but which cannot be incorporated into the modeling framework. Quantified characterization and inclusion of these assumptions into regional models will require further research. The specific ecological assumptions made in this analysis were as follows:

1. Wildlife and fish populations used in establishing the habitat relationship models occurred at the habitat's carrying capacity.
2. Wildlife and fish population changes predicted over the projection period (1985–2030) are due solely to changes in land use and forestland characteristics. Consequently, factors other than habitat, including competition, harvest rates, and wildlife and fish population management practices, are assumed to remain constant over the projection period.

These are obviously simplifying assumptions; although changes in factors are likely, data were not available to incorporate their influence into species habitat relationships or to project their influence over time. In addition, the wildlife and fish modeling effort represents an impacts analysis that is entirely driven by the land use and the timber inventory projections. Feedback mechanisms, whereby the wildlife and fish responses alter the timber resource and timber management activities, are being considered for future research.

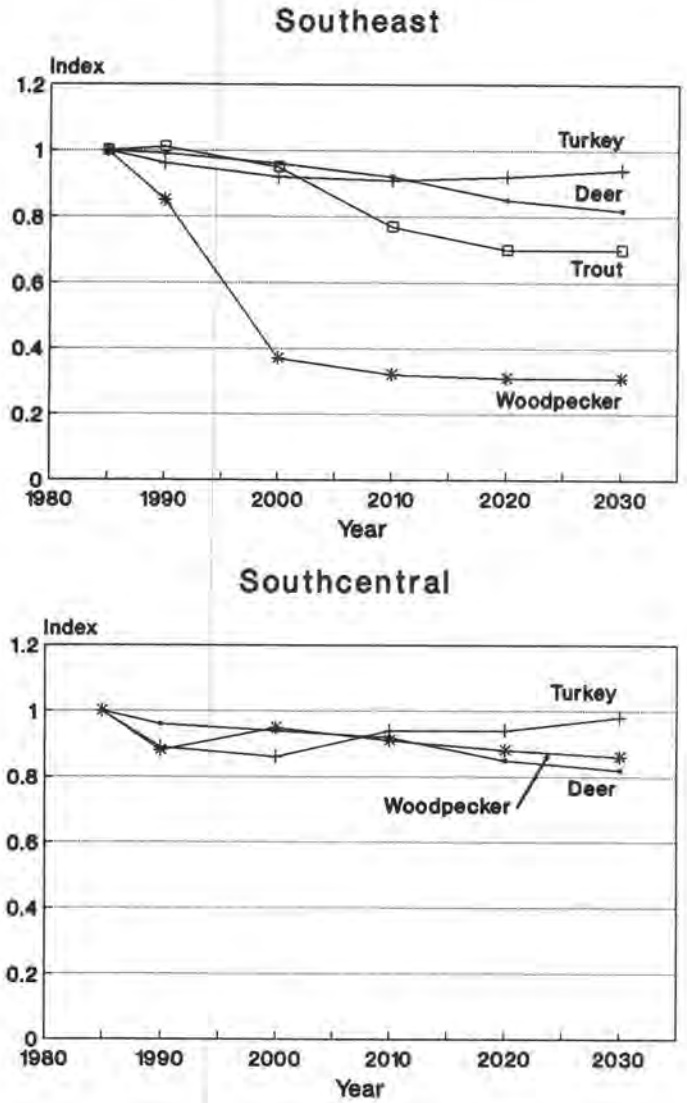
In light of these assumptions, projections were made for a baseline condition representing the likely future demand for timber products and what level of timber management would be required to ensure that timber supplies would meet that demand. The land area changes under this likely future baseline condition for the Southeast and South-central between 1985 and 2030 are summarized in table 44. The overall land use and forest type patterns are similar across the two regions and the projected trends indicate more intensive forest management and more human dominated land uses. Forest area in general, and to a lesser degree pasture, declined over the projection period. Cropland showed only slight increases in the South-central region. Area of human-related land uses showed relatively large increases across both subregions. The most notable forest type changes that occurred were conversion of natural forest types to pine plantations. Natural pine accounts for the majority of the converted acres; however, oak-pine and upland hardwood types also were harvested and planted to pine. The major changes in forest stand structure involved gains in younger forest age classes in both subregions, and increases in older hardwood age classes in the South-central.

Table 44.—Projected land area changes (percent of total land base) in the South between 1985 and 2030.

	Southeast		South-central	
	1985	2030	1985	2030
Total cropland	14.6	14.6	18.5	18.9
Total pasture/range	12.9	12.1	17.8	14.5
Human-related land	9.0	12.3	5.9	9.9
Total forestland	57.8	55.3	54.9	53.7
Natural pine	14.6	7.6	11.1	7.2
Planted pine	8.5	15.7	4.6	14.1
Oak-pine	6.6	6.7	9.7	6.5
Upland hardwood	18.7	17.2	20.2	17.4
Lowland hardwood	9.4	8.1	9.3	8.5
Age class 1 (0–20 yrs.)	10.3	15.1	16.6	18.6
Age class 2 (20–50 yrs.)	24.2	14.9	31.3	15.0
Age class 3 (50+ yrs.)	14.8	9.6	2.4	6.0
Hardwood age class 1	6.4	11.1	12.5	14.1
Hardwood age class 2	14.7	11.3	24.7	12.5
Hardwood age class 3	13.5	9.6	2.1	5.8
Pine age class 1	5.8	6.7	8.1	7.3
Pine age class 2	12.8	7.5	12.1	5.8
Pine age class 3	2.6	0.1	0.5	0.5

The wildlife and fish responses to these land base changes are shown in figure 49. White-tailed deer, a species with relatively general habitat requirements, was not closely correlated in its response to changes in any single land cover characteristic. Deer are projected to experience approximately 18% density declines in both subregions. The decline was attributed to an overall loss of forested habitat acres, specifically upland hardwoods and the conversion of natural pine and oak-pine stands to planted pine. Increased acreage in human-related uses including urbanland and roads also contributed to the overall decline in deer numbers. Human-related land use not only directly reduces available habitat but is generally associated with higher mortality resulting from increased hunting pressure and human-related disturbance.

Wild turkeys have more specific habitat requirements than deer and were closely tied to the hardwood component of the forestland base. Increased human-related land use acres and the general loss of upland hardwood and oak-pine types contributed to the early decline. However, after the year 2000, average turkey density increased slightly in the Southeast and recovered in the



Source: Flather et al. (1989); Flather (1988); Flebbe et al. (1988)

Figure 49.—Projected changes in wildlife and fish abundance under the baseline conditions for the Southeast and South-central regions.

South-central in response to increased acreage of older hardwood stands.

The red-cockaded woodpecker showed the greatest decline of all species in the Southeast. Projections were made for the occurrence of active nesting sites within a county. The number of counties supporting active nesting colonies declined by nearly 70% in the Southeast and 20% in the South-central. The red-cockaded woodpecker has highly specialized habitat needs. Mature pine stands are required for nesting habitat. The decline followed conversion of mature natural pine to planted pine on private plantations. The leveling off in the number of counties supporting active colonies happened because of the expected retention of mature pine stands on federal ownerships, particularly national forests.

As was observed with the wildlife species, trout abundance in the coldwater region of the Southeast also declined. The approximately 30% decline reflected a decrease in the older age classes of hardwoods and increased area in human-related land uses. Implicit in these relationships are factors such as water temperature, instream cover, and shading that are favorable for trout under older hardwoods and unfavorable under most land cover other than forests.

The habitat-based abundance results for white-tailed deer and wild turkey are more pessimistic than the state agency projections. Under an assumed future of increased urbanization and more intensive timber management, both big game species are predicted to decline. However, the habitat-based models predict what may occur if no consideration is given to future wildlife management activities directed at altering the projected trends. For this reason, the projections reflect only a potential future for deer and turkey in the South. State and federal agencies have the option to intensify deer and turkey management to offset perceived declines, and this may be reflected in the projections provided by these agencies. Similarly, private landowners may find increased economic incentive (e.g., trespass fees, hunter lease agreements) to manage their lands for wildlife production. What this analysis has shown is that increased management expenditures and more intensive wildlife and fish management likely will be required in the future if deer, turkey, and trout populations and suitable nesting sites for red-cockaded woodpeckers are to be maintained in the South.

PROJECTION OF HARVEST INVENTORIES

Projections of future harvests were obtained from state and federal wildlife agencies. Because harvest is more easily monitored than populations, many wildlife management agencies use harvest as an indicator of wildlife population status. State and NFS personnel provided estimates of the likely future harvest based on anticipated changes in animal populations, available habitat, and participation rates in hunting. The Fish and Wildlife Service projected future duck harvests under assumed implementation of the North American Waterfowl Plan.

State Agency Harvest Projections

Estimates of harvests for 1995 and 2040 were treated in the same manner as state agency population projections. State estimates of the percentage harvest change from 1985, for each species, were summarized as a regional mean that was weighted by 1985 harvest estimates. In general, state agencies expect harvest levels for the majority of species to increase. All of the notable declines in future harvests were reported for small game species primarily associated with agricultural habitats.

Big Game

Big game harvests are regulated to a greater degree than are harvests of small game species. For this reason, the projected harvests of big game are affected by both

harvest regulations and animal population level. Most big game harvests could increase by 1995 (table 45) and the majority by more than 20%. The Pacific Coast region, in general, is an exception to this pattern. Deer and elk harvests could increase slightly by 1995 declining toward 1985 levels by 2040. Bear harvests could remain stable throughout the projection period. Wild turkey is the only big game species in the Pacific Coast region for which harvests could increase significantly—nearly doubling by 1995.

Wild turkey harvests across all regions will show the most consistent and largest relative short-term increases. Both the North and Rocky Mountain regions expect increases of about 40% by 2040. Turkey harvests in the South could increase 50% by 1995, yet the increase will probably not last over the projection period but decline to within 15% of 1985 levels.

Deer harvests in the East could increase by 1995 and then remain stable through the remainder of the projection period. Deer harvests in the Rocky Mountains could increase similarly to the East by 1995. However, short-term gains may not be maintained as projections by 2040 decline to 1985 harvest levels. Given that western deer populations are projected to remain stable from 1995 through 2040, declining harvests may reflect expected declines in the number of future big game hunters pursuing deer.

Harvest projections for the remaining big game species in the Rocky Mountain region are generally optimistic. Steady increases are expected for elk harvests through 2040 for all reporting states. Pronghorn harvests could increase in the short-term. The long-term projection for pronghorn is mixed in terms of the magnitude and the geographic location of the change, but on average is expected to decline slightly compared to 1995 estimates.

Small Game

Species which associate with either agriculture or forest could experience some short-term declines in harvest levels (table 46). The majority of these declines are minor with the exception of the quails. Northern bobwhite harvests are expected to decline by approximately 15% in the South while quail harvests in the Pacific Coast are expected to drop 50%, both by 1995. Lower quail harvests are expected to continue over the projection period in all regions with the Pacific Coast, Rocky Mountain, and Southern regions expecting long-term declines greater than 20%. Declining quail harvests were expected given the previously noted population declines.

Other species for which slight harvest declines are anticipated by 1995 include ruffed grouse and squirrel in the North, and rabbit and squirrel in the South. The trends for squirrel and rabbit harvests are consistent with the habitat trends in the South. Estimates of future ruffed grouse harvests are difficult to interpret based on either habitat or hunter effort since they demonstrate cyclic population patterns that have yet to be satisfactorily explained.

Table 45.—Indexed projection in big game harvests by region (Base = 1985 = 100), with number of states contributing to regional mean shown in parentheses.

Region Species	1995	2040
North		
Wild Turkey	114 (9)	139 (7)
White-Tailed Deer	123 (13)	121 (11)
Black Bear	125 (6)	110 (5)
South		
Wild Turkey	152 (8)	115 (9)
White-Tailed Deer	128 (8)	126 (6)
Black Bear	139 (4)	179 (3)
Rocky Mountain		
Wild Turkey	136 (10)	143 (9)
Deer	128 (11)	118 (11)
Bear	123 (5)	99 (4)
Elk	114 (8)	139 (7)
Pronghorn	125 (11)	117 (10)
Pacific Coast		
Wild Turkey	196 (3)	195 (4)
Deer	106 (3)	102 (4)
Elk	106 (1)	102 (2)
Pronghorn	([1])	100 (1)
Black Bear	100 (1)	100 (2)

[1]*No data provided.*

Table 46.—Indexed projection in small game harvest by region (Base = 1985 = 100), with number of states contributing to regional mean shown in parentheses.

Region Species	1995	2040
North		
Grouse	97 (8)	100 (6)
Pheasant	136 (9)	122 (7)
Quail	98 (9)	86 (8)
Rabbit	113 (10)	103 (9)
Squirrel	98 (10)	107 (9)
South		
Grouse	100 (1)	125 (1)
Quail	84 (6)	79 (4)
Rabbit	102 (4)	103 (3)
Squirrel	99 (6)	109 (4)
Rocky Mountain		
Forest Grouse	224 (8)	215 (7)
Prairie Grouse	143 (9)	92 (8)
Pheasant	142 (10)	122 (9)
Quail	99 (8)	77 (9)
Rabbit	153 (9)	143 (8)
Squirrel	117 (8)	113 (8)
Pacific Coast		
Forest Grouse	110 (1)	108 (2)
Prairie Grouse	100 (1)	100 (2)
Pheasant	99 (3)	99 (4)
Quail	50 (2)	59 (3)
Rabbit	103 (2)	102 (2)
Squirrel	100 (1)	100 (1)

Pheasant and prairie grouse harvests could increase over the primary ranges largely because of increased habitat and subsequent population growth derived from the CRP. The gain is primarily a short-term expectation.

Harvests after 1995 depend on the longevity of the CRP and accessibility of private lands to small game hunters.

National Forest System Harvest Projections

Future big game harvests on national forests (table 47) are generally correlated with anticipated increases in populations. The one exception is Pacific Coast black bear harvests which could increase despite stable populations over the projection period (table 43). All other big game species could experience consistent gains in harvest over the 50-year planning period. The greatest harvest increases, relative to the mid-1980's estimate, could occur with wild turkey in all regions, black bear in the Pacific Coast and South, and bighorn sheep in the Rocky Mountains. Mule deer could show the greatest absolute harvest increase in the Rocky Mountains.

In general, the relative increase in big game harvests from the national forests is greater than the totals reported by state agencies. Consequently, national forests could become more important to big game hunters. An important causal factor that may affect this projection is limited private land access. This observation is amplified in the west where, historically, the harvest of some big game species has come almost exclusively from federal ownerships (Hoekstra et al. 1981).

Fish and Wildlife Service Harvest Projections

As described under the population projection section of this chapter, the Fish and Wildlife Service has set harvest objectives for waterfowl under assumed implementation of the North American Waterfowl Plan (USDI Fish and Wildlife Service and Canadian Wildlife Service 1986a). The harvest objectives specified in the plan would permit 2.2 million hunters to harvest 20 million ducks annually, for an average seasonal harvest of 9.1 birds per hunter by the year 2000. Realization of these objectives is contingent upon full completion of the management schedule for purchase, protection, and improvement of approximately 5.5 million acres of waterfowl habitat in the United States and Canada.

SUMMARY

Wildlife and fish resource inventory projections were based on professional judgments and empirical models. The results from these various analyses indicate that the South and Rocky Mountain regions will have the most significant future land base changes. The South is expected to lose acres in natural vegetation cover to urban and cropland development. The Rocky Mountain region, which includes the Great Plains, is expected to experience the largest increases in the rangeland base due to plantings associated with the Conservation Reserve Program under the 1985 Farm Act. Other Farm

Table 47.—Regional big game harvest trends for national forests.

Region Species	Mid-1980	1990	2000	2010	2020	2030	2040
				Thousands			
North							
Wild Turkey	5.7	5.7	5.8	5.9	6.0	6.2	6.2
White-Tailed Deer	54	55	56	57	58	59	60
Moose	0.32	0.39	0.40	0.40	0.40	0.41	0.41
Black Bear	1.3	1.3	1.4	1.5	1.5	1.6	1.7
South							
Wild Turkey	10	27	29	32	33	34	35
White-Tailed Deer	49	57	59	62	64	65	66
Black Bear	0.45	0.70	0.82	0.86	0.96	1.0	1.4
Rocky Mountain[1]							
Mule Deer	166	168	175	181	187	193	199
White-Tailed Deer	41	42	45	45	46	46	46
Elk	61	62	64	66	67	70	71
Bighorn Sheep[2]	0.22	0.23	0.24	0.26	0.27	0.29	0.30
Pacific Coast[3]							
Wild Turkey	0.19	0.66	1.7	2.5	3.1	3.8	4.7
Mule & Black-Tailed Deer	55	60	64	65	68	69	72
Elk	16	16	16	17	17	17	18
Black Bear[4]	1.3	1.4	1.5	1.6	1.7	1.8	2.0

[1]*Data from Forest Service Regions 1, 2, and 4.*
[2]*Data from Forest Service Regions 1 and 2.*
[3]*Data from Forest Service Regions 5 and 6.*
[4]*Data from Forest Service Region 6.*

Act conservation programs also have the potential to significantly reduce the rate at which wetland habitats are converted to cropland, and also to reduce the sedimentation of wetlands and other aquatic habitats.

Wildlife population projections provided by state agencies tended to be consistent with the projected changes in habitat. All big game populations and harvest levels for which information was available are expected to increase or remain stable over the 50-year projection period. The future for small game populations and harvests is less optimistic. Historical declines in northern bobwhite populations and harvests are expected to continue. Pheasant populations and harvests, however, are projected to respond favorably in all regions to increased habitat resulting from the CRP.

The state agency projections implicitly consider the effects of planned wildlife management activities on future wildlife populations. Analyzing the impacts of changing land use and timber management while holding wildlife and fish management constant was the subject of a case study (and regional prototype for future assessments) in the South. Projections of white-tailed deer, wild turkey, red-cockaded woodpecker, and trout distribution and abundance indicated that all species could decline in the future. The results of this case study demonstrated that under expanding human populations and more intensive timber management, more intensive wildlife and fish management will be required to maintain or improve future wildlife and fish populations.

Wildlife and fish inventory projections provided by federal managing agencies indicated that national forest lands will continue to become more important to wildlife and fish resources in the future. Objectives specified by the Fish and Wildlife Service under two national plans, if realized, are expected to reverse the declining trends in waterfowl populations and harvests that have been observed in the recent past, and to increase the amount of fishable waters.

CHAPTER 4: COMPARISON OF RESOURCE INVENTORY AND USE PROJECTIONS

An important question to be addressed by natural resource assessments is whether future resource supplies are capable of supporting future levels of resource demand. The economic theory that supports supply-demand comparisons of commodity resources is not applicable to resources that are not produced, bought, or sold in a traditional competitive market. Consequently, for wildlife and fish, such comparisons are based on projected levels of resource use and inventories. Wildlife and fish recreational use and resource inventories have been projected as independent quantities in chapters 2 and 3. To make inventory-use comparisons, an analysis approach is required that converts units of use (number of recreationists) and units of inventory (number of animals, acres of habitat) into a common base.

The approach used in the 1979 national assessment for big and small game hunting compared the projected percentage change in wildlife populations to the projected percentage change in the number of hunters (USDA Forest Service 1981). Although such comparisons indicated change in the potential consumptive pressures placed on wildlife populations, the approach failed to acknowledge that participation in wildlife and fish recreation depends partly on resource availability (Hay and McConnell 1984, Hof and Kaiser 1983, Walsh et al. 1987).

This assessment uses a different approach to make inventory-use comparisons. As described in chapter 2, Walsh et al. (1987) developed a series of models that empirically related participation in wildlife and fish recreational activities with factors thought to be important in explaining that participation. Resource supply was one factor explicitly used in these models, and this inclusion allowed an examination of how changes in resource supplies might alter participation in wildlife and fish recreational activities.

The recreational use projections reviewed in chapter 2 presented expected levels of participation in major wildlife and fish recreational activities due solely to socioeconomic determinants of recreation preferences and recreation participation rates. These projections are interpreted to represent a *base level* participation that could be expected assuming a future level of resource inventory similar to that which was available to recreationists in the past. Changing the level of resource availability not only acknowledges the uncertainty associated with the future status of wildlife and fish inventories, but also provides a means to examine situations where future resource inventories may not be sufficient to meet projected base level participation.

This chapter is organized into three major sections. First, the resource supply variables for each wildlife and fish recreational activity are defined and reviewed. This is followed by an analysis of the sensitivity of projected participation in wildlife and fish recreation to hypothetical alternative future wildlife and fish resource inventory situations. The final section addresses the degree to which habitat, population, and harvest changes projected in chapter 3 will affect future participation in wildlife and fish recreational activities, and the degree to which base level use (demand) will be met by future resource inventories (supply).

INDICATORS OF WILDLIFE AND FISH RESOURCE SUPPLIES

Habitat area affects wildlife and fish population levels, which in turn affect the resource available for viewing by nonconsumptive recreationists and harvest by anglers and hunters. Past studies of factors affecting participation in wildlife and fish recreational activities have acknowledged the relationship between habitat and animal populations. Typically, they used acres of habitat, abundance of wildlife, or harvest success rates interchangeably to examine resource supply effects on recreational opportunities and the quality of the recreational experience. The indicators of resource supply reported here are those that Walsh et al. (1987) found to be important, based on statistical criteria, in explaining participation in wildlife and fish recreation.

Although one or several of the basic supply indicators listed above were incorporated into each model, the actual supply indicator used varied by recreational activity reflecting, in part, basic differences in the factors affecting participation in each activity.

For primary nonresidential nonconsumptive recreation, total acres of forest, pasture, and range in each state were used as the resource supply proxy. These land types collectively represent a basic measure of the amount of natural habitats available to wildlife, which are in turn the output sought by the nonconsumptive recreating public. Forestland was defined to include all areas at least 10% covered by trees of any size. Pasture and rangeland were defined as areas predominantly vegetated by grasses, legumes, forbs, or shrubs suitable for grazing but excluding land used for orchards, vineyards, or other crops. It was assumed that increases in more intensive land uses (e.g., cropland and urbanland) would decrease the opportunity to participate in, and the attractiveness of an area for, primary nonresidential nonconsumptive activities.

Participation in hunting was also affected by the amount of public and private forest, pasture, and range in each state. Although some cropland is used for hunting, Walsh et al. (1987) assumed that increases in cropland area tends, in general, to destroy game habitat. McConnell (1984) found that increasing the amount of cropland decreased the likelihood of persons engaging in hunting activities.

Resource supply indicators for specific hunting activities included:

Big game hunting.—Total population of deer, elk, moose, pronghorn, black bear, bighorn sheep, mountain goat, boar, and wild turkey within the respondent's state of residence.

Small game hunting.—Average number of small game harvested per day in the respondent's region of residence.

Migratory bird hunting.—Average number of migratory game birds harvested per day in the respondent's region of residence.

Participation in fishing was affected by the acreage of fishable water available to potential anglers in each state. Fishable water area was chosen as the appropriate supply indicator over total inland water area since only 73% of the streams sampled in the National Fisheries Survey (Judy et al. 1984) were found capable of supporting sport fish populations during some portion of the year. Failure to sustain game fish was attributed to intermittent flows and water quality problems (see chapter 1).

Participation in coldwater fishing was further affected by the proportion of fishable waters specifically capable of supporting a coldwater fishery. State estimates of the proportion of total fishable waters suitable for coldwater fishing were used to estimate the availability of coldwater fish habitat (Resources for the Future 1980). Participation in warmwater fishing had a stronger statistical relationship with the average number of warmwater fish species taken per day than the availability of warmwater fish habitat.

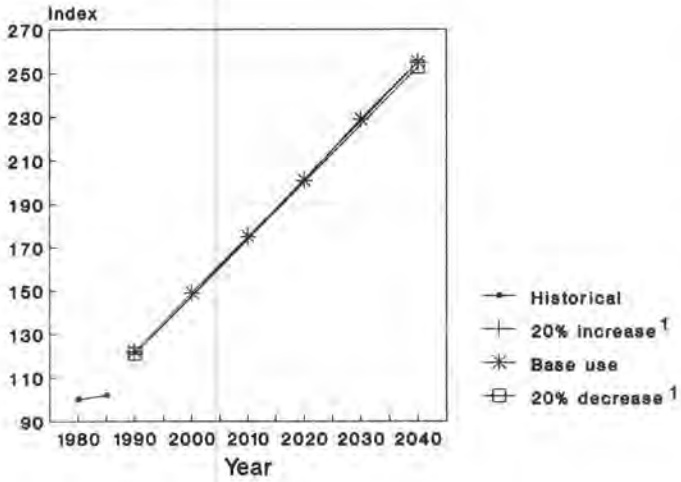
In addition to the statistical criteria used in selecting resource supply variables, data availability also limited the full suite of potentially important resource supply indicators that could be examined. For example, the actual land area open to the recreating public would be a better indicator of resource availability than total forest, pasture, or range, particularly in the East where private land ownership dominates. Similarly, area of habitat of varying quality would also be a likely important indicator of resource supply. However, nationally complete information on each state's land area open to the public or the amount of habitat in various quality classes was not available. Consequently, potentially better indicators of resource supply are definable, yet current inventory information does not support an examination of their effect on participation in wildlife and fish recreational activities at this time. This fact should be kept in mind when interpreting the relative sensitivity of each recreational activity to changes in resource supply.

SENSITIVITY OF RECREATIONAL USE TO CHANGES IN RESOURCE SUPPLIES

Potential changes in public participation in wildlife-related recreational activities that could be attributed to resource management activities were evaluated by altering the level of the resource supply indicators within the recreation participation models developed by Walsh et al. (1987). Resource management activities that could be interpreted as beneficial or detrimental to wildlife and fish habitat or populations were represented by assuming a 20% increase or decrease in the activity-specific supply indicators. The number of recreationists under inflated and deflated resource supply conditions were compared to the base level projections reviewed in chapter 2 to measure the sensitivity of each activity to changes in resource supply. The sensitivity of each recreational activity to changes in resource supply are shown in figures 50–55. Each figure shows the recent historical participation from chapter 1, the base level use projection from chapter 2, and projections depicting the sensitivity of each recreational activity to changes in resource supply. Participation levels have been indexed to a 1980 base year which was set to 100 to facilitate comparison across recreational activities. Equal portions of the assumed change in resource supply indicators are applied to each decade such that the total change in resource supply by 2040 is equal to 20% of the base year.

Nonconsumptive Wildlife-Related Recreation

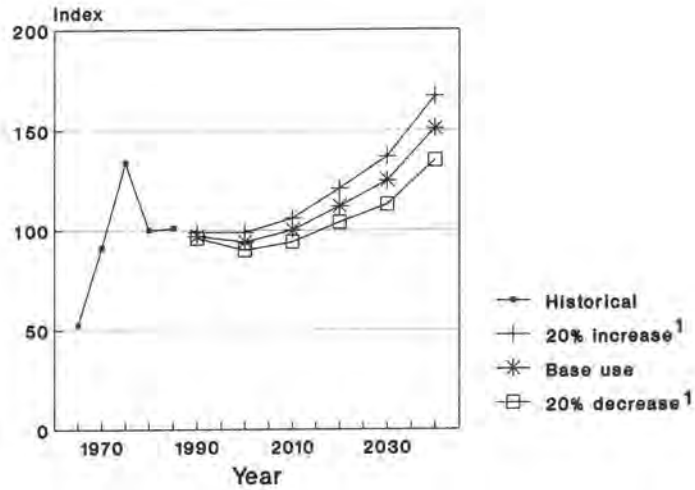
Primary nonresidential nonconsumptive wildlife recreation was not sensitive to a 20% change in the amount of forest, pasture, and range (fig. 50). Hay and McConnell (1984) also found that resource availability was not an important factor explaining participation in nonconsumptive wildlife recreation. The low sensitivity of primary nonresidential activities to changes in resource supply may be a function of two factors. It may



[1]Use based on 20% increase or decrease in resource inventories.

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

Figure 50.—Sensitivity of primary nonresidential nonconsumptive recreation to changes in resource supply (Base = 1980 = 100).



[1]Use based on a 20% increase or decrease in resource inventories.

NOTE.--Historical trends based on participants 12 years old and older that hunted waterfowl

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

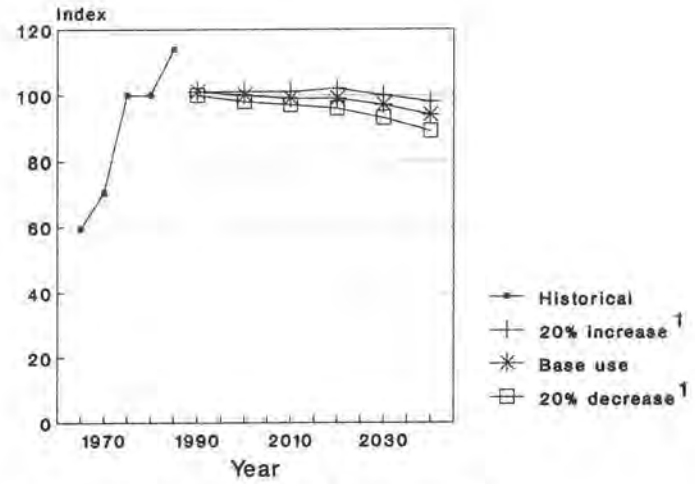
Figure 51.—Sensitivity of migratory bird hunting activities to changes in resource supply (Base = 1980 = 100).

indicate that an appropriate measure of resource supply has not yet been specified, or it may be that current resource supplies are more than sufficient to support current recreational activity. Considering that nonconsumptive activities are less constrained to a particular season, current opportunities to observe, photograph, or study wildlife may be sufficient to support current public demand for primary nonresidential activities. Determining whether model misspecification or sufficient supplies is the reason for the observed relationship will require further research.

Recreational Hunting

Hunting activities tended to be more sensitive to changes in resource supply than nonconsumptive activities although specific types of hunting vary considerably. Migratory game bird hunting was the most sensitive with a 20% increase in resource supply resulting in a greater than 10% change from base level participation (fig. 51). The habitat supply indicator for migratory game bird hunting is measured as the amount of forest, pasture, and range acres within a state. A wetland habitat variable was examined but found to be insignificant in explaining participation in migratory game bird hunting (Walsh et al. 1987). A similar observation was made by Miller and Hay (1981) and may be related to the inclusion of webless migratory game bird hunters (e.g., woodcock and dove hunters) in this category of recreational use.

Big game hunting was the second most sensitive activity to changes in resource supply (fig. 52). A 20% change in acres of forest, pasture, and range habitats and in big game populations resulted in a 5% change in the number of big game hunters. A major assumption in the



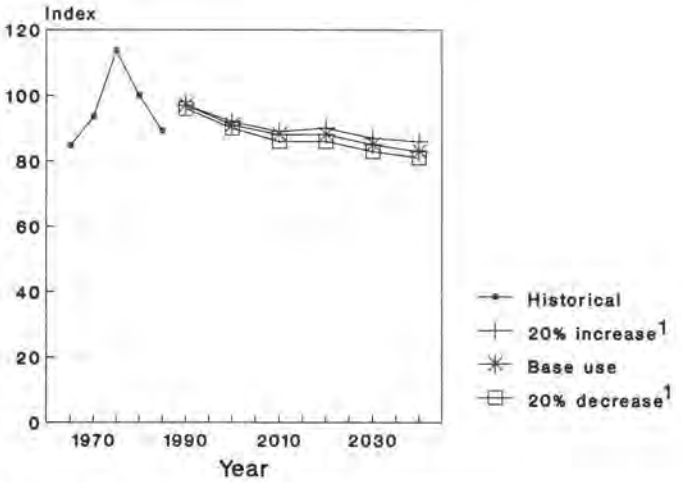
[1]Use based on 20% increase or decrease in resource inventories.

NOTE.--Historical trends based on participants 12 years old and older

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

Figure 52.—Sensitivity of big game hunting activities to changes in resource supply (Base = 1980 = 100).

analysis of big game hunting was that increases or decreases in animal populations were important information used by potential big game hunters in deciding whether or not to participate. Given the noted concerns for decreased accessibility to hunting land, crowded hunting conditions (National Shooting Sports Foundation 1986), and the projected increases in hunter lease agreements, future big game participation may become



[1]Use based on a 20% increase or decrease in resource inventories.

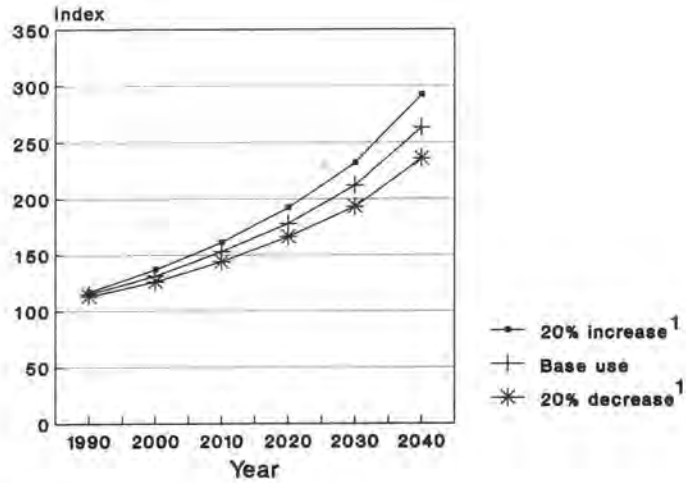
NOTE.--Historical trends based on participants 12 years old and older

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

Figure 53.—Sensitivity of small game hunting activities to changes in resource supply (Base = 1980 = 100).

more dependant on accessible game and lease prices than total game populations.

Small game hunting was least sensitive to changes in resource supply (fig. 53). The assumed 20% change in forest, pasture, and range habitat and in the number of small game animals harvested per day translated into a 4% change in the number of small game hunters compared to the base level projection. Small game hunting was the only wildlife-related recreational activity for which statistically significant relationships between participation and an activity-specific measure of resource supply could not be found (Walsh et al. 1987). The lack of significant relationships between recreation use levels and resource supply probably indicate that more appropriate measures of small game resource supply exist. As reviewed in chapter 1, the evidence suggests that declines in small game hunters results from limited access to suitable habitat, increasingly crowded hunting conditions, and declining game populations (National Shooting Sports Foundation 1986). Apparently, current supplies are insufficient to maintain the quality of the recreational experience. Although the actual availability of small game habitat and populations and levels of crowding are difficult to measure, such indicators of supply may more accurately reflect the resource supply determinant of participation in small game hunting. An additional consideration is that the analysis of small game use may be too coarse. It may not adequately account for the potential differences in the factors that determine whether, for example, a quail hunter or squirrel hunter decides to hunt.



[1]Use based on a 20% increase or decrease in resource inventories.

Figure 54.—Sensitivity of coldwater fisheries to changes in resource supply (Base = 1980 = 100).

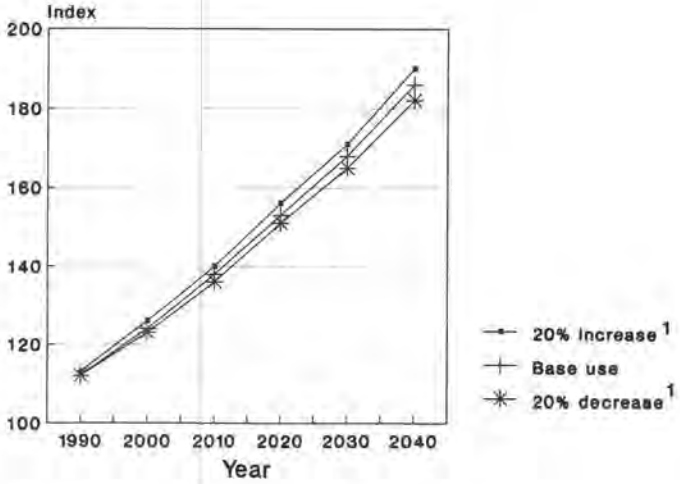
Recreational Fishing

Coldwater fishing on inland waters (excluding saltwater and Great Lake fishing) was found to be more sensitive to changes in the resource supply indicators than was warmwater fishing. An assumed 20% change in the proportion of a state's fishable waters suitable for coldwater fishing resulted in nearly an 11% change from the base level condition (fig. 54). Comparisons to historical trends were not possible since the National Survey of Fishing and Hunting (USDI Fish and Wildlife Service, and USDC Bureau of Census 1982) did not differentiate between cold- and warmwater fishing. Coldwater fishing was the most sensitive recreational activity to changes in resource supply. Observed participation could deviate dramatically from the base level projection in response to the future availability of fishable waters.

The decision of whether to participate in warmwater fishing was a function of both the amount of fishable water in general, and specifically the number of warmwater fish species caught per day. Warmwater fishing appears to be less sensitive to shifts in resource supply with a 20% change yielding only a 2% shift in the number of warmwater fishers (fig. 55).

IMPLICATIONS OF RESOURCE INVENTORY PROJECTIONS ON RECREATIONAL USE

Sensitivity analysis indicated the relative magnitude of recreational use response to hypothetical changes in resource supply indicators. Incorporation of resource inventory projections into the inventory-use comparison approach previously outlined provides an opportunity to examine whether anticipated levels of resource inventories will meet base level projections of resource use.



[1]Use based on a 20% increase or decrease in resource inventories.

Figure 55.—Sensitivity of warmwater fisheries to changes in resource supply (Base = 1980 = 100).

Increasing human populations imply that future recreationists will each find less habitat and fewer animals. Accounting for the per capita availability of resources has been shown to be important in capturing the effect of crowding on the availability of recreation opportunities (Hay and McConnell 1984, Walsh et al. 1987). Based on this logic, wildlife and fish inventory-use comparisons would be better based on two alternative resource supply situations. The first would be to predict the number of recreational participants, assuming that habitat and animal populations will be maintained, resulting in a per capita decline in the future availability of resource supplies. The second would be to examine participation levels using the projected habitat and animal populations provided by federal and state resource managing agencies. This latter projection represents the future status of wildlife and fish resources assuming implementation of state and federal management programs. These two comparisons, reviewed below, provide one evaluation of the extent to which future resource management will meet anticipated levels of use.

Declining Per Capita Resource Availability

Dividing the various resource supply indicators for each recreational activity by the projected human population level (see table 33, medium level assumptions) results in a 32% decline in wildlife and fish resources available to each potential recreationist by the end of the projection period (year 2040). Migratory game bird hunting and coldwater fishing show the greatest declines from the base condition (table 48). The crowded conditions implied under this analysis result in at least a 10% decline in the number of coldwater fishers and migratory bird hunters. More moderate declines in the number of big game hunters and small game hunters are noted. Warmwater fishing showed the least percentage decline from the base condition of all the consumptive recreational activities. Nonconsumptive recreation showed essentially no deviation from the base level use projection—an expected result given the low sensitivity of nonconsumptive recreation to shifts in resource supply.

State and Federal Agency Projections of Resource Inventories

Given the declining participation under the per capita resource availability projection, a legitimate question arises. To what extent will anticipated land base changes and planned wildlife and fish management activities support a greater level of recreational participation than that projected under the declining per capita availability of resources? In other words, what proportion of the recreational user "gap" depicted in table 48 will be eliminated by future resource management activities?

The land base, population, and harvest projections are reviewed in detail in chapter 3. A brief national summary is presented here. The amount of land classified as forest, pasture, or range is expected to change little over the projection period of this report. The 26 million acre decline in forest area and the 40 million acre increase in pasture and range results in a 1% net gain

Table 48.—Comparison of national base level recreational use projections to projected use under declining per capita availability of resources at 2040 (Index = 1980 = 100).

Use projection	Nonconsumptive recreation	Coldwater fishing	Warmwater fishing	Big game hunting	Small game hunting	Migratory game bird hunting
Base level[1]	254	263	186	94	83	151
Per capita resource availability	253	232	179	87	79	127
Difference	1	31	7	7	4	24
(% of Base)	*	(12)	(4)	(7)	(5)	(16)

[1]*From chapter 2.*
Less than 1%.

in land area capable of supporting wildlife and fish recreational activities. Changes in aquatic habitat (defined as fishable water) could potentially increase by 20% according to the USDI Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife (1968b). For this analysis, the 20% gain in fishable water was assumed to be distributed equally among both cold- and warmwater fisheries. Big game populations are expected to increase over the projection period. A sum across state agency big game projections indicates that an 11% gain in the number of big game animals can be expected if management activities planned by the state are actually implemented. Under a similar assumption, harvest levels of small game are expected to increase only 2% nationwide. The relatively small gain in the resource supply indicator for small game hunting is due primarily to declines in species associated with agricultural habitats, particularly northern bobwhite (see table 46). If habitat acquisition and habitat improvement activities scheduled in the North American Waterfowl Plan are accomplished, then hunter success (average number of birds bagged) is projected to increase by 17% (USDI Fish and Wildlife Service and Canadian Wildlife Service 1986a).

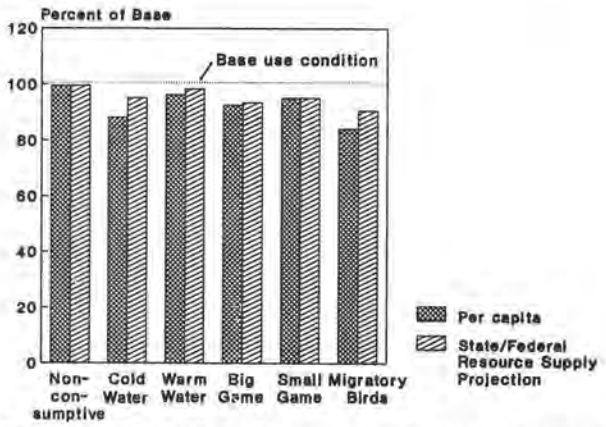


Figure 56.—Comparison of resource use projections under per capita availability and state/federal projection of future resource supplies as a percentage of base use conditions at 2040 (Base = 1980 = 100).

Recreational use projections under this set of resource supply indicators showed that even under assumed implementation of proposed management to improve future resource supplies, a relatively large component of unmet "demand" may remain for migratory game bird hunting (fig. 56). More moderate deviations from base level use, in rank order, were observed for big game hunting, coldwater fishing, and small game hunting. Nonconsumptive recreation and warmwater fishing deviated the least from base conditions.

SUMMARY

Comparison of wildlife and fish resource use and resource inventories is complicated by the fact that the number of people engaging in wildlife and fish recreation depends on the availability of wildlife and fish habitats and populations. A modeling approach that explicitly considered the relationship between recreational use levels and resource inventories provided a framework within which to compare the resource use and inventory projections. Coldwater fishing and migratory game bird hunting were the recreational activities most sensitive to changes in resource supply, followed by big game hunting, small game hunting, and warmwater fishing. The number of nonconsumptive recreationists was not affected by changes in the resource supply variable.

Increasing human populations imply that there will be less habitat and fewer animals per potential recreationist. A comparison of recreational use projections under two different resource supply situations—one assuming declining per capita resource availability, and another based on resource projections provided by state and federal agencies—indicate that migratory game bird hunting could potentially have the greatest proportion of "unmet demand." Big game hunting, coldwater fishing, and small game hunting had potentially moderate levels of unmet demand. The social, economic, and environmental implications of these comparisons, and of the use and inventory projections in general, are the subject of chapter 5.

CHAPTER 5: SOCIAL, ECONOMIC, AND ENVIRONMENTAL IMPLICATIONS OF WILDLIFE AND FISH INVENTORY AND USE PROJECTIONS

Wildlife and fish inventory and use projections have certain social, economic, and environmental implications. Social implications concern the behavior of individuals and groups and encompass cultural, societal, psychological, and physiological aspects. Economic implications concern consumption and production relationships, human community impacts, and monetary aspects of wildlife and fish resources. Environmental implications, arising out of concern for ecosystem health, are ultimately based on understanding the functioning of ecological systems.

Past evaluations of social, economic, and environmental implications of resource supplies and demands have tended to focus primarily on direct implications. However, direct implications stemming from resource use and management may represent only a small part of the cumulative impacts that can trace throughout social or ecological systems. Although people generally recognize that accounting for cumulative impacts is important, characterizing them can be especially difficult (Harris 1988). The complexity of social and environmental systems, as reflected in our limited understanding of how these systems respond when perturbed (human-induced and otherwise), hampers attempts to quantitatively address the implications. Consequently, this chapter largely synthesizes the literature on the potential impacts, direct and cumulative, as they relate to the uses and inventories of the nation's wildlife and fish resources.

SOCIAL IMPLICATIONS

Brown and Manfredo (1987) defined a social value typology that includes cultural, societal, psychological, and physiological values. These categories were used to discuss social implications. Although they are defined as separate classes of social value, they are not mutually exclusive.

Cultural Values

Different cultures, as defined by language, geographic boundary, and common historical and ethnic heritage (Kellert 1980), perceive and use wildlife and fish differently. Being able to use wildlife and fish resources in a manner consistent with those perceptions reinforces the social bond related to a person's cultural heritage.

Of the four social value categories, those dealing with cultural matters have been controversial regarding wildlife and fish resource use in recent years. For example, Native Americans' desire for increased jurisdiction over wildlife and fish resources to ensure preservation of their cultural heritage conflicts with the public trust doctrine (Steiner and Roberts 1987) in which state and federal governments control the management of wildlife and fish resources. The issue is an ongoing legal struggle concerning cultural values (Skoog 1979). Included in this conflict is the harvest of threatened and endangered species by Native Americans for subsistence and religious purposes (Bean 1986).

The general problem of illegal harvest also has roots in varying cultural values held for wildlife and fish resources. Disregard for harvest regulations can often be traced to traditional values held by certain cultural segments of society (see Anderson 1988).

Although individuals and cultural groups concede that wildlife and fish resources can only sustain a finite amount of consumptive use, determining and regulating appropriate resource distribution has been difficult (Cook 1982, Van Ballenberghe 1986). Failure to resolve the conflicts stemming from differences in cultural values could result in excessive use of wildlife and fish resources.

Societal Values

Societal values concern relationships among people and include family and social cohesion, social interaction, and community use values (Brown and Manfredo

1987, West 1986). Differences in societal values held by different cultures sharing a common resource have contributed to the difficulty in mediating resource use. Native Americans tender religious, subsistence, and other societal reasons for experiencing and consuming wildlife and fish resources. More recent immigrants to North America have societal values that include building personal character and social bonding among family and friends while participating in wildlife and fish related outdoor activities (Driver and Brown 1986). The implications of plural societal values are that wildlife and fish are important to different segments of the United States population in different ways. Despite variation in the public's interpretation of societal values, all interpretations share the basic similarity that family, community, and nation receive constructive influences from wildlife and fish.

Psychological Values

The psychological value of wildlife and fish is most obvious to the recreational user. The value of the opportunity to spend time in a natural environment observing or photographing wild animals, catching trout, or stalking big game is difficult to describe or quantify. Equally difficult to quantify is the value that a person derives from just knowing that species exist within a functioning ecosystem even though he or she may never use the resource directly (e.g., view or photograph that species). These experiences can be described in terms of the psychological value to an individual's personal well being. The cumulative implications stemming from this direct psychological benefit are broad and include increased productivity in the work place, enhanced creativity, enhanced cooperation, and increased respect for the law (Driver and Brown 1986, Ewert 1986). While the majority of individuals in the United States have positive psychological feelings toward wild animals, some people do dislike or find some wild animals to be threatening (Kellert 1980).

Physiological Values

Wildlife and fish resources can be of physiological benefit to individuals. Many recreational, commercial, and subsistence pursuits of wildlife and fish resources require a high degree of physical exertion resulting in fitness benefits to participants (Ewert 1986). Certain recreational experiences are perceived as a "competition" between human being and animal that involves mastering certain physical skills in order to observe, photograph, or harvest wild animals. Participants often express the belief that engaging in wildlife and fish recreation improves physical health through exercise, change of pace, and reduction of stress (Brown and Manfredo 1987).

Implications to Future Social Values

The wildlife and fish use and inventory projections reviewed in chapters 2, 3, and 4 raise concerns over the ability of wildlife and fish habitats and populations to meet future public demands for these resources. If resource inventories are not maintained and improved, then future social benefits currently attributable to wildlife and fish resources may decline. Wildlife and fish recreational activities could become overcrowded with an overall reduction in perceived societal, psychological, or physiological benefits as quality of experience is degraded.

Restricting future levels of use can facilitate balancing resource use with existing resource inventories. However, limiting the public's opportunity to enjoy wildlife and fish will not only infringe on the lifestyles of certain cultural segments of society but may also reduce or eliminate recreational outlets for which few complete substitutes exist (Krutilla and Fisher 1975). An alternative management option that at least maintains the social benefits attributable to wildlife and fish resources is to increase inventories to accommodate anticipated levels of use. The opportunities that exist to accomplish this, as perceived by state and federal managing agencies, are discussed in chapter 6.

ECONOMIC IMPLICATIONS

Economic implications are those that affect the way in which goods and services are produced, consumed, and exchanged in society. For wildlife and fish, economic implications are discussed as the effects on consumers (e.g., changes in "prices" paid for wildlife and fish outputs) and the effects on local economies and resource management budgets (e.g., changes in gross expenditures that ultimately affect businesses and resource managing agencies that support or provide wildlife and fish outputs).

Consumer or Price Effects

The capability to measure monetary value or prices varies with the way a resource is bought or consumed by the public. Unlike timber, mineral, and livestock resources which are generally bought and sold in the market place, wildlife and fish outputs are primarily produced and consumed outside traditionally organized markets. Exceptions to this generalization are found with commercial products such as fish and furs, and with fee-access for wildlife and fish recreation.

Commercial Products

Dockside salmon prices from 1979 to 1985 (measured in constant 1979 dollars) went from 77 cents/pound to

43 cents/pound, while total value (price x harvest) went from $413 million to $310 million—reductions of 44% and 26%, respectively (USDC National Oceanic and Atmospheric Administration, National Marine Fisheries Service 1979, 1985). Average pelt prices and total fur value received by trappers have also declined (Linscombe 1988). Between 1979 and 1985, the average real price per pelt received by trappers declined by 50%, while real total value declined by 75% (see figs. 26 and 29).

Predicting change in future dockside salmon and pelt prices is difficult; however, there are indications that scarcer resources could result in increased future prices for these commercial products. Weber (1986) discussed the concern for excessive salmon harvests and the need to restrict the future take to ensure future stocks are not depleted. If such restrictions are implemented, it seems likely that salmon prices will increase. Fur prices are variable due to changes in fashion. Assuming a constant demand for natural furs, then habitat losses, particularly wetland habitats, and potential restrictions in harvest from anti-trapping sentiments, are likely to limit pelt supplies resulting in future price increases.

Recreational Value of Wildlife and Fish

Apart from these commercial products, actual cash transactions for wildlife and fish outputs are relatively uncommon. In the absence of actual transactions, researchers have had to rely on indirect measures of wildlife and fish recreational values (Davis and Lim 1987).

Recreational and experiential uses of wildlife and fish have been measured in a variety of ways (Stoll 1986), but all methods involve estimates of prices consumers would be willing to pay under a market situation (Verburg et al. 1987). The two primary techniques used during the last 20 years for estimating recreational value of wildlife and fish are the "indirect actual market," or travel cost method, and the "direct hypothetical market," or the contingent value method (Peterson et al. n.d.). As described by Rosenthal et al. (1984), the travel cost method uses actual observations of travel costs and travel time from various origins to a particular recreation site, characteristics of that recreation site, and characteristics of consumers to indirectly estimate the price consumers may be willing to pay for a given recreational activity. Under the contingent value method, surveys are designed to directly elicit price estimates that consumers would be willing to pay for different types of recreational activities under a series of hypothetical situations.

In an effort to estimate the value of various wildlife and fish recreation activities, Sorg and Loomis (1984) summarized the best available information based on these indirect value estimation techniques. Brown and Hay (1987) subsequently estimated wildlife and fish recreational values from each state based on the 1980 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (USDI Fish and Wildlife Service, and USDC Bureau of Census 1982) using the contingent value method. The wildlife and fish recreation values estimated from these two sources vary and reflect, in part, value differences associated with changes in location (site or state). Although the range in estimates is high, recreationists appear willing to pay the most for a day of big game hunting, followed by waterfowl hunting, small game hunting, coldwater fishing, and warmwater fishing (table 49).

Future Trends in Recreation Values

Given this review of current recreational value estimates, an important consideration for resource decision-making is whether future values will change, and in what direction. Peterson et al. (n.d.) described some factors that are responsible for changes in recreational economic values over time including: (1) changes in the real value of money, (2) changes in the real value of recreation due to supply and demand changes, (3) changes in methods and measurements, and (4) confusion over concepts and definitions. Factor 1 can be controlled by converting nominal values into real (net of inflation) dollars. Factors 3 and 4 affect the interpretation of historical value trends as evidence for future trends. While it is important to control for factors 1, 3, and 4, estimating change in value is most dependent on factor 2—namely, how will future supply (inventory) and demand (use) relationships for wildlife and fish resources influence future value?

In theory, changes in the balance between inventories and use would change wildlife and fish prices in the same fashion as though these resources were market goods. The results of the inventory and use comparisons reviewed in chapter 4 indicate that future inventories of wildlife and fish habitats and populations may not be capable of supporting the desired levels of recreational use. Under such a future, economic theory would project an increase in wildlife and fish recreation prices. In addition to resource scarcity, the lack of perfect substitutes for wildlife and fish recreation activities (Krutilla and Fisher 1975) also would suggest future increases in the economic value of wildlife and fish recreation.

Although theory suggests that prices will increase, the magnitude of the increase is unknown. Research on economic valuation of wildlife and fish resources has focused primarily on current estimates of value because no accepted or reliable method for predicting future values presently exists (Schweitzer and Stone 1987).

Despite the methodological problems associated with projecting future values, some data can be used to estimate the rate of value change based on trends from

Table 49.—Estimates and range of net economic values for various wildlife and fish recreational activities.

Activity	Activity day values in 1982 dollars		
	Sorg and Loomis Range	Brown and Hay Range	Brown and Hay Mean
	Dollars/day		
Big game hunting[1]	18–132	15–33	22
Small game hunting	16–43	—	—
Waterfowl hunting	16–85	9–26	15
Coldwater fishing[2]	9–38	8–33	14
Warmwater fishing	15–26	—	—

[1]*Brown and Hay estimates are for deer hunting only.*
[2]*Brown and Hay estimates are for trout fishing only.*
Note: All values were rounded to the nearest dollar.
Source: Brown and Hay (1987), Sorg and Loomis (1984).

the recent past. Peterson et al. (n.d.) and Sorg and Loomis (1984) were able to compare estimated values for coldwater fishing and deer hunting in three western states. Two time periods, at least 5 years apart, were used. Adjustments were made in the estimates to control for methodological differences, and comparisons were made within states to control for site differences. Based on these results, the real value of coldwater fishing appears to have increased from the late 1960's to the early 1980's at an average annual rate of 8.6% in Idaho and 5.5% in Arizona (table 50). The real value of deer hunting in Colorado increased at an average annual rate of 7.6% from 1974 to 1980.

Additional information on value trends of wildlife and fish recreation come from private access fees, ownership costs, and private lease fees for the primary purpose of fishing and hunting. Private fees and lease agreements provide previously unavailable transaction-based estimates of wildlife and fish values (Schenck et al. 1987). The demand for fee-hunting appears to be increasing (White 1987), and the projections reviewed in chapter 2 indicate that participation in fee-hunting could more than double by 2040 (see fig. 48). As demand has increased, the amount individual hunters and anglers have spent for private fees also has increased. The average annual increase from 1980 to 1985 (in constant 1980 dollars) varied from 7.1% for fishing to 12.3% for big game hunting (fig. 57) (USDI Fish and Wildlife Service 1988b; USDI Fish and Wildlife Service, and USDC Bureau of Census 1982). The increase in expenditures by persons who owned or leased land for wildlife and fish recreation was substantially greater. From 1980 to 1985, the average real amount an individual spent per year increased from $406 to $900 for an average annual increase of 24%. If the number of days spent hunting or fishing per individual under fee or lease situations has increased over this 5-year period, then the rates of increase reported here overestimate the increase on a per unit-day activity basis.

Local Economy and Management Budget Effects

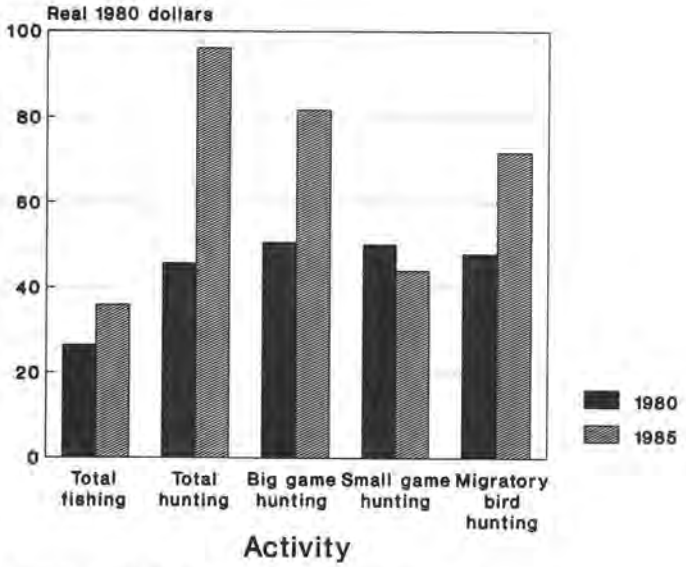
For commercial salmon and fur resources, harvest restrictions go beyond affecting the price. They also affect the income of fishers and trappers and income and employment in other businesses dependent on the harvests of these species (e.g., fish processing plants, furriers). Although the local economic implications associated with commercial harvests are important, particularly in regions such as the salmon-harvest areas of Alaska and the Northwest, more nationally widespread implications are associated with recreational aspects of wildlife and fish resources.

Historically, the role of economics in fisheries and wildlife management has been limited to estimating wildlife and fish recreation expenditures (Verburg et al. 1987). However, gross expenditures do not provide a satisfactory measure of economic value, but rather provide insight into local economic impacts (Bishop 1987). Expenditures also have a direct impact on state wildlife and fish management budgets.

Gross expenditures (in constant 1965 dollars) associated with hunting and fishing increased significantly from 1965 through 1980 for all activities except small game hunting and waterfowl hunting (figs. 58 and 59) (USDI Fish and Wildlife Service 1988b). After 1980, gross fishing expenditures continued to increase while hunting expenditures declined. Trends in expenditures for nonconsumptive recreational activities were only available since 1980 and indicate that trip-related

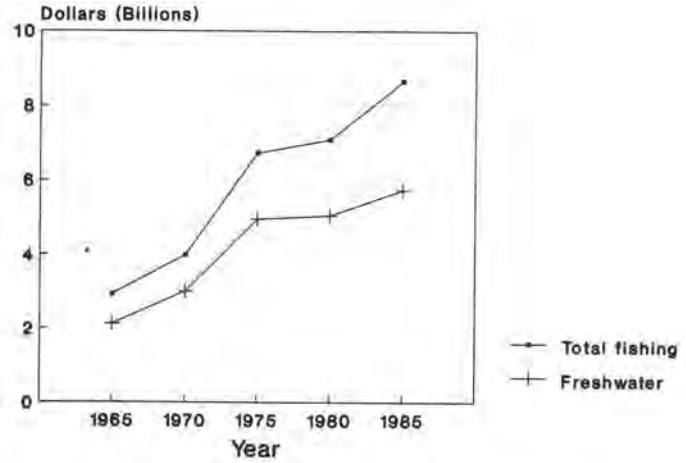
Table 50.—Recent historical trends in the value of coldwater fishing and deer hunting in three western states.

Activity	State	Study	Year	Activity day values (1982 dollars)
Coldwater fishing	Idaho	Gordon (1970)	1968	11.57
		Sorg et al. (1982)	1982	25.55
	Arizona	Martin et al. (1974)	1970	25.75
		Miller and Hay (1984)	1980	39.90
Deer hunting	Colorado	Miller (1980)	1974	18.40
		USDI Fish and Wildlife Service [n.d.]	1980	26.78



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

Figure 57.—Trend in private access fees (dollars per individual) for fishing and hunting.

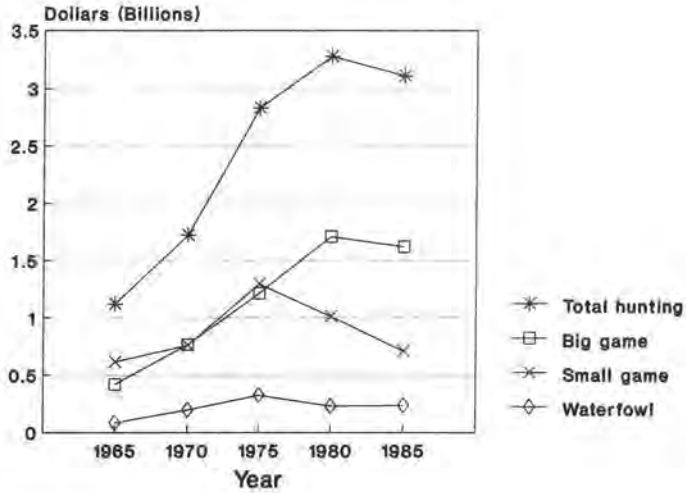


Source: USDI, Fish and Wildlife Service (1988b)

Figure 58.—Trends in gross expenditures for fishing from 1965–1985.

expenditures for primary nonresidential recreation declined from $1.58 billion in 1980 to $1.34 billion in 1985 (in constant 1965 dollars).

Given the recreation use projections in chapter 2, gross expenditures for fishing could increase in response to increased participation. Expenditures associated with primary nonresidential nonconsumptive trips could also increase since the number of recreationists engaging in this activity is expected to increase substantially (154%) by 2040. Hunting-related expenditures could decline as



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

Figure 59.—Trends in gross expenditures for hunting from 1965–1985.

total participation drops. If restrictive regulations are implemented to bring resource use in line with future resource inventories, then the expected increase in fishing expenditures would be dampened while the decline in hunting expenditures would be accentuated.

The effect of future declines in hunting-related expenditures goes beyond the direct impact on support businesses (e.g., those businesses providing lodging, food, equipment, etc.). An input-output model has been developed to track the expenditure effects throughout a regional economy (Alward and Palmer 1983). In a case study of how changes in big game hunting regulations affect the Colorado regional economy, Alward et al. (1984) showed that reduced expenditures not only affected direct support services but also affected wages and employment throughout the majority of industrial sectors comprising the regional economy. Although the greatest impact of reduced hunting expenditures would be to local areas that provide support services to this recreational activity, in the longer term substitute spending patterns would likely result in a restructuring of the regional economy rather than a total reduction in economic activity (Alward et al. 1984).

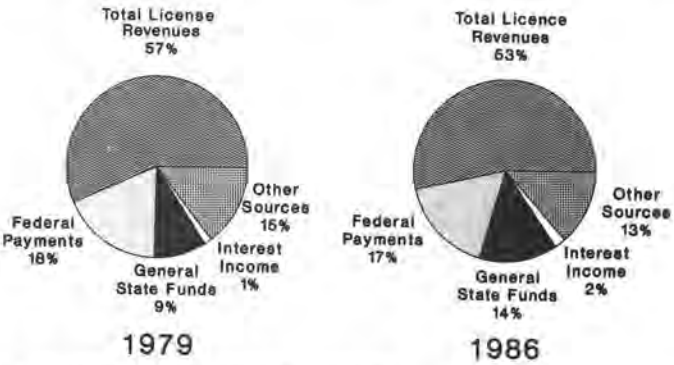
Declines in the number of hunters and declining expenditures also would impact state wildlife and fish agency budgets. The majority of funds available to state agencies are derived from hunters and anglers either through licence fees or excise taxes on equipment that are authorized under the Pittman-Robertson, Dingell-Johnson, and Wallop-Breaux Acts. State managers have expressed concern that revenues have not kept pace with inflation as many wildlife and fish agencies have experienced substantial declines in real revenue from license sales (Anderson et al. 1985). To maintain wildlife and fish programs, states have had to increase license fees or seek alternative funding sources.

Between 1979 and 1986, state agencies have witnessed shifts in the relative contributions from various funding sources (fig. 60). The most significant change in funding source was the increase from general state revenues. The proportional contribution of licence revenues has declined along with federal payments. The decline in the proportional contribution from federal payments would have been greater had it not been for the Wallop-Breaux program which tripled revenues into the Dingell-Johnson program (The Wildlife Conservation Fund of America 1987).

Anticipating further declines in hunter participation and the potential need for restricted access and use, state agencies will continue to face fiscal challenges and may have to restructure programs and funding sources (see for example Executive Task Force on the Future of Wildlife 1987, Van Vleck 1984). One potential opportunity for increasing state revenues concerns the nonconsumptive user. Although states have taken important steps towards integrating nongame programs into the management of wildlife and fish resources (45 states had recently allocated funds for nongame and endangered wildlife programs), the programs remain severely underfunded (Cerulean and Fosburgh 1986). In 1986, nongame programs represented less than 5% of the total budget in 29 states (Audubon Activist 1987). The nongame income tax check-off program, which is now in use in over 30 states, has witnessed significant declines as other checkoff options have been added to state income-tax forms (Shelton 1987). Harpman and Reuler (1985) concluded that although check-off programs were successful in the short-term, they should not be considered a stable, long-term source for funding nongame wildlife and fish programs.

ENVIRONMENTAL IMPLICATIONS

Evaluating environmental implications of the wildlife and fish use and inventory projections requires



NOTE.--Other sources includes tax checkoffs

Source: Wildlife Management Institute. Outdoors News Bulletin 41(20).

Figure 60.—Sources of funds for fish and wildlife management in 1979 compared to 1986.

understanding ecological systems and society's values for the mix of outputs that can be produced from the environment.

Society's values related to the environment have changed over time. The "exploitation era" of the 1800's was driven by strong commercial values (Poole and McCabe 1987). The abundance of natural resources on the North American continent appeared boundless. However, after a century of market hunting, trapping, clearing of forests for agriculture, fuel, and wood products, and plowing of native prairie, some Americans reconsidered the ability of the environment to support the rate of resource exploitation witnessed during the early 1900's (Kimball and Johnson 1978). As wildlife and fish resources became scarce, society's values changed. Notable declines, and in some cases the extinction, of wildlife and fish species stimulated a new emphasis on resource conservation. A series of protective laws was passed and wildlife and fish management became a profession entrusted with the responsibility of ensuring that wildlife and fish resources would be available to future generations.

Despite the growing support for wildlife and fish conservation and the mounting success stories attributable to wildlife and fish management, rising human populations will continue to encroach on remaining wildlife and fish habitat. In addition, continued demand for timber, domestic livestock, and crops will conflict, in many instances, with wildlife and fish resources. The challenge for future wildlife and fish management involves how to balance these multiple resource demands within the constraints defined by the environment. Failure to do so will result in unfavorable environmental alterations for wildlife and fish.

Demands for wildlife and fish resources are also expected to increase in the future, although the relative importance of various recreational activities is expected to change. Hunting-related demands are expected to become relatively less important than fishing and nonconsumptive recreation. Similarly, the American public increasingly pressures management agencies to maintain the integrity of ecological systems (Russell 1987) as evidenced in the passage of laws such as the Endangered Species Act and a number of other federal laws directed at maintaining habitat and species diversity (Bean 1977, Lund 1980). Consequently, more people demanding more wildlife and fish recreation opportunity indirectly demand more vigorous habitat and population management on a dwindling land base. The environmental implications of this assessment involve both habitat and species population considerations.

Implications for Wildlife and Fish Habitat

In recent history, the amount and quality of wildlife habitat has been changing. Additional changes are expected in the future, including a decline in forestland area, an increase in rangeland acres (expected under

the Conservation Reserve Program), and continued increases in urbanization. The "Swampbuster" and "Sodbuster" provisions of the 1985 Food Security Act could slow the rate at which wetlands are drained and highly erodible rangeland is converted to crop production. Acreage of open water habitats is projected to increase with farm pond and reservoir construction, and water quality is expected to improve as a result of the 1985 Food Security Act conservation programs and compliance with clean water legislation. In addition to these habitat composition changes (i.e., the amounts of land in various land-use types), future habitats will likely become more fragmented and insular in nature.

In this scenario, the composite national land area available for suitable wildlife habitat is likely to decline. This, coupled with a general increase in the number of wildlife and fish recreationists, will result in more crowded conditions.

Increased density of outdoor recreational use has been shown to cause vegetation trampling, changes in vegetation composition, soil compaction, and increased erosion (Cole 1986, Vaske et al. 1983), all resulting in degraded terrestrial and aquatic habitats. Washburne and Cole (1983) have reported that recreational use of wilderness areas (a portion of which is related to wildlife and fish use) has caused vegetation problems in 71% of all wilderness areas, soil impacts in 61%, and water pollution in 18%. Similar recreation impacts have also been noted in some riparian forests in the eastern United States (Cole and Marion 1988).

Although such impacts can be attributed to both consumptive and nonconsumptive activities, they appear to be especially common among nonconsumptive uses because of the significant increase in participants. Wilkes (1977) has stated that the term "nonconsumptive" has been detrimental to land-use planning because it projects a notion that such activities are benign in terms of environmental impacts, when in fact there are some very real and important impacts that must be addressed to preserve wildlife and fish habitat.

Implications for Wildlife and Fish Populations

As the amount and quality of habitats change, so will the distribution and abundance of wildlife and fish species. Wildlife and fish are critical components of ecosystems and perform various important functions such as pollination, dispersal and germination of seeds, soil and nutrient cycling processes, herbivory, predation, parasitism, and competition (Prescott-Allen and Prescott-Allen 1987). As these roles interact over time, they influence the distribution and abundance of species, the composition of functioning biotic communities, and thus ultimately determine the biotic diversity of animal communities (Harris 1988, Talbot 1987).

Based on the recent historical and future land base trends, faunas could become less diverse as human use of the land intensifies—a concern that is both national and global in scope (Norton 1986, Schonewald-Cox et al. 1983, Wilson 1988). Based on our current understanding, the effects of land-use intensification on biotic diversity can be grouped into four categories (Harris 1988): (1) loss of large, wide-ranging species, (2) loss of area-sensitive or interior species that require large tracts of contiguous habitat, (3) loss of genetic integrity, and (4) increased abundance of habitat generalists characteristic of disturbed environments. Ultimately, these four impacts result in the loss of species that give different communities their unique and distinguishing faunal characteristics while species already widespread and common among many regions are becoming more prominent.

Concern for declining diversity in natural communities is a concern for increasing species rarity and, in the extreme case, a concern for species extinctions. Species associated with old-growth or mature forests, native prairie, and wetlands seem destined to become rarer. Apart from these general perceptions, no one can predict with certainty how many additional species will become threatened or endangered with extinction. However, as land uses intensify, the potential exists for a higher proportion of the fauna to be threatened with extinction. In the United States, less than 10% of the vertebrate fauna is threatened or endangered. In West Germany, where intensive land use has a much longer history, 41% of the vertebrate fauna is endangered or threatened (The Conservation Foundation 1984).

Two direct consequences of increasing species rarity are prominent. First, genetic diversity declines which may ultimately affect the survival or recovery of a species. Loss of genetic diversity permanently eliminates opportunities to study how animals relate to their environments and their potential utility to humans (Ehrlich 1988, Schonewald-Cox 1986). A second consequence of rarity is that species' distributions become restricted to isolated areas. Although protection of special habitats has been important in the preservation of some species, Russell (1987) has expressed the view that the ecological legacy that the public wishes to leave to future generations is not one of open zoos in a few isolated areas of natural habitat, but one of healthy ecological systems in a common setting with human populations.

Increasing species rarity within a community is often accompanied by increasing abundance of common, widespread species with general habitat requirements. As was noted in chapter 1, downward trends in breeding nongame bird populations was accompanied by increases in species adapted to urban environments. In addition, Degraaf (1986) found that the habitat generalists dominating urban bird communities were often exotic species. Exotics are anthropogenically displaced species that have not been subjected to the coevolutionary processes important in the original formation of existing biotic communities and therefore violate the community's natural history.

Expression of reduced biotic diversity through dominance of a few abundant species can also lead to important economic costs associated with crop losses, reduction in timber regeneration, or livestock losses. In 1980, estimated losses of property to wildlife exceeded $8.6 million, and the Animal Damage Control Program (then under the Fish and Wildlife Service) spent $17.6 million in wildlife damage control efforts (USDI Fish and Wildlife Service 1981b). Overabundant wildlife usually generates concern for human health. Excessive populations of some furbearers has contributed to near epidemic levels of rabies throughout much of the East (Burridge et al. 1986), and increasing deer populations in the suburban Northeast are raising concern for the spread of Lyme disease.

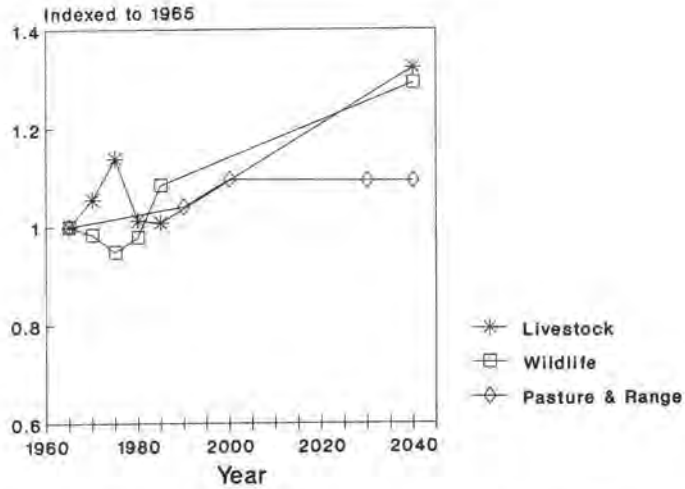
In addition to concerns for reduced biological diversity stemming from land-use intensification, use of wildlife and fish resources in excess of what inventories can support also has important implications to certain wildlife and fish populations. Despite declining dockside prices, commercial salmon harvests were the highest ever in 1985; the salmon population probably cannot sustain such harvest rates (Weber 1986). Illegal duck harvest in one Gulf coast state has been estimated to exceed four times the legal harvest, a situation an already declining duck population cannot withstand (Anderson 1988). Negative impacts associated with excessive use of wildlife and fish, however, are not restricted to consumptive activities. Nonconsumptive recreational activities have also been implicated in the displacement and even the death of wildlife (Cole 1986, MacArthur et al. 1982, Ream 1979, Stalmaster and Newman 1978, Vaske et al. 1983).

Environmental Implications from other Resource Demands

Clearly, public demands for resources other than wildlife and fish are an important consideration in identifying environmental implications. Demands for timber, range, and agricultural goods affect the kinds, amounts, and quality of wildlife and fish habitat. Increasing demands for timber products will likely have to be met with more intensive timber management (Haynes in press). Similarly, livestock forage demand is anticipated to increase which will require implementation of rangeland improvements to meet that demand (Joyce in press). The anticipated needs for more intensive management actions, in response to future demands for a single resource, carry with them multiple resource consequences (Hof and Baltic 1988, Risser et al. 1984).

The wildlife projections provided by state wildlife agencies did not explicitly consider these other resource demands on the land resource base and their resultant influence on wildlife and fish populations. Considering multiple demands for the resources jointly produced from any land type is necessary to avoid unanticipated resource management conflicts in the future.

As an example of the potential conflicts that can result, future wildlife demands for forage were compared to livestock demands for forage. Big game (deer, elk, and pronghorn) population projections from the state wildlife agencies were converted to AUM requirements and compared to projected livestock AUM's for the western United States (fig. 61). From 1985 to 2040, big game AUM's are projected to increase 19%; livestock AUM's are projected to increase 32%. Yet, the rangeland base is only expected to increase 10%. Although the degree of direct competition between wildlife and domestic livestock will depend on the species mix (wild and domestic) in any given area, the projections indicate that grazing pressure on western rangelands will intensify to a much greater degree than that implied by separate wildlife or livestock projections.



Source: Historical data: Livestock: USDA [various years], Joyce [in press], Wildlife: State Wildlife Agencies: 12 of 15 western states

Figure 61.—Indexed trends in livestock and wildlife AUM's and pasture- and rangeland area in the western United States.

SUMMARY

The wildlife and fish use and inventory projections imply certain economic, social, and environmental consequences that can occur if resource use and inventories are not balanced. The social values associated with fish and wildlife resources range from those held by Native Americans for subsistence and religious values, to rest, relaxation, and personal camaraderie resulting from recreational experiences dependent upon wildlife and fish. Declining future inventories or restricting opportunities to enjoy wildlife and fish not only infringes on the lifestyles of certain cultural segments of society, but also reduces or eliminates a recreational outlet for which few substitutes exist.

The economic costs associated with increasing scarcity of wildlife and fish resources can be grouped into direct effects on the "prices" paid by consumers and indirect effects on local economies and resource management budgets. Direct effects on consumers are most

obvious with commercial species such as salmon and furbearers. Concerns have been raised over the need to preserve minimum levels of salmon stocks, the loss of wetland habitats for furbearers, and a growing public sentiment against trapping. Under such restrictions in future supplies, consumers can expect to pay more for these products.

A similar situation holds for wildlife and fish recreation. Although not normally bought or sold under a market structure, wildlife and fish will "cost" recreationists more in the future. As 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 recreation sites, or may have to pay access fees which may limit participation to the more affluent of society.

Restrictions on commercial harvests and projected declines in hunting also have indirect economic impacts on income, employment, and state resource management budgets. Employment and income impacts have important consequences in fishing communities such as coastal Alaska where other opportunities are limited. Declining hunter participation and associated expenditures could impact local areas that provide support services for this recreational activity. State wildlife and fish management agency budgets, for which funds are derived primarily from licence fees and excise taxes on equipment, would also be affected.

Growing human populations will continue to encroach on the remaining wildlife and fish habitat. In addition, continued demand for timber, livestock, water, and agricultural crops will conflict, in many instances, with wildlife and fish resources. The challenge for future wildlife and fish management involves how to balance these multiple resource demands within the constraints defined by the environment.

The more crowded conditions suggested by comparisons of future demands and supplies indicate that vegetation impacts, soil compaction, water pollution, disturbance of wildlife, and other environmental problems will increase. Although such impacts can be attributed to all forms of wildlife and fish recreation, these impacts are of particular concern with the fishing and nonconsumptive recreating public because of the magnitude of projected increases.

As the amount and quality of habitats change, so will the distribution and abundance of wildlife and fish. The growing pressures on wildlife and fish are likely to be especially significant for endangered and threatened species and those species with the potential to become so. As the biotic diversity of the nation's wildlife and fish communities diminishes, the nation loses part of its natural heritage and future options for study and other interactions.

The specific resource management issues that stem from the social, economic, and environmental impacts discussed here were identified by state and federal resource managers. Chapter 6 summarizes these issues and reviews the management opportunities that exist to address them.

CHAPTER 6: MANAGEMENT ISSUES AND OPPORTUNITIES FOR IMPROVING THE WILDLIFE AND FISH RESOURCE SITUATION

Wildlife and fish resources were once perceived to have unlimited capacity to support human use (Kimball and Johnson 1978, Schmidt 1978, Taber 1983). With unregulated exploitation of wild populations and habitats, the fact became apparent that conservation of the nation's flora and fauna would require management—willful and informed manipulation by human beings.

Regulating the exploitation of wildlife and fish resources was the first and most important conservation concern in the early history of wildlife management. However, simply regulating the take of game populations failed to control the decline of many animal populations. Growing human populations and the attendant intensified land-use has reduced the availability of suitable wildlife and fish habitats. Human beings have expanded their niche at the expense of other animals (Brokaw 1978). The implication is that conservation of wildlife and fish resources, in light of what are often conflicting human demands for natural resources, will require improved wildlife and fish management (Taber 1983).

WILDLIFE AND FISH MANAGEMENT ISSUES

Management issues were identified by state agencies responsible for wildlife and fish management, National Forest System biologists, and Bureau of Land Management biologists. These agencies provided a priority listing of the most important management issues for each of eight species groups. These groups included big game, small game, waterfowl, anadromous fish, resident coldwater fish, resident warmwater fish, nongame, and threatened and endangered species. Within each species group, management issues were split into four categories: habitat, population, user, and planning-related issues.

Issues Perceived by the States

States are entrusted with the stewardship of wildlife and fish resources; and as resource trustees, they have a major responsibility for wildlife and fish management. Federal agencies also have wildlife and fish stewardship obligations for migratory birds, marine animals, and for animals and habitats on federal lands. However, the federal stewardship role has, in general, been one of cooperation with states to facilitate their management goals (Lund 1980). Under the state ownership doctrine, the state wildlife agencies must hold a comprehensive view of wildlife and fish resources within its boundaries. Consequently, the state biologists' perceptions of the important wildlife and fish management issues presumably represent a composite across all land ownerships.

Information provided by state agencies was summarized by examining the mean priority ranking (where "1" represents an issue of greatest concern) across states and the frequency with which an issue was cited. The overall importance of an issue was assumed to be a function of its mean rank and its frequency. An index of relative importance was calculated using the following method:

1. Divide the mean rank of each management issue by the frequency. The management issue with the lowest quotient is interpreted to be the most important.
2. Calculate an "index of importance" for each issue relative to the most important management issue. This was accomplished by dividing the quotient of the most important issue identified in step one into the quotient associated with each management issue. Thus, the most important issue has an index of importance equal to 1.0.
3. Sort the scores of relative importance calculated in step two in ascending order. The result is a list of management issues from the most important to the least important.

Summary Across Species Groups

State wildlife and fish biologists identified 30 management issues (table 51). At the national level, seven issues appeared to be particularly important to current resource managers. These issues are evenly distributed across the major management categories of habitat, population, user, and planning.

Habitat ranked as the most important management issue identified. Habitat area loss and habitat quality degradation were the two most frequently cited problems and were the greatest concern of all identified management issues. As human populations expand and land uses intensify, the amount and quality of wildlife and fish habitats suffer. Habitat is in many ways the most fundamental management issue now confronting state agencies, for landscapes lacking in suitable wildlife and fish habitats will no longer support animal populations to monitor or uses to regulate. Although states hold wildlife and fish resources in trust, they have no habitat management authority on private lands unless landowners request assistance or enter into habitat management agreements.

The third and fourth most critical management issues concerned aspects of wildlife and fish populations. Inventory information on wildlife occurrence, population

Table 51.—Management issues for all species groups identified by state wildlife and fish management agencies in order of national priority (rank of 1.0 represents issue of greatest concern).

	National			North			South			Rocky Mountain			Pacific Coast		
Management issue	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank
Habitat loss	1.0	142	1.6	1.0	54	1.6	1.0	38	1.7	1.0	42	1.6	1.5	8	1.6
Habitat degradation	1.6	117	2.1	1.9	37	2.1	2.4	24	2.6	1.1	45	1.9	1.0	11	1.5
Lack population information	2.0	98	2.2	1.4	43	1.8	3.7	15	2.5	2.1	32	2.5	2.6	8	2.8
Population low/ unoccupied habitat	3.3	57	2.1	4.0	21	2.5	2.6	14	1.6	2.8	18	1.9	4.2	4	2.3
Restricted access	3.3	71	2.6	3.1	29	2.7	4.3	15	2.9	3.1	22	2.6	2.6	5	1.8
Lack info. on public/ public support	3.3	70	2.6	3.0	29	2.6	4.5	13	2.6	2.5	26	2.5	11.0	2	3.0
Multiple resource conflicts	3.7	60	2.5	2.5	28	2.1	4.7	11	2.3	5.4	17	3.5	2.4	4	1.3
Lack habitat info. (requirements/ inventory)	5.3	37	2.2	4.2	12	1.5	9.5	8	3.4	3.9	15	2.2	5.5	2	1.5
Excessive demand	6.3	42	3.0	4.6	22	3.0	9.6	7	3.0	6.1	13	3.0	.	.	.
Pollution	7.0	33	2.6	4.4	19	2.5	7.5	6	2.0	12.4	7	3.3	22.0	1	3.0
Limited resource planning	9.2	25	2.6	8.8	10	2.6	6.1	7	1.9	12.8	7	3.4	7.3	1	1.0
Population too high	12.2	8	1.1	6.8	5	1.0	16.8	2	1.5	26.3	1	1.0	.	.	.
Habitat management constrained/ineffective	12.4	20	2.8	67.5	1	2.0	7.0	9	2.8	8.8	9	3.0	7.3	1	1.0
Increased human populations	13.0	15	2.2	30.4	3	2.7	4.2	8	1.5	35.0	3	4.0	7.3	1	1.0
Enforcement of regs./inadequate regs.	14.5	19	3.1	12.2	10	3.6	13.4	5	3.0	17.5	3	2.0	7.3	1	1.0
Interspecific competition	15.1	17	2.9	59.1	2	3.5	33.5	2	3.0	11.8	8	3.6	2.1	5	1.4
Barriers to migration	17.8	8	1.6	9.5	5	1.4	27.9	2	2.5	26.3	1	1.0	.	.	.
Hunter ethics	18.9	15	3.2	25.3	4	3.0	50.3	2	4.5	12.4	7	3.3	7.3	2	2.0
Insufficient/inadequate harvest	23.7	9	2.4	50.6	2	3.0	8.4	4	1.5	39.4	2	3.0	29.3	1	4.0
Excessive harvest	24.1	7	1.9	25.9	3	2.3	9.7	3	1.3	52.5	1	2.0	.	.	.
Illegal harvest	25.3	13	3.7	23.6	4	2.8	22.4	4	4.0	26.3	4	4.0	36.7	1	5.0
Declining/low demand	29.3	10	3.3	59.1	2	3.5	33.5	2	3.0	17.9	5	3.4	22.0	1	3.0
Population distribution inadequate	33.0	7	2.6	25.3	2	1.5	27.9	2	2.5	52.5	2	4.0	14.7	1	2.0
Habitat diversity loss	39.9	4	1.8	22.5	3	2.0	22.4	1	1.0	.	.	.	.	.	.
Disease/parasites	53.3	5	3.0	59.1	2	3.5	.	.	.	45.9	2	3.5	7.3	1	1.0
Other population-related problems	53.3	5	3.0	33.8	3	3.0	.	.	.	39.4	2	3.0	.	.	.
Political constraints	68.0	3	2.3	67.5	1	2.0	.	.	.	32.8	2	2.5	.	.	.
Predation	79.9	3	2.7	.	.	.	.	.	.	23.6	3	2.7	.	.	.
Excessive access	155.3	2	3.5	.	.	.	.	.	.	78.8	1	3.0	29.3	1	4.0
Other habitat-related problems	266.3	1	3.0	.	.	.	67.1	1	3.0	.	.	.	.	.	.

Note: f = Frequency.

levels, and population parameters (e.g., natality and mortality rates) are difficult to obtain. Considerable research has been devoted to developing both theory and techniques for monitoring wildlife and fish populations; however, for large scale assessments there is a need for practical techniques that provide information at the regional and state levels of geographic resolution (Hawkes et al. 1983, Moyle et al. 1979, Sanderson et al. 1979). Although the importance of population inventory deficiencies varies across species groups, it represents the third most important management issue when summarized across all species groups. The fourth most important management issue involved low population levels. In some cases, this management issue is ultimately related to low habitat quality. In other cases, wildlife and fish population levels have not reached the carrying capacity of the habitat, or suitable habitat remains unoccupied.

Issues related to resource use are another important component of wildlife and fish management. Regulating the number of consumptive users, hunting and fishing season lengths, and harvest quotas are important responsibilities of state agencies. The amount of forest and rangeland environments has not changed dramatically in the recent past, nor is it expected to change dramatically in the future (Bones in press). However, the availability of land for wildlife and fish recreation has become an important concern. Although certainly related to habitat loss, restricted access is an equally important factor contributing to the declining availability of land for recreation. This is of particular interest in areas of the country with little public land. The problem is not restricted to these areas since access to public land is often controlled by private landowners and trespass privileges are not always granted.

Another important issue related to use of wildlife and fish resources concerns the lack of comprehensive information on attitudes about wildlife and fish resources and their management. There are two points of reference in this management issue. State agencies lack information on the public attitudes and values held for wildlife and fish resources, and the public lacks information on the justification for specific management actions implemented by state agencies. Ultimately, both translate into a concern for public support of wildlife and fish management. As summarized by Peek (1986), wildlife managers need more than ever to ensure public understanding of how proposed management activities will benefit the resource, or run the risk of declining support stemming from a misinformed public.

Because the nation faces increased competition for resources produced from a finite land base, multiple resource conflicts are an important concern of state wildlife and fish managing agencies. More intensive agricultural practices and timber management, competition with livestock, mineral development, water withdrawals for consumption or irrigation, and wildlife damage to crops all serve to illustrate that wildlife and fish management is much more complicated than direct habitat improvement, manipulating animal populations, or regulating use. Resource planning that acknowledges and addresses wildlife and fish in a multiple resource context is critical if future supplies of wildlife and fish habitats and populations are going to be available to commercial, subsistence, and recreational user groups. Although widely recognized as an important planning objective, the integration of wildlife and fish programs into other land management activities remains a notable shortcoming (Peek 1986).

These major issues tended to be consistent across each assessment region though the rank order varied (table 51). There were only a few cases where the most important regional issues were absent from the national list. In the South, a general concern for increasing human populations due to increased migration to the sunbelt states was raised as an important issue. In the Rocky Mountains, a lack of habitat inventory information was viewed as a constraint on effective wildlife management. Interspecific competition was the third most important issue in the Pacific Coast, owing to unique problems on the Hawaiian archipelago with exotics.

The summarization across all species groups provides a general picture of the states' perception of important wildlife and fish management issues. However, important issues specific to individual species categories are lost in such a comprehensive summary.

Big Game

A total of 20 big game management issues were identified by state wildlife and fish agencies. Many are the same as those described by Wolfe (1978) and the previous wildlife and fish assessment (USDA Forest Service 1981). The highest ranked big game management issues included habitat loss, habitat degradation, restricted access for users, excessive game populations, multiresource conflicts, and deficient data to quantify wildlife and fish populations (table 52).

The recent historical picture documented in chapter 1 indicates that issues related to big game management exist at several scales. For example, the loss of forestland throughout the nation will, in general, reduce the habitat available to forest big game species. More specifically, the loss of winter range or thermal cover in the North and West could make the habitat remaining for big game species less useful. Human development on winter range and domestic livestock conflicts were important habitat related concerns in the West. In the North, the absence of forest disturbance was an important habitat management issue. Farming and timber harvesting have replaced, in part, the natural role of fire in disrupting and retarding forest succession (Wolfe 1978). However, forest disturbance factors have not kept pace with the forest succession resulting in a deterioration of big game habitat quality in the North.

An issue unique to big game management was that population levels of some species were considered excessive. This was largely an issue related to white-tailed deer in some of the eastern and midwestern states. Although excessive big game populations were not frequently cited, in those states where it was a problem it was the most important big game management issue.

Table 52.—Management issues for big game identified by state wildlife and fish management agencies in order of national priority (rank of 1.0 represents issue of greatest concern).

Management issue	National			North			South			Rocky Mountain			Pacific Coast		
	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank
Habitat loss	1.0	21	1.6	1.0	9	1.8	1.0	5	1.6	1.3	6	1.5	1.3	1	1.0
Habitat degradation	1.6	16	1.9	2.9	4	2.3	3.9	2	2.5	1.0	8	1.6	1.0	2	1.5
Restricted access	2.0	17	2.6	2.1	6	2.5	1.5	5	2.4	3.2	5	3.2	1.3	1	1.0
Population too high	2.1	7	1.1	1.3	4	1.0	2.3	2	1.5	5.0	1	1.0	.	.	.
Multiple resource conflicts	2.3	18	3.1	1.9	8	3.0	3.4	3	3.3	2.8	6	3.3	2.7	1	2.0
Lack population information	2.4	14	2.6	1.7	6	2.0	.	.	.	2.3	6	2.8	2.3	2	3.5
Insufficient/inadequate harvest	3.6	7	1.9	7.5	2	3.0	1.2	4	1.5	5.0	1	1.0	.	.	.
Population low/unoccupied habitat	3.8	8	2.3	3.8	3	2.3	2.4	3	2.3	5.0	1	1.0	4.0	1	3.0
Lack info. on public/public support	4.9	10	3.7	2.3	8	3.6	15.6	1	5.0	15.0	1	3.0	.	.	.
Illegal harvest	5.5	9	3.8	5.0	3	3.0	4.2	3	4.0	10.0	2	4.0	6.7	1	5.0
Hunter ethics	6.1	6	2.8	5.0	1	1.0	.	.	.	4.4	4	3.5	2.7	1	2.0
Excessive demand	7.9	5	3.0	8.8	2	3.5	9.4	1	3.0	6.3	2	2.5	.	.	.
Increased human populations	9.8	2	1.5	10.0	1	2.0	3.1	1	1.0	.	.	.	.	.	.
Enforcement of regs./inadequate regs.	13.1	1	1.0	.	.	.	.	.	.	.	.	.	1.3	1	1.0
Political constraints	13.1	1	1.0	.	.	.	.	.	.	5.0	1	1.0	.	.	.
Habitat management constrained/ineffective	19.7	2	3.0	.	.	.	4.7	2	3.0	.	.	.	.	.	.
Lack habitat info. (requirements/inventory)	23.0	2	3.5	.	.	.	15.6	1	5.0	10.0	1	2.0	.	.	.
Declining/low demand	23.0	2	3.5	20.0	1	4.0	.	.	.	15.0	1	3.0	.	.	.
Excessive access	23.0	2	3.5	.	.	.	.	.	.	15.0	1	3.0	5.3	1	4.0
Interspecific competition	26.3	2	4.0	.	.	.	9.4	1	3.0	25.0	1	5.0	.	.	.

Note: f = frequency.

Restricted access for users was a contributing factor to the excessive population issue since it constrains meeting harvest objectives. Restricted access is also a concern since it prevents satisfaction of the user demand for the resource. The availability of big game hunting recreation on public lands becomes an increasingly important consideration as access is restricted on private lands. The southeastern states were particularly concerned about access to big game ranges.

Alteration of habitat resulting from land use changes, logging or the lack of logging activities, developed recreation areas, disturbance from off-road vehicles, livestock management, and crop damage by big game species were the basis for the multiple resource conflict issue.

Small Game

A majority of the most important issues related to small game management were the same as for big game; however, the order of importance was different. From the states' perspectives, the critical management issues were habitat area loss, restricted access, habitat degradation, multiple resource conflicts, and low populations or unoccupied habitat (table 53).

A prominent small game management issue was low populations of species associated with agricultural habitats. However, inadequate populations of small game can not be discussed independently from habitat degradation and loss. Many small game species require a close juxtaposition of life requisites. Consequently, the trend toward more intensive agriculture (see chapter 1) has reduced the availability of suitable small game habitats. Fortunately, most small game species have a high reproductive potential and can recover quickly from low population levels when suitable habitat becomes available.

Much of the small game resource is produced on private land and related to agriculture forest-range interfaces or early successional forest habitats. Even where quality habitat exists, restricted access to private lands has resulted in populations that are unavailable to the recreating public. This is particularly important to small game recreation since nearly 75% of all small game hunting occurred on private lands in 1980 (USDI Fish and Wildlife Service, and USDC Bureau of Census 1982).

The relative rankings of small game management issues within assessment regions deviated little from the national level. Concerns for habitat loss, habitat degradation, and multiple resource conflicts were well distributed across the country and tended to maintain their relative rankings across regions. Restricted access was generally ranked as a more important issue and was a more wide-spread concern than low population levels. Low small game populations were a prevalent concern in the South.

Waterfowl

Twenty-five issues were identified to be of concern regarding waterfowl management (table 54). Long-distance migration is a distinctive feature of this group. Consequently, management issues raised by individual agencies many times spanned state and national boundaries.

Loss of wetland habitats was clearly the most important national and regional management issue related to this species group. Wetland habitat degradation and isolation resulting from intensive use of surrounding upland environments was also one of the top concerns raised by the state agencies. As reviewed in chapter 1, the major factor contributing to habitat loss and degradation was agricultural development. Although ducks will make use of agricultural grains, they prefer natural

Table 53.—Management issues for small game identified by state wildlife and fish management agencies in order of national priority (rank of 1.0 represents issue of greatest concern).

Management issue	National			North			South			Rocky Mountain			Pacific Coast		
	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank
Habitat loss	1.0	25	1.2	1.0	11	1.2	1.0	7	1.4	1.0	6	1.2	1.3	1	1.0
Restricted access	2.5	19	2.3	2.6	8	2.3	3.5	4	2.8	2.4	5	2.4	1.0	2	1.5
Habitat degradation	3.2	15	2.3	5.3	4	2.3	3.8	4	3.0	1.7	6	2.0	1.3	1	1.0
Multiple resource conflicts	4.3	12	2.5	5.7	4	2.5	2.8	3	1.7	4.4	4	3.5	1.3	1	1.0
Population low/unoccupied habitat	4.6	9	2.0	7.0	3	2.3	2.2	3	1.3	3.8	2	1.5	5.3	1	4.0
Lack population information	6.0	9	2.6	4.6	4	2.0	.	.	.	5.0	3	3.0	2.0	2	3.0
Lack info. on public/public support	6.3	7	2.1	8.3	3	2.7	.	.	.	2.3	4	1.8	.	.	.
Increased human populations	6.9	6	2.0	.	.	.	2.2	3	1.3	8.8	2	3.5	1.3	1	1.0
Hunter ethics	11.7	5	2.8	27.5	1	3.0	20.0	1	4.0	6.3	2	2.5	2.7	1	2.0
Lack habitat info. (requirements/inventory)	12.5	5	3.0	9.2	2	2.0	8.8	2	3.5	20.0	1	4.0	.	.	.
Habitat management constrained/ineffective	15.6	4	3.0	.	.	.	.	.	.	3.8	4	3.0	.	.	.
Habitat diversity loss	15.6	2	1.5	6.9	2	1.5	.	.	.	.	.	.	.	.	.
Excessive demand	17.5	5	4.2	8.7	4	3.8	.	.	.	30.0	1	6.0	.	.	.
Declining/low demand	31.3	2	3.0	.	.	.	7.5	2	3.0	.	.	.	.	.	.
Insufficient/inadequate harvest	46.9	2	4.5	.	.	.	.	.	.	25.0	1	5.0	5.3	1	4.0
Limited resource planning	62.5	1	3.0	27.5	1	3.0	.	.	.	.	.	.	.	.	.
Predation	62.5	1	3.0	.	.	.	.	.	.	15.0	1	3.0	.	.	.

Note: f = frequency.

Table 54.—Management issues for waterfowl identified by state wildlife and fish management agencies in order of national priority (rank of 1.0 represents issue of greatest concern).

Management issue	National			North			South			Rocky Mountain			Pacific Coast		
	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank
Habitat loss	1.0	27	1.4	1.0	12	1.2	1.0	6	1.5	1.0	7	1.7	1	2	1
Multiple resource conflicts	3.2	11	1.8	2.0	6	1.2	12.0	1	3.0	8.2	2	4.0	1	2	1
Population low/unoccupied habitat	3.7	10	1.9	8.3	4	3.3	1.3	3	1.0	1.4	3	1.0	.	.	.
Habitat degradation	4.4	11	2.5	10.0	2	2.0	3.8	4	3.8	1.9	4	1.8	2	1	1
Restricted access	5.0	12	3.1	11.0	3	3.3	4.4	3	3.3	2.3	5	2.8	6	1	3
Lack population information	6.3	8	2.6	5.7	3	1.7	6.0	2	3.0	6.2	2	3.0	8	1	4
Excessive demand	7.1	9	3.3	20.0	2	4.0	2.6	5	3.2	6.2	2	3.0	.	.	.
Population distribution inadequate	7.7	5	2.0	7.5	2	1.5	5.0	2	2.5	.	.	.	4	1	2
Habitat management constrained/ineffective	8.5	5	2.2	20.0	1	2.0	12.0	1	3.0	5.1	2	2.5	2	1	1
Pollution	9.2	8	3.8	12.3	3	3.7	5.0	2	2.5	6.5	3	4.7	.	.	.
Lack info. on public/public support	13.5	4	2.8	12.5	2	2.5	.	.	.	6.2	2	3.0	.	.	.
Population too high	19.3	1	1.0	10.0	1	1.0	.	.	.	.	.	.	.	.	.
Increased human populations	19.3	2	2.0	.	.	.	4.0	2	2.0	.	.	.	.	.	.
Interspecific competition	21.2	3	3.3	50.0	1	5.0	.	.	.	12.4	1	3.0	4	1	2
Predation	24.1	2	2.5	.	.	.	.	.	.	5.1	2	2.5	.	.	.
Excessive harvest	28.9	2	3.0	15.0	2	3.0	.	.	.	.	.	.	.	.	.
Political constraints	28.9	2	3.0	20.0	1	2.0	.	.	.	16.5	1	4.0	.	.	.
Illegal harvest	33.8	2	3.5	.	.	.	16.0	1	4.0	12.4	1	3.0	.	.	.
Declining/low demand	33.8	2	3.5	.	.	.	.	.	.	16.5	1	4.0	6	1	3
Limited resource planning	38.6	2	4.0	40.0	1	4.0	.	.	.	16.5	1	4.0	.	.	.
Hunter ethics	43.4	2	4.5	.	.	.	20.0	1	5.0	16.5	1	4.0	.	.	.
Habitat diversity loss	57.9	1	3.0	30.0	1	3.0	.	.	.	.	.	.	.	.	.
Other population-related problems	57.9	1	3.0	.	.	.	.	.	.	12.4	1	3.0	.	.	.
Lack information (requirements/inventory)	77.1	1	4.0	.	.	.	16.0	1	4.0	.	.	.	.	.	.
Enforcement of regs./inadequate regs.	96.4	1	5.0	.	.	.	20.0	1	5.0	.	.	.	.	.	.

Note: f = frequency.

foods that grow in or near water (Bellrose 1976). Geese, on the other hand, are more adaptable and will feed readily on green vegetation or waste grains on upland sites (USDI Fish and Wildlife Service 1987a). Agricultural crops are the mainstay of migrating and wintering goose populations (Bellrose 1976). Based on these differing habitats, state concerns for habitat loss and low waterfowl populations were, in general, related to ducks rather than geese.

Because of the close association between waterfowl habitat and agriculture development, multiple resource conflicts also ranked as an important waterfowl management issue. Multiple resource conflicts, however, are not restricted to agricultural land uses but also include timber, range, and water management interactions.

Another correlate of wetlands in agricultural environments is concern over the availability of the resource to the recreating public. Nearly three-quarters of the

nation's remaining wetland habitat is privately owned and restricted access for waterfowl hunters is a problem cited in all regions of the country. Although hunter lease agreements may provide incentive to landowners to provide access and preserve wetland habitats, participation in waterfowl hunting may become limited to that clientele who can afford to pay for the privilege to hunt on private land. In a survey asking state agencies to rank those species most important in hunter lease arrangements, Wiggers and Rootes (1987) found that waterfowl was the most frequently cited species category, followed by white-tailed deer, wild turkey, and bobwhite quail.

Two issues that were of regional importance, primarily in the East, were inadequate waterfowl population distribution and the use of lead shot. Although of low national priority, some southern states are concerned that waterfowl populations are being held farther north during the fall migration which effectively limits the availability of waterfowl for southern hunters. This alteration of migration chronology has been documented for both snow and Canada geese in response to agricultural development and associated reservoir construction in the Midwest (Batemen et al. 1988, Simpson 1988). Lead poisoning in ducks that ingest lead shotgun pellets and secondary poisoning in some raptors that feed on those ducks has been documented (USDI Fish and Wildlife Service 1987a). However, with total conversion to nontoxic steel shot planned by 1991, the lead shot issue should only continue into the short-term.

Anadromous Fish

The most important management concerns related to the anadromous fishery result from the migratory habits of the species comprising this category. These species mature in the ocean and migrate to spawning areas in headwater streams. The number one management issue identified by the states was dams that exist in the east, west, and Great Lakes coastal rivers that serve as migration barriers (table 55). Originally, fisheries biologists thought that providing upstream passage for adults would be sufficient to maintain anadromous fishery stocks. However, research has shown that fish can suffer high mortality as they encounter dams during juvenile downstream migration (Northwest Power Planning Council 1987). The concern associated with juvenile migration to the ocean is further confounded by water storage facilities designed to increase the generating capacity of mainstem hydroelectric dams. These storage facilities decrease water flows over spillways and force passage through the turbines where mortality can be as high as 15% to 20% per dam (Phinney 1986). Consequently, the cumulative impacts associated with passage through multiple hydroelectric facilities can be high, particularly during low flow years (Phinney 1986).

Although considerable progress has been made in the installation of fishways, additional installations, and improved operation of fishways formed the basis for concern with returning adult spawners. Inadequate flows at fishways have resulted in ineffective use of these facilities by migrating salmon and steelhead (Northwest Power Planning Council 1987).

Additional management issues of primary concern included: (1) habitat degradation associated with sedimentation, and the loss of within stream and streamside cover; (2) low populations of certain species including the Atlantic salmon and striped bass; (3) both point and nonpoint sources of pollution; (4) multiple resource conflicts with agricultural development, increased sediment and loss of streamside cover associated with timber harvesting and road development, and livestock conflicts associated with grazing on riparian areas; and (5) excessive harvest. Continual excessive harvests could have the greatest long-term effect on the anadromous fishery but also have the best opportunity for short-term change.

Resident Coldwater Fish

Primary concerns for coldwater fishery management included the loss and degradation of habitat (table 56). Fewer miles of coldwater streams resulting from

Table 55.—Management issues for anadromous fish identified by state wildlife and fish management agencies in order of national priority (rank of 1.0 represents issue of greatest concern).

	National			North			South			Rocky Mountain			Pacific Coast		
Management issue	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank
Barriers to migration	1.0	8	1.6	1.0	5	1.4	2.5	2	2.5	1	1	1	.	.	.
Habitat degradation	1.2	8	1.9	1.3	5	1.8	2.0	1	1.0	4	1	4	1	1	1
Population low/unoccupied habitat	2.5	4	2.0	5.4	2	3.0	1.0	2	1.0	.	.	.	.	.	.
Pollution	3.3	3	2.0	3.6	2	2.0	4.0	1	2.0	.	.	.	.	.	.
Multiple resource conflicts	3.4	5	3.4	3.6	3	3.0	6.0	1	3.0	5	1	5	.	.	.
Excessive harvest	3.8	2	1.5	.	.	.	2.0	1	1.0	2	1	2	.	.	.
Habitat loss	5.0	2	2.0	3.6	2	2.0	.	.	.	.	.	.	.	.	.
Lack population information	5.0	1	1.0	3.6	1	1.0	.	.	.	.	.	.	.	.	.
Excessive demand	5.0	2	2.0	3.6	2	2.0	.	.	.	.	.	.	.	.	.
Enforcement of regs./inadequate regs.	7.5	2	3.0	14.3	1	4.0	4.0	1	2.0	.	.	.	.	.	.
Other population-related problems	7.5	2	3.0	10.7	1	3.0	.	.	.	3	1	3	.	.	.
Disease/parasites	15.0	1	3.0	10.7	1	3.0	.	.	.	.	.	.	.	.	.

Note: f = frequency.

Table 56.—Management issues for resident coldwater fish identified by state wildlife and fish management agencies in order of national priority (rank of 1.0 represents issue of greatest concern).

Management issue	National			North			South			Rocky Mountain			Pacific Coast		
	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank
Habitat degradation	1.0	18	1.4	1.0	7	1.3	1.2	2	1.0	1.2	7	1.7	1.0	2	1.5
Habitat loss	1.8	11	1.5	4.8	3	2.7	1.0	3	1.3	1.0	5	1.0	.	.	.
Population low/unoccupied habitat	2.7	11	2.3	2.0	6	2.2	2.9	2	2.5	3.8	3	2.3	.	.	.
Restricted access	2.8	12	2.6	2.3	7	3.0	4.6	1	2.0	2.5	4	2.0	.	.	.
Pollution	3.4	8	2.1	2.2	5	2.0	6.9	1	3.0	5.0	2	2.0	.	.	.
Lack population information	4.1	10	3.2	3.1	4	2.3	3.3	3	4.3	5.5	3	3.3	.	.	.
Multiple resource conflicts	4.1	5	1.6	4.0	2	1.5	2.3	1	1.0	5.0	2	2.0	.	.	.
Excessive demand	5.5	7	3.0	4.0	4	3.0	.	.	.	5.0	3	3.0	.	.	.
Interspecific competition	6.0	6	2.8	10.8	1	2.0	.	.	.	4.4	4	3.5	1.3	1	1.0
Lack info. on public/public support	6.9	6	3.2	8.1	2	3.0	11.5	1	5.0	4.5	3	2.7	.	.	.
Excessive harvest	9.6	2	1.5	5.4	1	1.0	4.6	1	2.0	.	.	.	.	.	.
Habitat management constrained/ineffective	12.9	2	2.0	.	.	.	6.9	1	3.0	5.0	1	1.0	.	.	.
Other population-related problems	19.3	2	3.0	8.1	2	3.0	.	.	.	.	.	.	.	.	.
Limited resource planning	25.7	1	2.0	.	.	.	.	.	.	10.0	1	2.0	.	.	.
Illegal harvest	25.7	1	2.0	10.8	1	2.0	.	.	.	.	.	.	.	.	.
Disease/parasites	28.9	2	4.5	21.5	1	4.0	.	.	.	25.0	1	5.0	.	.	.
Other habitat-related problems	38.6	1	3.0	.	.	.	6.9	1	3.0	.	.	.	.	.	.
Enforcement of regs./inadequate regs.	64.3	1	5.0	26.9	1	5.0	.	.	.	.	.	.	.	.	.

Note: f = frequency.

impoundments, siltation of spawning beds, point and nonpoint sources of pollution, water withdrawals, and increased temperature associated with low flows and low streamside cover all interact to eliminate or significantly reduce the quality of coldwater fish habitat.

As with other groups, habitat management issues have an associated concern for multiple resource conflicts. Agricultural land uses can increase sediment loads and pollution; timber harvesting and associated road-building can alter protective streamside vegetation and also increase the amount of sediments reaching coldwater streams; and cattle grazing in riparian zones can significantly alter vegetation and stream bank structure which are important cover components of fish habitat.

In addition to habitat issues, insufficient information on population status, population parameters, and harvest were also cited as an important deficiency constraining effective management. Potential productivity and harvest pressure can vary considerably from one water body to the next, and detailed inventory information is required to plan for a balanced and efficient use of coldwater fishery resources.

Restricted access was also identified as a management issue constraining efficient use of resident coldwater fishery resources. Access was a particularly important problem in the North where the proportion of public land is low. Access was less of a concern in the South, presumably because public land access is available in the few locations where coldwater habitats occur.

Of the 18 coldwater fisheries issues identified by the states, no identifiable regional profile emerged, suggesting that the issues are generally consistent throughout the nation.

Resident Warmwater Fish

Of the 17 management issues identified for warmwater fisheries, habitat degradation was the most frequently cited and had the highest management priority (table 57). Warmwater habitats are frequently associated with many of the most intensive human uses of the environment, and pollution and other forms of habitat degradation are a significant consequence. While significant progress has been made in improving the nation's warmwater rivers and streams in recent years, water quality was still the number one issue with state agencies. Excessive nutrients from point and nonpoint pollution sources stimulates high phytoplankton blooms causing dissolved oxygen levels to drop below threshold levels needed to sustain the fishery (Boyd 1979). As reviewed by Fajen (1981), other important factors contributing to habitat degradation involve stream channelization which eliminates alternating pool and riffle zones, floodplain development which destablizes the floodplain, and water withdrawals resulting in low instream flows. Loss of important wetland spawning and nursery habitats affects many fish, such as the pikes.

Management concerns related to excessive demand and restricted access are frequently correlated. Accessible warmwater fishing areas are often forced to sustain excessive levels of use that could be alleviated with increased area of fishable water open to the public. Both fish populations and recreational satisfaction are diminished under crowded conditions.

As was the case for coldwater fisheries, inadequate information on populations and harvests of warmwater species is also a major concern. Resource decision-making

Table 57.—Management issues for resident warmwater fish identified by state wildlife and fish management agencies in order of national priority (rank of 1.0 represents issue of greatest concern).

Management issue	National			North			South			Rocky Mountain			Pacific Coast		
	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank
Habitat degradation	1.0	23	2.0	1.0	7	2.0	1.0	6	2.0	1.0	10	2.0	.	.	.
Habitat loss	1.8	13	2.0	1.8	5	2.6	1.7	3	1.7	1.6	5	1.6	.	.	.
Excessive demand	2.1	12	2.2	1.1	6	1.8	6.0	1	2.0	2.6	5	2.6	.	.	.
Lack population information	2.2	12	2.3	1.0	7	2.0	3.8	2	2.5	5.0	3	3.0	.	.	.
Pollution	2.3	9	1.8	1.3	5	1.8	1.5	2	1.0	6.3	2	2.5	.	.	.
Restricted access	3.1	10	2.7	2.0	4	2.3	6.0	2	4.0	4.5	3	2.7	2	1	2
Population low/unoccupied habitat	4.4	7	2.7	5.3	2	3.0	.	.	.	2.6	5	2.6	.	.	.
Multiple resource conflicts	5.8	2	1.0	3.5	1	1.0	3.0	1	1.0	.	.	.	.	.	.
Lack info. on public/public support	6.4	5	2.8	2.7	3	2.3	.	.	.	8.8	2	3.5	.	.	.
Interspecific competition	7.7	3	2.0	.	.	.	9.0	1	3.0	10.0	1	2.0	1	1	1
Enforcement of regs./inadequate regs.	8.1	4	2.8	7.0	2	4.0	3.0	1	1.0	10.0	1	2.0	.	.	.
Declining/low demand	9.5	4	3.3	10.5	1	3.0	.	.	.	5.5	3	3.3	.	.	.
Excessive harvest	11.5	1	1.0	.	.	.	3.0	1	1.0	.	.	.	.	.	.
Lack habitat info. (requirements/inventory)	14.4	2	2.5	3.5	1	1.0	.	.	.	20.0	1	4.0	.	.	.
Habitat management constrained/ineffective	14.4	2	2.5	.	.	.	3.8	2	2.5	.	.	.	.	.	.
Limited resource planning	17.3	2	3.0	.	.	.	3.0	1	1.0	25.0	1	5.0	.	.	.
Population distribution inadequate	23.0	2	4.0	.	.	.	.	.	.	10.0	2	4.0	.	.	.

Note: f = frequency.

Table 58.—Management issues for nongame species identified by state wildlife and fish management agencies in order of national priority (rank of 1.0 represents issue of greatest concern).

Management issue	National			North			South			Rocky Mountain			Pacific Coast		
	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank
Lack population information	1.0	25	1.8	1.0	10	1.8	1.1	5	1.6	1.0	9	2.0	2.7	1	2.0
Lack info. on public/public support	1.1	27	2.1	1.3	8	1.8	1.0	7	2.1	1.0	11	2.4	4.0	1	3.0
Habitat loss	1.3	21	2.0	1.6	6	1.7	1.0	7	2.1	1.5	6	2.0	1.3	2	2.0
Lack habitat info. (requirements/inventory)	2.8	10	2.0	6.9	2	2.5	4.2	2	2.5	1.7	5	1.8	1.3	1	1.0
Limited resource planning	2.9	12	2.5	3.2	4	2.3	1.7	4	2.0	3.8	4	3.3	.	.	.
Habitat degradation	3.0	12	2.6	3.3	5	3.0	5.0	2	3.0	3.5	3	2.3	1.0	2	1.5
Population low/unoccupied habitat	6.9	2	1.0	.	.	.	.	.	.	4.6	1	1.0	1.3	1	1.0
Multiple resource conflicts	6.9	4	2.0	2.8	2	1.0	6.7	1	2.0	18.3	1	4.0	.	.	.
Enforcement of regs./inadequate regs.	6.9	6	3.0	4.2	4	3.0	13.3	1	4.0	9.2	1	2.0	.	.	.
Interspecific competition	13.9	1	1.0	.	.	.	.	.	.	.	.	.	1.3	1	1.0
Habitat diversity loss	13.9	1	1.0	.	.	.	3.3	1	1.0	.	.	.	.	.	.
Pollution	17.1	3	3.7	11.1	2	4.0	.	.	.	.	.	.	4.0	1	3.0
Habitat management constrained/ineffective	18.5	3	4.0	.	.	.	10.0	1	3.0	10.3	2	4.5	.	.	.
Increased human populations	20.8	2	3.0	.	.	.	3.3	1	1.0	22.9	1	5.0	.	.	.
Excessive demand	55.6	1	4.0	22.2	1	4.0	.	.	.	.	.	.	.	.	.
Hunter ethics	55.6	1	4.0	22.2	1	4.0	.	.	.	.	.	.	.	.	.
Restricted access	69.4	1	5.0	27.8	1	5.0	.	.	.	.	.	.	.	.	.

Note: f = frequency.

requires population and harvest data to recommend management actions and to evaluate the success of such activities. Currently, this capability appears to be generally lacking with warmwater fish and many other species groups.

Nongame Wildlife

Unfortunately, nongame species individually and collectively enjoy less data accumulation than game species. Therefore, the most important management concerns were the lack of information about nongame population status, habitat requirements, habitat inventories, and public attitudes and use (table 58). Basic information on population trends and habitat needs is required for effective incorporation of nongame wildlife into multiple resource planning. The states cite both as being inadequate at this time. A similar finding, reported by the USDI Fish and Wildlife Service (1982a), revealed that in 31% of the considered cases, reasons for declines among bird species identified as having declining or unstable populations were either unknown or the species were not adequately monitored. The paucity of information regarding nongame wildlife is widely recognized and a number of workshops have been held to improve the information base on regional aspects of nongame communities and their management (DeGraaf 1978, 1979, 1980; Smith 1975). However, the focus of these workshops has been heavily biased toward nongame birds. Information on nongame mammals, reptiles,

amphibians, fish, and invertebrates has been more difficult to obtain. Even for the relatively well studied class of birds, efficient and accurate estimates of populations cannot be accomplished with current methods (Verner 1985).

Existing information about nongame species, however, does suggest that habitat loss is as much of a concern for this group as for others. Forest management practices influence forest succession, which in turn affects the fauna inhabiting a site at any given time. As forests are managed more intensively, the tendency is to shorten the successional process which can effectively eliminate the habitat for species requiring mature forest stands. Intensive, even-aged forest management can simplify stand structure, can reduce or eliminate special habitat components such as snags for cavity-nesting species, and can also affect the landscape diversity of forest types and successional stages.

Similar concerns for nongame wildlife inhabiting rangeland types exist and are associated with agricultural development and livestock management. Cultivation eliminates grassland communities, grazing can alter vegetation composition and impact special habitat components such as riparian areas in arid climates, and the seeding of exotic species can impair native floras. All negatively impact wildlife communities.

Urbanization associated with expanding human populations is a common disturbance factor on both forest and rangeland environments. Urbanization results in the removal or alteration of natural vegetation which can significantly affect the native fauna. The effect of urbanization on nongame bird communities has shown that, overall, species diversity declines with the avifauna becoming dominated by a few common, often exotic, species (DeGraaf 1986, Geis 1974).

The preceding discussion is not meant to imply that forest and rangeland management for timber or livestock is consistently detrimental to nongame communities. Rather, nongame wildlife represents such a diverse array of species that forest or rangeland management that fails to recognize the animals' habitat needs will tend to reduce the natural biotic diversity characteristic to a particular region. Given that information on nongame communities is lacking, no one can ensure that the habitats of all species will be maintained.

Threatened and Endangered Species

Management issues identified by state biologists were pertinent to species on both federal and state endangered species lists. The major concerns of the states for threatened and endangered species were the loss and degradation of habitat (table 59). These issues were consistent with the information provided by the USDI Fish and Wildlife Service's Endangered Species Information System as reviewed in chapter 1. The frequency with which habitat loss was cited, however, is inflated since state lists often include species occurring at the periphery of their ranges. Consequently, habitat may have been historically rare within a particular state as opposed to being recently lost through resource or human development.

Since part of the basis for a species to be considered threatened and endangered is a low population level, finding that states listed this as an important management issue is not surprising. However, population levels of these species have declined to the point where the genetic consequences must now be considered. As populations reach critically low levels, genetic variability is lost which can ultimately reduce the probability of species survival and recovery (Schonewald-Cox et al. 1983).

The other major management concerns for threatened and endangered species were the lack of adequate information about species population levels, habitat requirements, and public attitudes, which in turn limit effective incorporation of threatened and endangered species into comprehensive resource planning efforts. These

Table 59.—Management issues for threatened and endangered species identified by state wildlife and fish management agencies in order of national priority (rank of 1.0 represents issue of greatest concern).

	National			North			South			Rocky Mountain			Pacific Coast		
Management issue	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank	Index of importance	f	Mean rank
Habitat loss	1.0	22	1.9	1.9	6	1.8	1.0	7	1.9	1.0	7	1.9	1.7	2	2.5
Lack population information	1.0	19	1.6	1.1	8	1.4	2.5	3	2.0	1.1	6	1.8	1.0	2	1.5
Lack habitat info. (requirements/inventory)	1.3	17	1.8	1.0	7	1.1	5.5	2	3.0	1.1	7	2.0	2.7	1	2.0
Habitat degradation	2.0	14	2.3	5.7	3	2.7	3.7	3	3.0	1.0	6	1.7	1.7	2	2.5
Lack info. on public/public support	2.5	11	2.3	4.2	3	2.0	2.1	4	2.3	2.8	3	2.3	4.0	1	3.0
Population low/unoccupied habitat	3.6	6	1.8	6.4	1	1.0	7.4	1	2.0	2.8	3	2.3	1.3	1	1.0
Limited resource planning	3.6	7	2.1	4.0	4	2.5	3.7	2	2.0	.	.	.	1.3	1	1.0
Multiple resource conflicts	7.9	3	2.0	3.2	2	1.0	.	.	.	14.7	1	4.0	.	.	.
Enforcement of regs./inadequate regs.	8.9	4	3.0	11.1	2	3.5	11.1	1	3.0	7.4	1	2.0	.	.	.
Disease/parasites	8.9	2	1.5	.	.	.	.	.	.	7.4	1	2.0	1.3	1	1.0
Increased human populations	10.7	3	2.7	9.5	2	3.0	7.4	1	2.0	.	.	.	.	.	.
Habitat management constrained/ineffective	14.8	2	2.5	.	.	.	4.6	2	2.5	.	.	.	.	.	.
Pollution	17.8	2	3.0	9.5	2	3.0	.	.	.	.	.	.	.	.	.
Interspecific competition	20.8	2	3.5	.	.	.	.	.	.	18.4	1	5.0	2.7	1	2.0
Excessive demand	47.5	1	4.0	25.5	1	4.0	.	.	.	.	.	.	.	.	.
Hunter ethics	47.5	1	4.0	25.5	1	4.0	.	.	.	.	.	.	.	.	.
Illegal harvest	59.4	1	5.0	.	.	.	.	.	.	18.4	1	5.0	.	.	.

Note: f = frequency.

issues are related, in part, to the ownership pattern of remaining habitat. Several states claimed that threatened and endangered species management could not be effective on private lands, citing landowners' lack of concern for the species, limited regulatory authority, and inadequate public understanding about the basis for the states' concern for these species.

Issues Perceived on Public Lands

The Forest Service (FS) and Bureau of Land Management (BLM) are responsible for managing wildlife and fish resources on approximately 525 million acres. Although the states technically have the lead responsibility in the management of resident wildlife and fish populations, the FS and BLM are responsible for managing wildlife and fish habitats. However, strict adherence to this division of responsibility would foster inefficient management of wildlife and fish resources. Consequently, wildlife and fish management is, in practice, conducted through cooperation among state and federal agencies.

The FS and the BLM are multiple-use agencies which by definition means that decisions have to be made as to how lands are used among a variety of competing uses. In many cases, the source of the wildlife and fish management issues facing these two agencies can be traced to this multiple resource management responsibility. Biologists from both agencies were asked to provide a priority listing of the major management issues for each species category. Because of the high degree of cooperation between federal and state agencies, many of the issues are similar to those cited by state personnel.

Forest Service

Biologists provided information on the most important management issues facing wildlife and fish resources in their region. As with the state agencies, the issues varied across the species groups.

For big game species, a major habitat management issue concerned the effect of intermingled land ownerships. Big game species range widely and independently of ownership boundaries. Effective management of big game species on national forests was often viewed as being constrained by human development and resource management on surrounding private lands. This was especially a concern in the West where development of private lands is resulting in losses of important winter ranges, and in the East where private ownerships dominate. Other important habitat-related problems included: (1) a noted decline in shade-intolerant timber types (e.g., aspen, jack pine) through natural forest succession which has reduced the amount and quality of deer and moose habitat in the North; (2) reduction in winter thermal cover (lowland conifer and cedar) in the North; and (3) maintenance of a suitable mosaic of old-growth and second-growth stands for species such as Sitka black-tailed deer in Alaska.

Management issues related to the recreational use of big game were also a prominent concern and were largely related to the distribution of that use. In some cases, hunting pressure and excessive access have increased on national forests as hunting opportunities declined on private ownerships. Road development associated with timber harvesting has increased the accessibility of game to the public and in some instances has facilitated the illegal harvest of deer and black bear. Conversely, in some cases restricted access was the concern. For example, private landowners can deny passage through their property to national forest land, and major portions of some national forests remain undeveloped and inaccessible to big game hunters. The composite result of both access issues is an inadequate distribution of big game recreational use.

A final concern for big game management is that multiple uses of national forests often conflict with big game management objectives. This issue translates into a general concern for adequate integration of wildlife into the resource planning process.

Traditionally, small game and waterfowl have received less emphasis in the resource planning process on national forests. The habitat-related concerns that were raised centered around three issues: (1) loss of both early and late forest seral stages, (2) livestock grazing impacts on riparian and other wetland habitats, and (3) declining quantity and quality of wetland habitats on public and private lands. Other management problems associated with small game and waterfowl derived from the low priority that these species have received in the past. These included a general lack of population and habitat inventory information. In some regions, biologists felt that the resource was underutilized by the public.

Approximately 50% of salmon and steelhead spawning and rearing habitat occurs on national forests in Oregon, Washington, and Idaho; in Alaska the estimate is 27% (Barton and Fosburgh 1986). However, biologists have noticed fewer spawners returning to the headwaters on national forests resulting in an underutilization of available habitat. FS biologists also noted habitat degradation problems associated with livestock grazing, sedimentation from timber harvesting and road development, lack of overhead cover resulting in high water temperatures, and low pH in some eastern streams. Other management issues that constrain effective planning for anadromous fish included inadequate information on habitat condition, the cumulative impacts of forest management, and the economic benefits and levels of recreational use of the fishery.

Resident cold- and warmwater fishery resources share many habitat concerns with the anadromous fishery. In the West, habitat management issues focused on the loss of streambank structure and vegetation due to livestock grazing and poor implementation of recommended streamside silvicultural practices. In the East, habitat concerns involved low streamside cover which elevates water temperature, low pH, and nuisance aquatic vegetation which promotes stunting among panfish populations and hinders fishing. Stunted panfish was also the result of inadequate predators. As with anadromous fish, an important management issue was the lack of adequate

information on habitat, populations, factors limiting productivity, and the effectiveness of direct habitat improvements.

The National Forest Management Act of 1976 (NFMA) mandated the FS to maintain a diversity of plant and animal communities and to ensure viability of all animal species inhabiting the NFS. Consequently, wildlife and fish management and planning must consider the animal community in its entirety, including nongame species which constitute the majority of species found on national forests. A frequently cited nongame management issue raised by FS biologists related directly to the viability requirement. Insufficient information on nongame population status and habitat requirements confound their responsibility to demonstrate that viability of species will be assured. A contributing factor to the inventory problem is the implied number of wildlife and fish species that must be monitored. The NFMA recognizes this concern and requires the designation of species which "indicate" the trends of other species with similar habitat requirements. However, the basic assumption underlying this approach (i.e., that the status of one species is representative of the status of several species) has been challenged (Block et al. 1987, Landres 1983, Mannan et al. 1984, Szaro 1986, Verner 1984). As a result, considerable uncertainty exists in the selection and use of indicator species in resource planning for nongame species.

In addition to concerns stemming from the requirement for maintaining viable populations, important nongame management issues involved quantity and quality of habitat. In particular, the disappearance of old-growth forests, poor distribution of age classes, and loss of bottomland hardwoods were of concern in the East. Key issues raised in the West were provision of adequate habitat for cavity-nesting species, maintenance of old-growth forest habitats for such species as the spotted owl, loss of aspen communities to succession, and the degradation of riparian habitats from livestock grazing practices.

A particularly important subset of nongame wildlife and fish are those species that are currently listed as threatened and endangered. The FS consults with the Fish and Wildlife Service to ensure recovery of listed species. Species of particular concern include the grizzly bear, California condor, red-cockaded woodpecker, Kirtland's warbler, woodland caribou, bald eagle, peregrine falcon, Puerto Rican parrot, Lahontan cutthroat and greenback cutthroat trout, and the gray, Indiana, and Virginia big-eared bats. By definition, concern for low populations and maintenance of habitat are of primary concern for these species. However, other management issues included the lack of comprehensive information on the distribution of all threatened and endangered species on national forests, intermingled ownerships hindering effective management and limiting the recovery of some species, and conflicts between public use in areas with high access and species requiring limited human disturbance.

Bureau of Land Management

BLM biologists from western states provided information on wildlife and fish management issues of primary importance to the agency. In general, the management issues identified are consistent with those issues identified by FS and state biologists. The discussion here will focus on those issues emphasized as particularly important on BLM lands.

Without question, the most important wildlife and fish management issue cited by BLM biologists was the effect of livestock grazing. BLM lands have a history of overgrazing, and although range conditions have improved somewhat, the majority of the public range is still seriously deteriorated and producing far below its potential (Barton 1987). Degraded rangeland condition particularly affects big game winter ranges, which are prevalent on BLM lands, and small game habitats.

Another important issue related to grazing was the impact of livestock on riparian communities. Riparian areas are critical to wildlife and fish, particularly in arid climates. In the West, riparian systems support a disproportionate number of wildlife species when compared to adjacent upland ecosystems (Ohmart and Anderson 1986). Livestock also make disproportionate use of riparian systems, and BLM biologists cited maintenance and recovery of riparian ecosystems more frequently than any other management issue across all species groups.

Other habitat-related issues included adequate distribution of water, conflicts with mineral development, unoccupied desert bighorn sheep habitat, noxious weed infestation, and encroachment of undesirable woody species.

Intermingled ownerships were also cited as a hindrance to effective wildlife and fish management. Instances exist where key habitat features exist on private ownerships and therefore are beyond the management jurisdiction of the BLM; access to BLM lands is often restricted under such ownership patterns; and intermingled ownerships also result in ineffective resource planning unless there is a high degree of cooperation among all land owning parties.

Throughout much of its existence, the BLM lacked the authority and funding to manage its lands (Barton 1986). The agency's mandate to manage for multiple uses is relatively recent. As a consequence of this history, BLM biologists have cited limited inventory information on the amounts and quality of wildlife and fish habitats, the status of wildlife and fish populations, ecological relationships between animals and their habitat, and the distribution of threatened and endangered species as restrictions on effectual multiple use planning.

WILDLIFE AND FISH MANAGEMENT OPPORTUNITIES

Wildlife and fish management has been defined as the art and science of "changing the characteristics and interactions of habitat, wild animal populations, and men in order to achieve specific human goals" (Giles 1969:1). As defined by Poole and Trefethen (1978),

the primary goal of wildlife and fish management is to maintain animal populations at levels that are consistent with the capacity of the ecological system and the social, economic, and cultural needs of the public. Failure to manage wildlife and fish resources would almost certainly lead to the domination of generalist species rather than a balanced interacting fauna (Bolen and Rodiek 1986, Lyle 1985). Berryman (1983:473) asked the questions: "Do we want only to preserve islands of habitat, only remnants of fish and wildlife populations? Or do we want fish and wildlife resources to remain as a part of the fabric of our total landscape and environment?" The management opportunities discussed here are in the spirit of the latter; however, the former is a possible future for some species and communities.

The management issues identified by state and federal agencies were classified into four categories: habitat, population, user, and planning-related issues. This categorization is also appropriate for discussing future wildlife and fish management opportunities. The order in which these aspects of wildlife and fish management are listed is not arbitrary. Habitat is often the factor most limiting to wildlife and fish species, and it makes little sense to consider population manipulations if the habitat does not exist. By the same logic, regulation of users becomes unnecessary when wild populations are not present to be enjoyed by the recreating public. Planning is listed last as it involves all aspects of wildlife and fish management, and in a world of competing uses, must also consider aspects of management across multiple resource areas.

Habitat Management Opportunities

Management issues related to wildlife and fish habitat focused on two aspects. The first was a concern for the loss or total removal of certain habitat types from the landscape. The second was a concern for degradation or the reduced quality of habitats and was usually associated with multiple resource conflicts.

The most obvious management opportunity involves the outright purchase of land. This gives the resource managing agencies control over land-use activities that would otherwise jeopardize the existence of the habitat. Probably the best example where acquisition has been critical to the preservation of a habitat type is the protection of wetland habitats under the National Wildlife Refuge System. Under such programs as the Migratory Bird Hunting and Conservation Stamp, the Wetlands Loan Act, and the Land and Water Conservation Fund, the Refuge System has grown to 90 million acres (Office of Technology Assessment 1984). The Endangered Species Act also authorizes the purchase of land for the protection of critical habitat.

Another important land acquisition opportunity exists through established natural area programs. State (Schwegman 1983), private (Cantera 1983) and federal (Burns 1983) natural area programs have all contributed to an extensive network of protected plant and animal communities. As of 1983, the Fish and Wildlife Service had designated 194 natural areas followed by the FS (148), National Park Service (64), and the BLM (23) (Burns 1983). The BLM also has special authority to designate and protect Areas of Critical Environmental Concern (ACEC). Protection of rare floras and faunas is a prominent objective of this program. The BLM now has approximately 300 ACEC's that cover over 5 million acres (Almand, pers. comm., 1988).

Coordination and cooperation among private, state, and federal programs will be critical to the effective management of these lands in the future (Harwell 1983). Consideration must be given to the size, shape, distribution, and linkages among communities of the same type if the goal of preserving natural diversity is to be attainable. As noted by Hoose (1983), the effect that large-scale disturbance factors such as acid rain, global warming, depletion of aquifers, and air and water pollution will have on the viability of some natural area communities remains unknown. Similarly, protected communities may lose integrity at their borders as private land uses intensify. The implication is that the management of natural areas will have to become more intensive and involve considerations on a broader landscape scale. For example, corridors of habitat to connect nature reserves have been proposed as being important in facilitating gene flow to maintain the ecological integrity of rare and isolated communities (Harris 1984, Office of Technology Assessment 1987).

Protection through purchase is in most cases limited by inadequate funds. The partial purchase of property rights through conservation easements, long-term leasing agreements, or management agreements with landowners have been used effectively in wildlife and fish habitat protection as alternatives to purchase (Gilbert and Dodds 1987). Private landowner incentive programs offer still another habitat protection opportunity that can range from wildlife habitat management assistance to preferential tax treatment for landowners who preserve wildlife habitat. The Sodbuster, Swampbuster, and conservation easement provisions of the 1985 Food Security Act (see chapter 3) provide examples of where such wildlife habitat protection opportunities have recently been implemented.

Protection, through purchase or otherwise, of wildlife and fish habitats is rarely sufficient to maintain the quality of the habitat into the future. The majority of the nation's wildlife and fish habitats exist under a resource management environment of competing uses for the land. Consequently, the general situation facing wildlife and fish managers is that the creation and enhancement of wildlife and fish habitats must be coordinated with other land and resource uses.

Reduced to its most fundamental principles, all forms of habitat restoration or enhancement involve the manipulation of wildlife and fish food, cover, and water in both time and space. The specific habitat management activities that are implemented depend on management objectives; however, some examples of habitat management opportunities are discussed below.

Restoration of degraded ecosystems has a relatively short history in the United States and probably saw its

beginnings with the restoration efforts of prairie ecosystems initiated by Aldo Leopold (Jordan et al. 1987). Out of those initial efforts grew an understanding of fire's role in prairie ecosystems. Since that time, research has demonstrated the important role that fire plays in the maintenance of many range and forest communities. Since the 1970's, many national parks and wilderness areas have been managed under a "let it burn" policy, but this may change as we learn about the consequences of such a policy. Passive management of fire, however, is not always feasible and deliberate controlled burns are a valuable wildlife management tool for improving habitat for wild ungulates (Scotter 1980) and other game and nongame species associated with or dependent on early successional stages (Landers 1987, Peek 1986).

Wildlife and fish restoration may also take the form of simply removing or more effectively controlling disturbance factors. In some cases, resting riparian areas from livestock grazing has been shown to be effective in restoring streamside vegetation communities (Kauffman and Krueger 1984) with associated benefits to both terrestrial and aquatic animals. Wetlands can sometimes be restored by eliminating cultivation and rendering drainage systems ineffective (Office of Technology Assessment 1984). Control of point and nonpoint sources of pollution will allow aquatic ecosystems to recover. Reductions in the use of certain pesticides has helped in the recovery of some raptor populations (Evans 1982). Removal of barriers to migrating anadromous fish represents an opportunity to significantly increase the production on spawning habitats. The Northwest Power Planning Council (1987) is examining a number of structural modifications to fishways that will increase the number of returning adult spawners and reduce mortality to juveniles during downstream migration.

More intensive restoration efforts could involve the direct manipulation of food and cover through seeding, planting, or chemical applications to control noxious or undesirable plants. Aquatic habitat developments also represent an intensive form of restoration management that includes the creation of wetland habitats, water facilities for wildlife in arid climates, structures to enhance the within-stream cover, and small ponds for warmwater fish habitat.

Habitat restoration through direct manipulation of food, cover, and water for the sole purpose of enhancing wildlife and fish habitat is often prohibitively expensive. More efficient habitat management can be attained through the integration of habitat management considerations into the management of other resources. Fundamentally, incorporating wildlife and fish habitat concerns into multiple resource management systems entails ensuring that habitat diversity is maintained. Three aspects of habitat diversity are important. The first aspect is vertical diversity, or the number of vegetation layers present within a given plant community. However, wildlife and fish are mobile resources and therefore require consideration of a horizontal diversity component to habitat as well. The size, shape, and distribution of vegetation types and successional stages in a given area and through time are important to the maintenance of the regional animal community. The final aspect of wildlife and fish habitat diversity is the presence of special habitat components including snags, caves, talus slopes, cliffs, and dead and down woody material. The absence of such special components will result in some species being absent from the community.

Timber and livestock management practices can all be modified to ensure that these aspects of habitat diversity are provided. Wildlife and fish can benefit from timber and livestock management, but only if planned for in advance. Timber harvesting methods, harvest rotations, and intermediate silvicultural treatments can be used to enhance or maintain, rather than limit the quantity and quality of wildlife and fish habitat (Everest et al. 1987, Harris 1984, Thomas 1979). Similarly, grazing systems, season of use, multiple species grazing, and livestock improvement practices (e.g., water facilities, control of noxious plants, fire) can be used to minimize impacts to riparian systems or even enhance habitat quality for wild ungulates on winter ranges (Joyce in press, Scotter 1980). Although integration of wildlife and fish management into timber and range management may carry costs (no single resource output is maximized), it will ensure that certain values, some of which are difficult to quantify, will not be excluded.

Integrated wildlife and fish management certainly represents a viable management opportunity under public lands with multiple use objectives. However, it should not be assumed that integrated resource management is not feasible on private lands. Opportunities exist for state and federal agencies to provide technical assistance to private landowners who desire to manage wildlife and fish habitats on their lands. Opportunities to assist private landowners could be expanded in the future. Under the 1985 Food Security Act, substantial acreage of highly erodible cropland will be planted to permanent cover which, if appropriate species are chosen, can provide high quality habitat for wildlife and improve fish habitat by reducing soil erosion into aquatic ecosystems. In addition, private landowners, including large industrial timber companies, are now entering into lease agreements with hunters and anglers or charging access fees for the privilege of using their lands. McKee (1987) showed that net revenues from the joint production of wildlife and timber under fee hunting situations in the South were greater than revenues generated from maximizing timber production. Such economic incentives may provide the motivation for active wildlife and fish management on private lands, and state and federal agencies have the opportunity to assist in guiding that management.

Population Management Opportunities

Although habitat management may provide the greatest opportunities for improving future wildlife and fish resources, in some cases actual manipulation of populations is required to address certain management issues. Wildlife managers can often manipulate animal numbers

through properly planned harvests more effectively than manipulating environmental factors to improve habitat (Scotter 1980). Under these situations, the goal is one of preventing habitat deterioration stemming from overly abundant wildlife. One of the more important management problems noted by the states was excessive populations of some big game species. Number of licenses, hunting season lengths, and either-sex regulations can all be adjusted to balance big game populations with the environment's capacity. The states have the primary authority for the setting of harvest regulations for resident game populations and population management through exploitation will continue to be an important responsibility of state agencies.

Another management issue raised by state and federal agencies was the prevalence of unoccupied habitat. Transplanting of wild stock offers an opportunity to hasten colonization of suitable habitat—assuming that the disturbance factor responsible for the species displacement has been removed (e.g., competing species). This technique was used effectively in reestablishing white-tailed deer (Downing 1987) and wild turkey (Lewis 1987) populations in the East. Transplanting animals into suitable habitat represents one of the most important opportunities for maintaining threatened and endangered species. Captive breeding programs and subsequent reintroduction into suitable habitat are critical to the restoration of such species as the peregrine falcon, red wolf, California condor, Puerto Rican parrot, greenback cutthroat trout, and black-footed ferret.

Aquaculture, the propagation of aquatic species in controlled environments, represents a general management opportunity that has both recreational and commercial application (Parker and Stevens 1988). Fish hatcheries, although important in the restoration of some endangered fishes, have their greatest utility in supplementing heavily exploited fish populations. A significant portion of the commercial and recreational harvest of sport fish is produced in hatcheries. However, artificial propagation should not be considered a substitute for natural reproduction (Everhart and Youngs 1981).

Given expected demand increases for commercial fish products and recreational fishing, aquaculture will likely become a more prominent management practice used to meet these rising demands on the nation's fishery resources. It has been estimated that aquaculture in the United States will produce 2 billion pounds of fish by the year 2000 (Parker and Stevens 1988). Stock-enhancement through aquaculture will also continue to be important in maintaining recreational fishing opportunities, particularly in and around high population centers.

Increased production from aquaculture can be accomplished through improved propagation practices which increase survival, increasing the capacity of existing facilities, and the building of new rearing facilities. For example, the Northwest Power Planning Council (1987) has found that acclimation ponds can improve survival of released fish and is recommending the development of low-cost, small-scale hatcheries. Smaller scale hatcheries have the advantage of smaller water supply requirements and they are readily adaptable to an individual drainage which facilitates the preservation of gene pools.

Other management opportunities that involve the direct manipulation of populations include the removal of pest or competing species. For example, certain bird species have a long history of damaging crops and causing health problems. When populations become excessive, intensive measures to control their numbers may have to be implemented. However, Dolbeer and Stehn (1979) pointed out that such measures may only be temporary solutions and recommended that studies be initiated to determine the cause for population increases so that longer term solutions can be achieved. In the case of interspecific competition, removal of the competing species may be the only possible solution to the management problem and has been an important management practice in the protection of threatened and endangered species such as the Kirtland's warbler (Walkinshaw and Faust 1974) and Hawaiian birds (Scott and Sincock 1985).

User and People Management Opportunities

Management issues related to use of wildlife and fish resources focused mainly on concerns for access. The states control use through restrictions on the number of licenses available or through special regulations that attempt to control the distribution of user pressure within the state. However, if access to land or water supporting wildlife and fish is limited, regulations to control use can be ineffective and recreationists can become dissatisfied. From the state's perspective, restricted access was the fifth most important management issue across all species groups. The reasons for closing lands are varied and include concern for liability, property damage, interference with other activities, and disturbance of privacy. Another major factor is that the landowners have traditionally received little or no economic return for allowing hunting or fishing on their lands. Evidence reviewed in chapters 2 and 5 showed that economic return to private landowners stemming from wildlife and fish recreation has been increasing and will probably continue to increase in the future. Consequently, opportunities exist for state and federal programs to promote and assist landowners in establishing such businesses. A more active policy for lease hunting and fishing could put wildlife and fish agencies in a stronger position to take an active role in shaping lease agreements and ultimately provide an opportunity to work more closely with private landowners in the management of habitats (Wiggers and Rootes 1987).

On public lands, both restricted and excessive access were important management concerns. Opportunities to increase access to public lands involve adjustments to ownership patterns through land exchanges, acquisition, or easements. Solution of the restricted access problem must, in part, address concerns for excessive access by helping to redistribute use. Road closures in high use

areas provide one opportunity for controlling the potential detrimental impacts on the land, and wildlife and fish populations.

Another important management concern was an uninformed public. As competition among land uses intensifies, wildlife and fish managers will require that the public have a complete understanding of the management problems and the justification for proposed management activities. Without public acceptance, wildlife and fish management will be ineffective. Public information and education programs are an obvious opportunity for gaining public confidence and support for wildlife and fish management on private, state, or federal lands.

The concern for user information, however, does not stop with educating the public. Managing agencies must educate themselves on public attitudes and values. Such information can be useful in establishing the priority that should be assigned to various management activities. The clientele has changed and will continue to change in the future. The future demands for wildlife and fish recreation, based on the results presented in chapter 2, are expected to shift from hunting to fishing and nonconsumptive activities. Managing agencies will need to respond to these shifts or risk failure in fulfilling the stewardship obligations entrusted to the resource managing agencies.

Planning Opportunities

Planning involves the specification of objectives, implementation of management strategies, and an evaluation of how well objectives were met. Four factors cited as contributing to ineffective decision-making were: (1) inadequate cooperation among agencies, (2) poorly coordinated planning among resource areas, (3) inadequate information on population and habitat status, and (4) limited capability to predict animal response to resource management activities.

Cooperative and Coordinated Planning

Cooperative planning is particularly important for mobile resources such as wildlife and fish. Political and administrative boundaries have been defined without respect to ecological systems. Wildlife and fish planning and management under multiple and intermingled land ownerships can be futile for wide-ranging species or species inhabiting aquatic systems unless habitat conditions across all ownerships are considered. Cooperative planning across land managing agencies, landowners, and user groups has been recognized in the National Recreational Fisheries Policy (USDI Fish and Wildlife Service 1988c) as being critical to effective and efficient management of the nation's fishery resources.

Opportunities to improve the planning environment include consolidation of land ownerships through purchase or land exchange. In the FS, purchase and exchange of lands are authorized under the 1911 Weeks Act, the 1922 General Exchange Act, the Federal Land Policy and Management Act, and a number of laws authorizing the purchase or exchange of lands for specific purposes including the Wilderness Act of 1964, the Eastern Wilderness Act of 1975, the Endangered Species Act of 1973, the Wild and Scenic Rivers Act of 1968, and the Sikes Act of 1967. While the authority exists, proposals for large land exchanges between agencies have met with resistance. The 1985 proposal to exchange 35 million acres between the FS and BLM was delayed because interest groups felt that such land swaps should be evaluated on a case-by-case basis (Barton and Fosburgh 1986). While focus on smaller land units and the "politics" involved may engender a perception that land purchase and exchanges are ineffectual, it appears to be an unavoidable consequence of the process.

Coordinated planning among resource areas, as reviewed under habitat management opportunities, probably represents the single greatest opportunity for improving the future wildlife and fish resource situation. Leopold (1933) noted that wildlife and fish management is essentially the "favorable alignment" of timber, agriculture, and livestock activities. Despite the history behind the concept, and the acceptance of its importance in wildlife and fish management, it has been difficult to integrate wildlife and fish management into comprehensive land use plans (Peek 1986). Part of the difficulty stems from incomplete information on how wildlife and fish respond to various timber, livestock, and water management activities. Knowledge gaps defined by the state and federal agencies help define the future research needs related to effective planning and management.

Research Needs

The information needs identified by the state and federal agencies fell into three broad categories: (1) species-habitat relationships, (2) population inventories, (3) public attitude about wildlife and fish values. Species-habitat relationship information is basic to any management plan. Additional research on species-habitat relationships is important for at least two reasons. First, basic knowledge of species life requisites is necessary before we can manage existing systems in a manner that maintains the biological diversity typical of a given community. Second, such knowledge is important to restoration efforts of those habitats that have become rare including old-growth forests (Nyberg et al. 1987), wetlands (Pearce 1985), tallgrass prairie (Platt 1983), and riparian systems (Platts 1986).

Apart from providing a knowledge base from which to recommend management and restore communities, species-habitat relationship information is also important in the development of resource planning models. Since the last national assessment of wildlife and fish (USDA Forest Service 1981), researchers have expended considerable effort to develop quantified characterizations of wildlife and fish habitat in the form of species-habitat relationship models (Fausch et al. 1988, Verner et al. 1986). One objective of these habitat models is to aid planners in assessing the impacts from multiple resource management on wildlife and fish resources. The

value of these models is as a tool to explore potential outcomes based on what biologists believe to be the habitat requirements of modeled species (Starfield and Bleloch 1986). Research has provided the resource planner with a diversity of habitat modeling approaches; however, model development has exceeded model validation and testing of basic assumptions. The research challenge now is not to develop new techniques for modeling wildlife and fish habitat but to rigorously explore the basic underlying assumptions and to test the performance of extant modeling approaches (Fausch et al. 1988, Sweeney and Wolters 1986).

Another area of future research concerns the application and testing of wildlife and fish habitat models at larger scales. Most habitat modeling efforts have focused on site-specific studies, but policy and management decisions are being made at regional scales. There is increasing recognition that informed resource planning decisions cannot be made exclusively at the site-level (Risser et al. 1984) and that more emphasis needs to be placed on analyses that explicitly address large geographic areas (Gall and Christian 1984, Sanderson et al. 1979). As reviewed in chapter 3, the use of wildlife and fish habitat models to evaluate the impacts from timber management and land-use change represented the first time that regional wildlife and fish models were linked to regional timber inventory and land use models (USDA Forest Service 1988). The conceptual framework for regional multiple resource analyses has been described (Joyce et al. 1986) and applied in the South (Flather et al. 1989, Flebbe et al. 1988). Further research on regional multiple resource modeling is needed in the areas of: rigorous evaluation of model performance, extending the methodology to other regions of the country, and incorporating wildlife and fish, forage, and water feedbacks that alter timber management and land use decisions.

Apart from being used to predict wildlife and fish response to land management activities, an additional use of habitat models is to support wildlife and fish population monitoring. Habitat characteristics are easily inventoried relative to wildlife and fish populations. The basic assumption of this application is that changes in habitat amounts and quality can be used to predict changes in animal population levels. Recent research has shown, however, that this assumption does not hold for some species (Rotenberry 1986, Van Horne 1983), and that other factors (interspecific interactions, weather, disease, mortality on wintering habitat, etc.) must be considered when explaining variation in population levels. Additional research is needed to characterize those kinds of species where the assumption of population levels tracking habitat condition is and is not valid.

The implication of the uncertainty associated with the habitat-population relationship is that inventories of habitat alone will not be sufficient to ensure that community diversity and viable populations will be maintained. Both state and federal agencies expressed concern that information on population status and important population parameters was inadequate to manage the resource effectively. This was more of a concern with nongame species than for game species. Inventory information was available for some game mammals and birds, and some nongame bird species, yet generally absent for small mammals, fish, amphibians, reptiles, and invertebrates. Although local inventories of such species may be available for a specific site, systematic and comprehensive approaches to monitoring wildlife and fish populations are lacking. Existing methods are, in general, too expensive and of questionable accuracy. Recent suggestions to use indicator species or guilds to monitor wildlife and fish communities have potential shortcomings (Verner 1986). Future research directed at developing wildlife and fish monitoring techniques applicable across a variety of scales (site, management unit, region) is not only important for providing baseline information on population status, but it is also important in evaluating the predictive accuracy of species-habitat relationship models.

The final area of needed research, as reflected by state and federal agencies, is in characterization of the public attitudes and values held for wildlife and fish resources. Because state and federal management agencies are public agencies, they need to know who the public is, what the public desires, what the public is willing to pay, and the factors responsible for changes in these components (Lyons 1987). The attitudes and wants of consumptive wildlife and fish recreationists have been studied to a much greater degree than either nonconsumptive users or nonusers. Such information is critical if management agencies are to respond and adjust their programs to satisfy the public demands. Failure to do so will only result in an eroding of public support and declining funding levels.

Characterizing the client is but one important component of research addressing the human dimension of wildlife and fish resource management. Another important component concerns estimating the economic value of wildlife and fish resources. Such information is not only important to setting wildlife and fish management priorities, but it is also critical if wildlife and fish are going to compete on a commensurate basis with other resources under multiple use management. Although a number of techniques have been developed to estimate nonmarket wildlife and fish resource values, additional research is needed to test model assumptions and validate methodologies. There is also a need to extend the user projection analysis used in chapter 2 to more accurately examine the relationship between wildlife and fish resource inventories and participation in wildlife and fish related recreation (Lyons 1987). Finally, the growing prevalence of fee-hunting in the United States offers an opportunity to further study the economic value of wildlife and fish resources and its role in private land-use management decisions.

OBSTACLES TO IMPROVING WILDLIFE AND FISH RESOURCES

Obstacles are those factors that prevent implementation of effective management opportunities. Unmet management goals and objectives can lead to a dissatisfied clientele or deterioration of the resource itself. The

most common obstacles identified by state and federal agencies were lack of knowledge, inadequate or unstable funding levels, and inadequate staffing and qualified personnel.

Insufficient knowledge has two aspects. The first is that research is required to add to the information base on wildlife and fish management. The research needs discussed above in the areas of habitat relationships, population monitoring, and public attitudes and values address this aspect of insufficient knowledge.

The other aspect concerns increased information exchange between researchers and managers. An efficient system is needed to transfer knowledge from those solving management problems to those who have the responsibility of implementing these solutions. (Seitz et al. 1987). As described by Naisbitt (1982), the United States is evolving into an information based, high technology society. The wildlife and fish profession needs to take advantage of information transfer technology to ensure that managers are applying state-of-the-art techniques and researchers are informed of the evolving problems facing managers.

Concern for sufficient funding was by far the most frequently cited obstacle. As reviewed in chapter 5, many state agencies have experienced substantial declines in real spending power. Similar declines have been noted in federal agency budgets. Between 1980 and 1985, in constant dollars, the FS budget declined by 16%; funding for wildlife and fish habitat management on national forests declined by 9%; wildlife and fish research funding declined by 9%; and funding for the State and Private Forestry Program which provides technical assistance to private landowners declined by 38% (Barton and Fosburgh 1986). Similarly, funding appropriations for wildlife habitat management on BLM lands declined by 22% from 1981 to 1986 (Barton 1987).

Adequate staffing is not unrelated to agency budgets. However, number of personnel is only part of the concern. As resource management problems become more complex, the qualifications for addressing the problems change. Education of existing personnel and the training of new professionals must evolve with these changes to ensure that resource professionals can be effective. Recommendations for improved curricula and continued training include: (1) explore new approaches to motivate the work force to continue formal education opportunities (Hamilton et al. 1987); (2) increase the opportunities for participation in continuing education programs (Cross 1987), with increased employer responsibility to do so (Nielsen 1987); and (3) revision of natural resource curricula to include not only a biological background, but also an increased emphasis on courses in law, communications, political processes, economics, long-range planning, information management and computer science, and human resource management (Knuth 1987, Streeter 1987).

SUMMARY

An important component of national resource assessments is to explore the management issues and attendant management opportunities that exist for minimizing the social, economic, and environmental costs associated with future imbalances in anticipated resource use and inventories. Management issues and opportunities were categorized into four areas: habitat, population, user, and planning.

Priority management issues were identified from responses provided by state and federal biologists. At the national level, and for all species groups covered in this assessment, habitat loss and habitat degradation were ranked as the two most important wildlife and fish management issues. Habitat is the most fundamental management issue now confronting resource managing agencies, for landscapes lacking in suitable wildlife and fish habitats will no longer support animal populations.

Management concerns related to wildlife and fish populations were ranked as the third and fourth most critical national issues. Inadequate population inventory information was cited as hindering effective management of wildlife and fish. A general concern for low populations of some species groups was viewed as an area for potential future improvement.

User-related issues were also a prominent concern of wildlife and fish resource management agencies. Restricted access to both public and private lands has resulted in an inadequate distribution of recreation use and managers felt they had insufficient information on public attitudes and values held for wildlife and fish. The latter was emphasized as particularly important since it ultimately affects public support for management activities.

The final issue of national concern was related to multiple resource planning. More intensive agricultural practices and timber management, competition with livestock, mineral development, water withdrawals for consumption or irrigation, and wildlife damage to crops all serve to illustrate that wildlife and fish management is much more complicated than direct habitat improvement, manipulating animal populations, or regulating use.

The specific management opportunities addressing habitat-related issues included:

- 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, diversity, and distribution of key habitat tracts to preserve the natural diversity characteristic of a given region.
- Restoration of degraded ecosystems through: 1) direct manipulation of vegetation and water through seedings, plantings, physical or chemical treatment, creation of wetlands, and development of water facilities and stream structures, or 2) removal or effective control of disturbance factors including control of point and nonpoint sources of pollution, removal of barriers to migrating fish, controlling livestock access to riparian areas, and removal of wetland drainage systems.

Opportunities for direct management of wildlife and fish populations included:

- Manipulation of populations through appropriate harvest strategies to ensure that populations remain within the productive capacities of their habitat.
- Increasing the 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.
- Control or removal of pest or competing species.

Opportunities for user and people management included:

- Improving access to private lands by promoting programs that would assist landowners in establishing wildlife and fish-related businesses.
- Increasing the use of land acquisition and user management programs to increase the amount of habitat available to recreationists and to better distribute use across suitable sites.
- Implementing programs to educate the public about the need for 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 needs and wants.

Opportunities to improve resource planning include:

- Increasing interagency cooperation among the many agencies that have responsibility for management of habitat, wildlife and fish populations, and hunting and fishing.
- More fully integrating wildlife and fish management objectives into the management of forest and range lands 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.

This review of important management problems, potential management opportunities, and obstacles to effective management indicates that improving the future wildlife and fish resource situation will become an increasingly difficult task. Human populations are expanding and land use is intensifying, yet declining funds for wildlife and fish management is an increasing concern. Unless these trends change, the wildlife and fish profession is faced with the challenging task of solving increasingly complex management problems with a shrinking monetary and personnel resource base. The wildlife and fish management issues and opportunities that could be addressed by future FS programs are discussed in chapter 7.

CHAPTER 7: IMPLICATIONS FOR FOREST SERVICE WILDLIFE AND FISH PROGRAMS

LEGISLATIVE EVOLUTION OF RPA AND THE ASSESSMENT-PROGRAM RELATIONSHIP

The Forest Service (FS) is one of the largest land-managing agencies in the federal government and the natural resources on the lands it administers are important national assets. National forests provide approximately 15% of the total wood volume harvested nationwide, 5% to 10% of the nation's livestock forage, a portion of the nation's energy and mineral resources, 43% of the total recreation visitor-days spent on federal lands, and habitat for approximately 3,000 species of wildlife and fish including critical habitat essential to the survival and recovery of many threatened and endangered species (Barton and Fosburgh 1986, Joyce in press, USDA Forest Service 1987).

Although the multiple benefits associated with FS lands are widely appreciated, the authority to manage the full variety of natural resources on national forests was not legally explicit until 1960 when the Multiple-Use Sustained Yield Act was passed. This Act established the policy that national forests shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes. While the resources to be considered were made explicit, the statute was criticized for being vague on how to reconcile conflicting resource uses (Bean 1977).

The Sikes Act Extension of 1974 further defined the authority to manage wildlife and fish on public lands by directing the Secretaries of Agriculture and the Interior to develop comprehensive plans for the conservation and rehabilitation of wildlife and fish resources in cooperation with state agencies. While the Act facilitated the execution of wildlife and fish management programs, it did little to change the "unlimited discretion" that the FS exercised in fulfilling its multiple use mandates (Bean 1977).

The dispute surrounding multiple use and the allocation of resources was eventually addressed explicitly in the Forest and Rangelands Renewable Resources Planning Act of 1974, as amended by the National Forest Management Act of 1976. These Acts defined a framework to guide long-term planning of natural resources on the nation's forest and rangeland base and required the preparation of a comprehensive *Assessment* that addressed the status and needs of forest and range resources; a *Program* outlining resource management levels and budget requests based on the findings of the assessment; and detailed *Resource Management Plans* for the national forests. The assessment is intended to be the factual and analytical basis for the FS Program. The Program specifies the resource goals "...to enable public and private initiative to meet the full range of opportunities that would secure for our people the benefits..." from the nation's forest and rangelands (Wolf 1982: 139). These goals are to be realized through resource management on national forests, by assisting states and the private sector through forestry assistance programs, and by conducting and promoting research within and outside the FS.

The 1985 Program (USDA Forest Service 1986b) specified the primary agency goal for wildlife and fish management as follows:

> Assure a diverse, well-distributed pattern of habitats for viable populations of wildlife and fish species in cooperation with states and other agencies. Provide technology and manage habitat to help recover threatened and endangered species, and to increase the productivity for native game and nongame species consistent with other resource uses, values, and user demands.

This goal reflected a considerable broadening of the traditional FS wildlife and fish management focus and was a response to increased public interest in wildlife and fish resources. The findings of this wildlife and fish assessment do not suggest that the FS should deviate from this goal. Rather, this assessment emphasizes the need for the agency to promote this broader ecological approach to wildlife and fish management on FS lands.

This chapter summarizes the broad implications of this assessment to the major FS Program areas as they affect wildlife and fish resources.

MAJOR FOREST SERVICE PROGRAMS

The wildlife and fish assessment has direct implications for three FS Program areas:

National Forest System.—Includes the administration and multiple-use management of national forests and national grasslands.

State and Private Forestry.—Includes programs that extend financial and technical assistance to states and private landowners.

Research.—Includes the development of scientific and technical knowledge to enhance the economic and environmental value, and the management of the nation's forest and range resources.

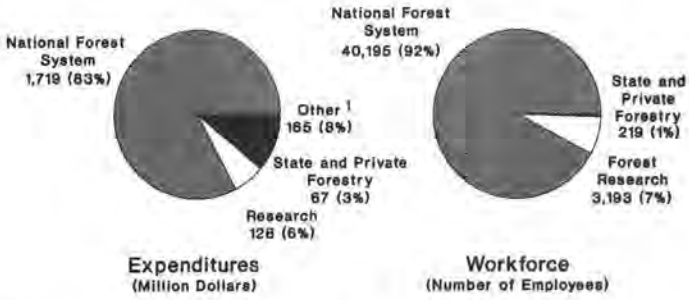
The expenditures and workforce in each of these program areas is concentrated in the National Forest System (NFS) (fig. 62). In fiscal year 1986, the NFS accounted for 83% of the $2.1 billion FS budget and employed over 92% of the FS workforce (USDA Forest Service 1987). The State and Private Forestry Program accounted for just over 3% of the budget and only 0.5% of the workforce. FS Research spent approximately 6% of the budget and employed 7% of the workforce. The broad FS Program implications of the wildlife and fish assessment will be discussed for each of these major program areas.

NATIONAL FOREST SYSTEM

The FS is responsible for the administration of 191 million acres, including 156 national forests (186.4 million acres), 19 national grasslands (3.8 million acres), and a number of smaller land units (275,000 acres) including land-utilization projects, research and experimental areas, and purchase units. Within the lands administered by the FS, wildlife and fish resources are managed primarily through manipulation of habitat while state agencies primarily manage populations and regulate harvests. As implied by the Sikes Act Extension, however, efficient management of wildlife and fish resources requires a close working relationship among agencies with wildlife and fish management responsibility.

The wildlife and fish assessment has implications to the NFS Program in four general areas. These four areas, stated as assessment findings, include:

1. The demand for wildlife and fish recreational activities is expected to increase in the future resulting in a shift in the relative importance of various activities demanded by the public.
2. NFS lands are expected to become more important in: (a) the protection and preservation of certain wildlife and fish species, (b) the preservation and protection of vegetation communities that define important wildlife and fish habitats, and (c) providing wildlife and fish recreational opportunities.



[1]Other consists of Human Resource Programs and Working Capital Fund

Source: USDA, Forest Service (1987)

Figure 62.—Expenditures and workforce by major Forest Service program areas.

3. As demands for all natural resources increase, integration of wildlife and fish management considerations into comprehensive land management plans will become increasingly important.
4. Because wildlife and fish are mobile resources, the purchase and exchange of land that will consolidate land ownership patterns will promote more efficient management of the resource.

Changing Demands for Wildlife and Fish

The national wildlife and fish recreational user projections showed that the relative importance of various activities to the outdoor recreating public is expected to shift. While the number of people participating in nonconsumptive activities, coldwater fishing, and warmwater fishing is expected to increase, participation in big game hunting and small game hunting is expected to decline (see fig. 46). Although participation in all types of wildlife and fish recreational activities is expected to increase on national forests, a similar shift in relative importance is expected. Nonconsumptive recreation and total fishing showed the greatest increases in future use (see table 36). The FS's wildlife and fish habitat management program should acknowledge these findings by shifting priority to management actions that will address those activities demanded by the public.

Increased Importance of National Forest System Lands

As land use intensifies on private lands, NFS lands will become more unique with respect to biotic community composition. Some of the unique wildlife and fish habitats associated with national forests include:

Old-growth forests.—More than half of the remaining old-growth in the Pacific Coast occurred on national forests in 1977; most of the old-growth in the Rocky Mountains occurs on FS lands; current trends indicate that much of the old-growth pine forests in the

South will only be found on national forests or other public ownerships in the future.

Wetlands.—Twenty-five percent of the remaining wetland habitats are under public ownership. The FS has management responsibility for 23% of the federally owned wetlands. Included in the definition of wetland are riparian areas which are a critical wildlife and fish habitat component particularly in arid rangeland ecosystems.

Fish spawning habitat.—Approximately 50% of the anadromous fish spawning and rearing habitat in California, Oregon, Washington, and Idaho is on national forests. In Alaska, 27% of the anadromous fish spawning and rearing habitat is on national forests.

With expanding human populations and increasing demands for multiple resource products from a finite land base, the pressure for intensive management of timber, range, and agricultural resources will remain strong. Consequently, management to conserve these habitat types on national forests will become increasingly important.

Correlated with the uniqueness of certain national forest wildlife and fish habitats are unique faunas. Of particular importance is the maintenance of biotic diversity on national forests (see Norse et al. 1986). The biological diversity issue is, in part, concerned with maintaining the number and kinds of species that exist or have existed on national forests in the recent past. Although maintaining biotic diversity is laudable, methods to quantify, monitor, and anticipate changes in biotic diversity in response to various management activities have not been developed. National forests should establish a process for quantifying and evaluating biological diversity that will permit incorporation of specific diversity objectives in National Forest Plans.

Threatened and endangered species are a special consideration in maintaining diversity. The current distribution of some vanishing species is becoming increasingly associated with NFS lands. Recent estimates indicate that 155 threatened or endangered species occur on national forests, of which 81 have approved recovery plans. However, because of budget and personnel constraints, national forests have emphasized recovery efforts on 13 high-priority species including the grizzly bear, California condor, red-cockaded woodpecker, Kirtland's warbler, woodland caribou, bald eagle, peregrine falcon, Puerto Rican parrot, Lahontan cutthroat and greenback cutthroat trout, and the gray, Indiana, and Virginia big-eared bats.

National forests are also expected to become increasingly important in providing wildlife and fish recreational opportunities. One of the most commonly cited management issues related to recreational use of wildlife and fish was restricted access to private lands (see chapter 6). This has resulted in emphasizing the importance of NFS lands in providing such outdoor recreational opportunities. Specifically, the recreational use projections reviewed in chapter 2 showed that, relative to private lands, national forests are expected to become more important in providing opportunities to hunt big game and small game species.

As national forests become increasingly distinctive with respect to habitat, faunal, and recreation opportunities, wildlife and fish management must intensify to ensure that the wildlife and fish goal, as outlined in the 1985 FS Program, is met. The FS manages habitat in two ways: directly, through specific habitat improvement practices, and indirectly, through coordination and mitigation measures in projects designed primarily for other resources. Direct habitat management, in many cases, offers the only approach to improve habitat for fish, threatened and endangered species, and waterfowl (USDA Forest Service 1985b). Some of the opportunities to directly improve wildlife and fish habitats on national forests to meet future demands include:

1. Expand programs to improve wildlife and fish habitats by increasing food supplies and suitable cover, improving water quality and availability, and improving the distribution of habitat.
2. Apply silvicultural and range management practices to emphasize management of indicator species.
3. Preserve and enhance waterfowl nesting, migration, and wintering habitat.
4. Reintroduce displaced or extirpated species into areas where suitable habitat exists or has been developed.
5. Increase efforts to define, protect, and improve essential habitats of threatened and endangered species.
6. Remove natural and man-made barriers to fish migration.

Wildlife and Fish Coordination

The second major approach to wildlife and fish habitat management on national forests is through coordination with management for other resources. In part, these activities are intended to minimize adverse impacts on wildlife and fish habitat from timber harvesting, road building, grazing, mineral development, and other resource projects. However, mitigation is not the only objective of integrating wildlife and fish resource considerations in other resource management activities. When feasible, wildlife and fish coordination efforts are to be designed to generate simultaneous resource benefits. For the wildlife and fish resource, these benefits take the form of indirect habitat improvements.

This assessment, along with associated assessment documents for timber, range, water, recreation and wilderness, and minerals, indicates that there will be increasing demands for multiple resource outputs from national forests. In order to meet these multiple resource demands, coordination among resources must continue as a high priority in wildlife and fish habitat management. Although funding for coordination has commanded the majority of wildlife and fish habitat management budgets in recent years (Barton and Fosburgh 1986), more effective integration of wildlife and fish

resource considerations in multiple use resource plans remains one of the most important management opportunities for wildlife and fish on NFS lands.

One recent advancement directed at improving the integration of wildlife and fish into resource planning is the Wildlife and Fish Habitat Relationships program. The program involves the development of data base management systems and predictive models that permit resource managers to evaluate wildlife and fish responses to a diversity of resource management alternatives. These models have been applied in various situations in providing information for Forest Plans, environmental analyses, and site-specific projects (USDA Forest Service 1987). Further development of the habitat relationships program is required to ensure that the maintenance of wildlife and fish diversity on national forests is considered in the resource planning process.

Consolidation of Land Ownership Patterns

A major management concern for public lands is the difficulty associated with managing a mobile resource over a land base with intermingled and fragmented land ownership (see chapter 6). Most of the larger mammalian and many avian species range widely and independently of ownership boundaries. Consequently, some wildlife and fish resource management can be unsuccessful because of conflicting land uses or conflicting resource management objectives. Potential wildlife and fish management problems associated with NFS lands in a mosaic of state and other federal ownerships can be solved through cooperation among resource managing agencies. However, land ownership patterns characterized by private inholdings, private land surrounding relatively small blocks of national forest, or private ownership of critical habitat components can impede attainment of resource management objectives. In the western United States, land ownership problems tend to be associated with mixed public and private ownership of critical habitat areas. In the East, concern is growing that as private land uses intensify, national forests will become isolated habitat islands with the eventual loss of those species requiring large areas of suitable habitat.

STATE AND PRIVATE FORESTRY

State and Private Forestry provides technical and financial assistance to states to help protect and improve the productivity and management of nonindustrial private forestlands (USDA Forest Service 1987). The Cooperative Forestry Assistance Act of 1978 authorized the Secretary of Agriculture to cooperate with state foresters and provide assistance in a variety of forest-related activities which include fire prevention and control, prevention and control of forest insects and diseases, and forest management and utilization (USDA Forest Service 1987). The latter activity can benefit wildlife through habitat improvement projects.

Private lands have been identified as having considerable potential for wildlife and fish habitat improvement and many investigations have concluded that wildlife and fish resources are considered a primary objective of some private landowners (Barton and Fosburgh 1986). Despite the importance of private lands in providing wildlife and fish habitat and recreational opportunities, the State and Private Forestry Program has recently experienced reductions in funds and personnel. Two findings presented in this assessment suggest that the FS Program should emphasize the importance of the State and Private Forestry activities in promoting effective multiple resource forest management including wildlife and fish resources, particularly in regions dominated by private ownership. These two findings were the projected increase in fee-hunting and the substantial increases in permanent grass and tree cover on private lands associated with the Conservation Reserve Program under the 1985 Food Securities Act.

Fee-hunting and access fees for wildlife and fish recreation on private lands are providing a strong economic incentive for landowners to consider wildlife and fish habitat needs—a consideration that has been absent in the past. Landowners need to be exposed to the full array of products that can be marketed from their land. As reviewed by Sample (1987), the Office of Management and Budget strongly advocates increased efforts to educate landowners about the economic opportunities that exist for their lands, including hunting leases and camping permits. In addition to information on existing markets, landowners need technical assistance on appropriate management practices to improve the quality and sustain productivity of wildlife and fish habitats.

Further support for more intensive education and technical assistance programs stems from the 1985 Food Security Act. Under this Act, substantial acreage of highly erodible cropland will be planted to permanent cover. If planned correctly, these lands can provide high quality wildlife habitat and significantly improve fish habitat through reductions in soil erosion and increased streamside cover. The State and Private Forestry Program has the opportunity to guide and provide assistance on how these lands are managed for multiple forest resources including wildlife and fish. The private landowner has the potential to supplement his income through recreation fees while the nation as a whole can benefit from improved wildlife and fish habitat on lands where there has been a significant eroding of suitable habitat in the recent past.

FOREST SERVICE RESEARCH

The Research Program of the FS is, in general, responsible for the development of scientific and technical knowledge to enhance the economic and environmental values of the nation's forest and rangeland ecosystems (USDA Forest Service 1987). The Program is divided into seven functional areas: Timber Management; Forest Insect and Disease; Forest Products and Harvesting; Forest Fire and Atmospheric Sciences; Forest Environment; Forest Inventory, Economics, and Recreation; and International Forestry. Research in these seven areas is conducted in cooperation with the nation's 61 forestry

schools and through the USDA Cooperative State Research Service.

Today, the dominant authority for Forest Research is the Forest and Rangeland Renewable Resources Research Act of 1978. This legislation revised and consolidated the FS's research authority from several previous Acts. In addition, the Act specifically required that research on natural resources include investigations related to threatened and endangered species and improving wildlife and fish habitat (Barton and Fosburgh 1986). Research related specifically to wildlife and fish is part of Forest Environment Research and is covered under four broad areas: (1) threatened, endangered, and sensitive species; (2) anadromous and coldwater fish habitats; (3) wildlife and fish interactions with livestock; and (4) wildlife and fish interactions with timber management.

In developing future research needs for wildlife and fish, the 1985 Program (USDA Forest Service 1986b) concluded:

> Wildlife and fish habitats will continue to be threatened by urban and suburban development pressures and industrial activities, timber harvesting, livestock grazing, and mining for energy production. Research is needed to: (1) further understand habitat requirements of anadromous and other coldwater fish, determine how their productivity is related to land management, and develop guidelines to integrate production with other resource management issues, and (2) improve wildlife monitoring techniques to measure the response to management.

The knowledge gaps and research needs identified in this assessment support a continuation of this research goal and also suggest a need to broaden future research related to wildlife and fish. As reviewed in chapter 6, information needs identified by federal agency personnel fell into three broad categories: (1) species-habitat relationships, (2) inventory and monitoring techniques, and (3) wildlife and fish values.

Species-habitat relationship research has improved the capability of wildlife and fish resource specialists to understand and predict resource response to land management activities. However, there is a pressing need to test and refine those models that have been developed to ensure that land managers are making reasonable decisions about multiple resource production (Sweeney and Wolters 1986). In addition, new models need to be developed in order for the FS to meet its legislated goal of maintaining biodiversity and habitats capable of supporting viable populations of all native and desired non-native (exotic) species that are found on NFS lands. As the demand for multiple resource outputs from national forests and national grasslands intensifies, accurate representation of wildlife and fish responses to alternative land management strategies will be critical to scientifically-based resource allocation decisions.

Research in the area of improving existing inventory or monitoring methodologies is needed for several reasons. First, inventory information on most of the wildlife and fish species inhabiting national forests does not exist. As discussed in chapter 6, inventory information tends to focus on game animals and selected nongame species of particular concern, yet is generally lacking for all other animal classes. Existing techniques are of questionable accuracy or are too expensive to provide a practicable approach to a comprehensive and systematic inventory of wildlife and fish resources on FS lands. Secondly, further research on population inventory techniques is required to establish the validity of species-habitat relationship models. Although habitat inventories, in conjunction with species-habitat models, may provide great assistance to inventories of the fauna, such faunal inventories will still be required to assess the predictive accuracy of habitat-based models.

A final broad area of research needs concerns the characterization of public attitudes and values held for wildlife and fish resources. The FS must not only monitor the state of wildlife and fish populations and habitat, but it also must monitor the economic values of wildlife and fish. Public demands related to wildlife and fish resources change and methods need to be developed to both measure and anticipate that change. Such information is critical if the FS, or any agency with wildlife and fish stewardship obligations, is to respond to public demands. Quantification of these demands in terms of economic values is critical if wildlife and fish are to compete on an equal basis with other resource elements that are demanded from NFS lands.

In addition to these broad research areas, FS planning requirements under the Renewable Resources Planning Act and National Forest Management Act imply that such research needs to be conducted at a number of geographic scales. These Acts require planning at the national, regional, and national forest level. Research in the areas outlined above must address resource management issues across these planning levels. Risser et al. (1984) summarized the need for multiple-scale resource analyses by concluding that informed resource planning can no longer be based solely at the site level, but must develop methodologies for examining the interaction of resources within landscapes or larger geographic areas. Questions concerning the habitat configurations required by wide-ranging terrestrial species, or the regional ecology of anadromous fish, necessitate an extension of traditional resource management scales to include a landscape ecology research approach.

Some people perceive the FS is at the forefront of fish and wildlife research (Fosburgh 1985b), and this perception should continue in the future by ensuring that the Research Program addresses land management and planning problems facing wildlife and fish resources. Research in the areas outlined above, and across planning scales, will provide a sound basis for meeting the goal of the RPA—namely "... to ensure that the nation achieves the full potential obtainable from its renewable resource base and avoids irreversible crisis in resource use" (Hewett 1982:225).

SUMMARY

The findings of the assessment have wildlife and fish program implications to the NFS, technical and cooperative assistance, and research. Four conclusions have particular importance to wildlife and fish management on national forests. First, the demand for wildlife and fish recreation appears to be shifting away from hunting to fishing and nonconsumptive activities. Such changes should encourage prioritization of those management activities that will address what is demanded by the public. Second, national forests are expected to become more important in the management of certain wildlife and fish habitats and their associated fauna, and in providing wildlife and fish recreational opportunities. For example, old-growth forests are becoming increasingly restricted to national forests; national forests and national grasslands provide critical habitat for threatened and endangered species and they provide increasingly important lands for recreation. Third, as demands for all natural resources increase, integration of wildlife and fish management considerations into the management of other resources will be critical. The wildlife and fish management opportunities considered in conjunction with the opportunities for timber, range, water, recreation and wilderness, and minerals indicate that there will be a need for more intensive and coordinated management if future multiple resource demands are to be met. Fourth, because wildlife and fish are mobile resources, purchase and exchange of land can consolidate land ownership patterns and promote more effective and efficient management of the resource.

This assessment also suggests that the future FS Program should emphasize the importance of technical and cooperative forest management assistance programs in achieving effective wildlife and fish management on private lands. The basis for this conclusion stems from the projected increase in fee-hunting and the substantial increases in permanent grass and tree cover on private lands associated with the Conservation Reserve Program under the 1985 Food Securities Act. Through State and Private Forestry, the FS has the opportunity to guide and provide assistance on how these lands are managed with respect to wildlife and fish resources. The private landowner has the potential to supplement his income through recreation fees while the nation as a whole can benefit from improved wildlife and fish habitat on lands where there has been a significant degradation of suitable habitat in the recent past.

The program implications to NFS's and technical assistance have related implications to wildlife and fish research. The research needs identified in this assessment include development and testing of species-habitat relationship models, improving inventory and monitoring methodologies, and developing techniques to quantify public attitudes and values held for wildlife and fish resources. Research in these areas will improve resource management on both national forests and private lands and will also provide a stronger technical basis for multiple resource planning.

REFERENCES

Adams, R. L.; Lewis, R. C.; Drake, B. H. 1973. Outdoor recreation, a legacy for America: appendix "a" and economic analysis. Washington DC: Bureau of Outdoor Recreation.

Administration of the Wild and Free-Roaming Horse and Burro Act. 1980. Third report to Congress. U.S. Department of the Interior. Washington, DC: U.S. Government Printing Office.

Akins, G. 1982. Deputy Commissioner, Alaska Department of Environmental Conservation, Testimony of the State of Alaska Regarding Sec. 404 of the Clean Water Act. Presented before the U.S. House of Representatives Committee on Merchant Marine Fisheries.

Alig, Ralph J. 1984. Forest acreage trends in the Southeast: econometric analysis and policy simulations. Corvallis, OR: Oregon State University. 155 p. Ph.D. dissertation.

Almand, J. David. 1988. Personal communication. Letter of April 7, 1988. U.S. Department of the Interior, Bureau of Land Management, Chief, Division of Wildlife and Fisheries, Washington, DC.

Alward, G. S.; Palmer C. J. 1983. IMPLAN: an input-output analysis system for Forest Service planning. In: Seppala, R.; Row, C.; Morgan, A., eds. Forest sector models: proceedings of the first North American conference. AB Academic Publishers: 131–140.

Alward, G. S.; Sullivan, B. J.; Hoekstra, T. W. 1984. Using socioeconomic data in the management of fishing and hunting. Transactions of the North American Wildlife and Natural Resources Conference. 49: 91–103.

Amaral, Michael J. 1985. The Aleutian Canada goose. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1985. New York, NY: The National Audubon Society: 437–442.

Anderson, Dennis. 1988. Empty skies: ducks in crisis. St. Paul, MN: St. Paul Pioneer Press Dispatch, February 7, Section C: 1, 12.

Anderson, Eric M. 1987. A critical review and annotated bibliography of literature on the bobcat. Special Report No. 62. Colorado Division of Wildlife. 61 p.

Anderson, Mark W.; Reiling, Stephen D.; Criner, George K. 1985. Consumer demand theory and wildlife agency revenue structure. Wildlife Society Bulletin. 13: 375–384.

Audubon Activist. 1987. Comparison of state nongame programs. March 1987: 16.

Autenrieth, Robert E. 1986. Sage grouse. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1986. New York, NY: The National Audubon Society: 763–779.

Bailey, R. W. 1980. The wild turkey status and outlook in 1979. In: Proceedings of the fourth national wild turkey symposium. 4: 1–9.

Barton, Katherine. 1986. Wildlife and the Bureau of Land Management. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1986. New York, NY: The National Audubon Society: 497–541.

Barton, Katherine. 1987. Bureau of Land Management. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1987. New York, NY: Academic Press: 3–59.

Barton, Katherine; Fosburgh, Whit. 1986. The U.S. Forest Service. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1986. New York, NY: The National Audubon Society: 1–156.

Bateman, Hugh A.; Joanen, Ted; Strutzenbaker, Charles D. 1988. History and status of midcontinent snow geese on their Gulf Coast winter ranges. In: Weller, Milton W., ed. Waterfowl in winter. Minneapolis, MN: University of Minnesota Press: 495–515.

Bean, Michael J. 1977. The evolution of national wildlife law. Council on Environmental Quality. Washington, DC: U.S. Government Printing Office. 485 p.

Bean, Michael J. 1986. The endangered species program. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1986. New York, NY: The National Audubon Society: 347–372.

Behnke, R. J.; Zarn, Mark. 1976. Biology and management of threatened and endangered western trouts. Gen. Tech. Rep. RM-28. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 45 p.

Beland, K. F. 1984. Management of Atlantic salmon in the state of Maine: a strategic plan. Bangor, ME: Atlantic Sea-Run Salmon Commission.

Bellrose, Frank C. 1976. Ducks, geese, and swans of North America. Harrisburg, PA: Stackpole Books. 543 p.

Bergerud, A. T. 1978. Caribou. In: Schmidt, John L.; Gilbert, Douglas L., eds. Big game of North America: ecology and management. Harrisburg, PA: Stackpole Books: 83–101.

Berner, A. H. 1984. Federal land retirement programs—a land management albatross. Transactions of the North American Wildlife and Natural Resources Conference. 49: 118–131.

Berryman, Jack H. 1983. Comments on emerging nonfederal initiatives in resource management. Transactions of the North American Wildlife and Natural Resources Conference. 48: 473–474.

Bishop, Richard C. 1987. Economic values defined. In: Decker, Daniel J.; Goff, Gary R., eds. Valuing wildlife: economic and social perspectives. Boulder, CO: Westview Press: 24–33.

Bivens, Rick D.; Strange, Richard J.; Peterson, Douglas, C. 1985. Current distribution of the native brook trout in the Appalachian region of Tennessee. Journal of the Tennessee Academy of Science. 60: 101–105.

Block, William M.; Brennan, Leonard A.; Gutierrez, R. J. 1987. Evaluation of guild-indicator species for use in resource management. Environmental Management. 11: 265–269.

Bolen, Eric G.; Rodiek, Jon E. 1986. Setting the stage. Transactions of the North American Wildlife and Natural Resources Conference. 51: 201–202.

Bones, James T. [In press.] An analysis of the land situation in the United States: 1989–2040. Gen. Tech. Rep. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Boreman, J.; Lange, A. M. T.; Anthony, V. C. 1984. Estimates of harvest of USA Atlantic salmon in non-USA fisheries. Working paper for ICES working group on north Atlantic salmon. St. Andrews, New Brunswick: ICES. 5 p.

Bortner, James Bradley. 1987. American woodcock harvest and breeding population status, 1987. Washington DC: U.S. Department of the Interior, Fish and Wildlife Service. 6 p.

Boyd, Claude E. 1979. Water quality in warmwater fish ponds. Auburn, AL: Auburn University Agriculture Experiment Station. 359 p.

Boyd, Raymond J. 1978. American elk. In: Schmidt, John L; Gilbert, Douglas L., eds. Big game of North America: ecology and management. Harrisburg, PA: Stackpole Books: 11–29.

Brace, R. K.; Pospahala, Richard S.; Jessen, Robert L. 1987. Background and objectives on stabilized duck hunting regulations: Canadian and U.S. perspectives. Transactions of the North American Wildlife and Natural Resources Conference. 52: 177–185.

Brady, Stephen J. 1985. Important soil conservation techniques that benefit wildlife. In: Office of Technology Assessment. Technologies to benefit agriculture and wildlife. OTA-BP-F-34. Washington, DC: U.S. Congress, Office of Technology Assessment: 55–62.

Brokaw, Howard P., ed. 1978. Wildlife and America. Washington, DC: Council on Environmental Quality. 532 p.

Brown, Gardner, Jr.; Hay, Michael J. 1987. Net economic recreation values for deer and waterfowl hunting and trout fishing, 1980. Working Paper No. 23. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 27 p.

Brown, Perry J.; Manfredo, Michael J. 1987. Social values defined. In: Decker, Daniel J.; Goff, Gary R., eds. Valuing wildlife: economic and social perspectives. Boulder, CO: Westview Press: 12–23.

Brown, Tommy L.; Decker, Daniel J.; Purdy, Ken G.; Mattfeld, George F. 1987. The future of hunting in New York. Transactions of the North American Wildlife and Natural Resources Conference. 52: 553–566.

Buechner, Helmut K. 1961. Regulation of numbers of pronghorn antelope in relation to land use. La Terre et la vie. 2: 266–285.

Bunch, Karen L. 1985. Food consumption, prices, and expenditures. Statistical Bulletin No. 749. U.S. Department of Agriculture, Economic Research Service.

Burger, George V. 1978. Agriculture and wildlife. In: Brokaw, Howard P., ed. Wildlife and America. Washington, DC: Council on Environmental Quality: 89–107.

Burgess, Robert L.; Sharpe, David M., eds. 1981. Forest island dynamics in man-dominated landscapes. Ecological Studies 41. New York, NY: Springer-Verlag. 310 p.

Burns, Russell M. 1983. Natural area selection and management: U.S. Forest Service programs. Transactions of the North American Wildlife and Natural Resources Conference. 48: 497–503.

Burridge, M.; Sawyer, L.; Bigler, W. 1986. Rabies in Florida. Tallahassee, FL: Florida Department of Health and Rehabilitation Services. 147 p.

Butler, William. 1985. The cackling Canada goose. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1985. New York, NY: National Audubon Society: 428–432.

Cantera, Lawrence. 1983. Private natural area programs: an overview. Transactions of the North American Wildlife and Natural Resources Conference. 48: 495–496.

Carbyn, L. N. 1982. Coyote population fluctuations and spatial distribution in relation to wolf territories in Riding Mountain National Park. Canadian Field-Naturalist. 96: 176–183.

Carlson, Catherine A. 1985. Wildlife and agriculture: can they co-exist? Journal of Soil and Water Conservation. 40: 263–266.

Caughley, G. 1977. Analysis of vertebrate populations. New York, NY: John Wiley and Sons. 234 p.

Cerulean, Susan; Fosburgh, Whit. 1986. State nongame wildlife programs. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1986. New York, NY: The National Audubon Society: 631–656.

Cicchetti, Charles J.; Seneca, Joseph J.; Davidson, Paul. 1969. The demand and supply of outdoor recreation. New Brunswick, NJ: Bureau of Economic Research, Rutgers—The State University. 301 p.

Cline, David; Lenhart, Cynthia. 1985. The dusky Canada goose. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1985. New York, NY: National Audubon Society: 433–436.

Cole, David N. 1986. Resource impacts caused by recreation. In: The President's Commission on Americans outdoors. A literature review. Natural resources management. Washington, DC: U.S. Government Printing Office: 1–11.

Cole, David N.; Marion, Jeffery L. 1988. Impacts in some riparian forests of the eastern United States. Environmental Management. 12: 99–107.

Connolly, Guy E. 1981. Trends in populations and harvest. In: Wallmo, Olaf C., ed. Mule and black-tailed deer of North America. Lincoln, NE: University of Nebraska Press: 225–243.

Conservation Foundation, The. 1984. State of the environment: an assessment at mid-decade. Washington, DC: The Conservation Foundation. 586 p.

Cook, Gregory F. 1982. Wildlife and fishery allocation in Alaska, 1982: allocations for subsistence, commercial, and recreational uses. Transactions of the North American Wildlife and Natural Resources Conference. 47: 617–629.

Coulter, Malcolm W.; Baird, John C. 1982. Changing forest land uses and opportunities for woodcock management in New England and the maritime provinces. In: Dwyer, Thomas J.; Storm, Gerald L., eds. Woodcock ecology and management. Wildlife Resource Report 14. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service: 75–85.

Council on Environmental Quality. 1985. Environmental quality 16th annual report of the council on environmental quality. Washington, DC. 446 p.

Cowan, James H.; Turner, R. Eugene. 1988. Modeling wetland loss in coastal Louisiana: geology, geography, and human modifications. Environmental Management. 12: 827–838.

Cowardin, Lewis M.; Carter, Virginia; Golet, Francis C.; LaRoe, Edward T. 1979. Classification of wetlands and deepwater habitats of the United States. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 103 p.

Craig, Gerald. 1986. Peregrine falcon. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1986. New York, NY: National Audubon Society: 807–826.

Crawford, Hewlette S. 1984. Wildlife habitat management and changing forest practices in the Northeast. Northern Journal of Applied Forestry. 1: 12–14.

Cross, Gerald H. 1987. Continuing education in natural resources: needs and opportunities. Transactions of the North American Wildlife and Natural Resources Conference. 52: 691–696.

Cubbage, Frederick W.; Gunter, John E. 1987. Conservation reserves: can they promote wildlife habitat and tree crops while protecting erodible soil? Journal of Forestry. 85: 21–27.

Darr, David. [In press.] Basic assumptions. Gen. Tech. Rep. Fort Collins CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO.

Davis, Robert K.; Lim, Diane. 1987. On measuring the economic value of wildlife. In: Decker, Daniel J.; Goff, Gary R., eds. Valuing wildlife: economic and social perspectives. Boulder, CO: Westview Press: 65–75.

Deems, Eugene F.; Pursley, Duane. 1983. North American furbearers: a contemporary reference. Washington, DC: International Association of Fish and Wildlife Agencies. 223 p.

DeGraaf, Richard M., tech. coord. 1978. Management of southern forests for nongame birds: proceedings of the workshop. Gen. Tech. Rep. SE-14. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 176 p.

DeGraaf, Richard M., tech. coord. 1979. Management of north central and northeastern forests for nongame birds: proceedings of the workshop. Gen. Tech. Rep. NC-51. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station. 268 p.

DeGraaf, Richard M., tech. coord. 1980. Management of western forests and grasslands for nongame birds: proceedings of the workshop. Gen. Tech. Rep. INT-86. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 535 p.

DeGraaf, Richard M. 1986. Urban bird habitat relationships: application to landscape design. Transactions of the North American Wildlife and Natural Resources Conference. 51: 232–259.

Dolbeer, Richard A.; Stehn, Robert A. 1979. Population trends of blackbirds and starlings in North America, 1966–76. Special Scientific Report-Wildlife No. 214. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 99 p.

Dolton, David D. 1986. Mourning dove administrative report: 1986. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 11 p.

Dolton, David D. 1987. Mourning dove breeding population status, 1987. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 10 p.

Dombeck, Mike. 1987. Personal communication. Letter of July 24, 1987. U.S. Department of Agriculture, Forest Service, National Fisheries Program, Washington, DC.

Downing, Robert L. 1987. Success story: white-tailed deer. In: Kallman, Harmon, ed. Restoring America's Wildlife, 1937–1987. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service: 45–57.

Driver, B. L.; Brown, Perry J. 1986. Probable personal benefits of outdoor recreation. In: The President's Commission on Americans outdoors. A literature review. Values and benefits. Washington, DC: U.S. Government Printing Office: 63–70.

Droege, Sam. 1988. Personal communication. Summary results of trend analysis results for 1966–1987. August 1988. U.S. Department of the Interior, Fish and Wildlife Service, Office of Migratory Bird Management, Laurel, MD.

Dunks, J. H.; Reeves, M.; Dolton, D. D.; Zapatka, T. 1982. Migration, harvest, and population dynamics of mourning doves banded in the Central Management Unit, 1967–77. Special Scientific Report-Wildlife No. 249. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 128 p.

Dwyer, T. J.; McAuley, D. G.; Derleth, E. L. 1983. Woodcock singing ground counts and habitat changes in the northeastern United States. Journal of Wildlife Management. 47(3): 772–779.

Ehrlich, Paul R. 1988. The loss of diversity: causes and consequences. In: Wilson, E. O., ed. Biodiversity. Washington, DC: National Academy Press: 21–27.

Environmental Protection Agency. 1987. National water quality inventory: 1986 report to Congress. EPA-440/4-87-008. Washington DC: U.S. Government Printing Office. 141 p.

Erskine, A. J. 1978. The first ten years of the cooperative breeding bird survey in Canada. Report Series 42. Canadian Wildlife Service. 61 p.

Evans, David L. 1982. Status reports on twelve raptors. Special Scientific Report-Wildlife No. 238. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 68 p.

Everest, Fred H.; Beschta, Robert L.; Scrivener, J. Charles; Koski, K. V.; Sedell, James R.; Cederholm, C. Jeff. 1987. Fine sediment and salmonid production: a paradox. In: Salo, Ernest O.; Cundy, Terrance W., eds. Streamside management: forestry and fishery interactions. Seattle, WA: College of Forest Resources, University of Washington: 98–142.

Everhart, W. Harry; Youngs, William D. 1981. Principles of fishery science. Ithaca, NY: Comstock Publishing Associates, Cornell University Press. 349 p.

Ewert, Alan. 1986. Values, benefits and consequences of participation in outdoor adventure recreation. In: The President's Commission on Americans Outdoors. A literature review. Values and benefits. Washington, DC: U.S. Government Printing Office: 71–80.

Executive Task Force on the Future of Wildlife. 1987. Wildlife 21: a report to the governor, the legislature, and the people of Colorado on the future of wildlife into the 21st century. 24 p.

Fajen, Otto F. 1981. Warmwater stream management with emphasis on bass streams in Missouri. In: Krumholz, Louis A., ed. The warmwater streams symposium. Southern Division of American Fisheries Society: 252–265.

Farris, A. L.; Cole, S. H. 1981. Strategies and goals for wildlife habitat restoration on agricultural lands. Transactions of the North American Wildlife and Natural Resources Conference. 46: 130–136.

Fausch, Kurt D.; Hawkes, Clifford L.; Parsons, Mit G. 1988. Models that predict standing crop of stream fish from habitat variables: .1950–85. Gen. Tech. Rep. PNW-213. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 52 p.

Flather, Curtis H. 1988. Wildlife abundance and occurrence models: application in regional resource planning. In: Gelinas, R.; Bond, D.; Smit, B., eds. Perspectives on land modelling. Montreal, Canada: Polyscience Publications: 37–48.

Flather, Curtis, H.; Hoekstra, Thomas W.; Chalk, David E.; Cost, Noel D.; Rudis, Victor A. 1989. Recent historical and projected regional trends of white-tailed deer and wild turkey in the southern United States. Gen. Tech. Rep. RM-172. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 22 p.

Flebbe, Patricia A.; Hoekstra, Thomas W.; Cost, Noel D. 1988. Recent historical and projected regional trends of trout in the southeastern United States. Gen. Tech. Rep. RM-160. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 19 p.

Flesness, Nate. 1986. Status and trends of wild animal diversity. In: Office of Technology Assessment. Technologies to maintain biological diversity. Vol. 2. Contract Papers Part B: animal technologies. Washington, DC: U.S. Department of Commerce, National Technical Information Service: 2–38.

Foner, Henry. 1982. The fur marketplace. In: Sanderson, Glen C., ed. Midwest furbearer management. North Central Section, Central Mountains and Plains Section, and Kansas Chapter of The Wildlife Society. 195 p.

Fosburgh, Whit. 1985a. The striped bass. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1985. New York, NY: The Audubon Society: 417–425.

Fosburgh, Whit. 1985b. Wildlife and the U.S. Forest Service. DiSilvestro, Roger L., ed. Audubon Wildlife Report 1985. New York, NY: The National Audubon Society: 305–431.

Fowler, Charles W.; Smith, Tim E., eds. 1981. Dynamics of large mammal populations. New York, NY: John Wiley and Sons. 477 p.

Franklin, Jerry F.; Cromack, Kermit, Jr.; Denison, William; McKee, Arthur; Maser, Chris; Sedell, James; Swanson, Fred; Juday, Glen. 1981. Ecological characteristics of old-growth Douglas-fir forests. Gen. Tech. Rep. PNW-118. Portland OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 48 p.

Frayer, W. E. 1987. In the absence of concern: wetland projections to the year 2000. In: Lund, Gyde H.; Caballero-Deloya, Miguel; Villarreal-Canton, Raul, eds. Land and resource evaluation for national planning in the tropics: proceedings of the international conference and workshop; 1987 January 25–31; Chetumal, Mexico. Gen. Tech. Rep. WO-39. Washington, DC: U.S. Department of Agriculture, Forest Service: 383–385.

Frayer, W. E.; Monahan, T. J.; Bowden, D. C.; Graybill, F. A. 1983. Status and trends of wetland and deepwater habitats in the conterminous United States, 1950's to 1970's. Fort Collins, CO: Colorado State University, Department of Forest and Wood Sciences. 32 p.

Frey, H. Thomas. 1983. Expansion of urban area in the United States: 1960–1980. ERS Staff Report AGES830615. U.S. Department of Agriculture, Economic Research Service. 22 p.

Frey, H. Thomas; Hexem, Roger W. 1985. Major use of land in the United States: 1982. Agricultural Economics Report No. 535. U.S. Department of Agriculture, Economic Research Service, Natural Resource Economics Division. 29 p.

Gable, Robert R.; Dobrott, Steven J. 1988. Saving the masked bobwhite. Endangered Species Technical Bulletin. 13: 6–7.

Gall, B. C.; Christian, K. R. 1984. A program for a wildlife inventory. Journal of Environmental Management. 19: 277–289.

Garrison, George A.; Bjugstad, Ardell J.; Duncan, Don A.; Lewis, Mont E.; Smith, Dixie R. 1977. Vegetation and environmental features of forest and range ecosystems. Agric. Handb. 475. Washington, DC: U.S. Department of Agriculture, Forest Service. 68 p.

Geis, Aelred D. 1974. The new town bird quadrille. Natural History. 83: 54–60.

Gilbert, Frederick F.; Dodds, Donald G. 1987. The philosophy and practice of wildlife management. Malabar, FL: Robert E. Krieger Publishing Company. 279 p.

Giles, R. H. 1969. Wildlife management techniques. 3rd ed. Revised. Washington, DC: The Wildlife Society. 663 p.

Gordon, Douglas. 1970. An economic analysis of Idaho sport fisheries. Idaho Cooperative Fishery Unit, Idaho Department of Fish and Game.

Gordon, William G. 1988. Study recommends federal fisheries reorganization. Journal of Forestry. 86: 5–7.

Graber, R.; Graber J. 1983. The declining grassland birds. Illinois Natural History Survey Reports No. 227. Champaign, IL: Illinois Natural History Survey.

Guldin, Richard W. [In press.] An analysis of the water situation in the United States: 1989–2040. Gen. Tech. Rep. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Halls, Lowell K., ed. 1984. White-tailed deer-ecology and management. Harrisburg, PA: Stackpole Books. 870 p.

Hamilton, Larry E.; McCluskey, Daniel C.; Lance, Donna L. 1987. Educating natural resource managers in a multiple-use federal agency. Transactions of the North American Wildlife and Natural Resources Conference. 52: 707–713.

Hamilton, Thomas E.; Thorton, Philip L. 1982. The RPA assessment and program. In: Hewett, Charles E.; Hamilton, Thomas E., eds. Forests in demand: conflicts and solutions. Boston, MA: Auburn House Publishing Company: 169–189.

Harpman, D. A.; Reuler, C. F. 1985. Economic aspects of the nongame checkoff. Nongame Newsletter. 3: 5.

Harris, Larry D. 1984. The fragmented forest: island biogeography theory and the preservation of biotic diversity. Chicago, IL: University of Chicago Press. 211 p.

Harris, Larry D. 1988. The nature of cumulative impacts on biotic diversity of wetland vertebrates. Environmental Management. 12: 675–693.

Harwell, Hugh J. 1983. A national perspective on natural area programs: major problems and suggested solutions. Transactions of the North American Wildlife and Natural Resources Conference. 48: 518–530.

Hawkes, Clifford L.; Chalk, David E.; Hoekstra, Thomas W.; Flather, Curtis H. 1983. Prediction of wildlife and fish resources for national assessments and appraisals. Gen. Tech. Rep. RM-100. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 21 p.

Hay, Michael J.; McConnell, Kenneth E. 1979. An analysis of participation in nonconsumptive wildlife recreation. Land Economics. 55: 460–471.

Hay, Michael J.; McConnell, Kenneth E. 1984. Harvesting and nonconsumptive wildlife recreation decisions. Land Economics. 60: 288–396.

Haynes, Richard W. [In press.] An analysis of the timber situation in the United States: 1989–2040. Gen. Tech. Rep. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Hench, John E.; Flyger, Vagn; Gibbs, Robert; Van Ness, Keith. 1985. Predicting the effects of land-use changes on wildlife. Transactions of the North American Wildlife and Natural Resources Conference. 50: 345–351.

Hewett, Charles E. 1982. Achieving the potential of the Resources Planning Act. In: Hewett, Charles E.; Hamilton Thomas E., eds. Forests in demand: conflicts and solutions. Boston, MA: Auburn House Publishing Company: 225–233.

Hirsch, Allan; Krohn, William B.; Schweitzer, Dennis L.; Thomas, Carl H. 1979. Trends and needs in federal inventories of wildlife habitat. Transactions of the North American Wildlife and Natural Resources Conference. 44: 340–359.

Hoekstra, Thomas W.; Farrell, Michael P.; Flather, Curtis H.; Hawkes, Clifford L. 1983. Wildlife and fish data base for the 1989 national RPA assessment. In: Proceedings of a national workshop on computer uses in fish and wildlife programs. Blacksburg, VA: Virginia Polytechnic Institute and State University: 75–83.

Hoekstra, Thomas W.; Hof, John G. 1985. National assessments of wildlife and fish: a technical framework. Gen. Tech. Rep. RM-122. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 6 p.

Hoekstra, Thomas W.; Thomas, Jack Ward; Lennartz, Michael R.; Worley, David P. 1981. Managing federal lands for production and use of wildlife and fish. Transactions of the North American Wildlife and Natural Resources Conference. 46: 336–344.

Hof, John G.; Baltic, Tony. 1988. Forest and rangeland resource interactions. Gen. Tech. Rep. RM-156. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 31 p.

Hof, John G.; Kaiser, H. Fred. 1983. Long-term outdoor recreation participation projections for public land management agencies. Journal of Leisure Research. 15: 1–14.

Hoose, Phillip M. 1983. Successes and problems in trying to preserve natural diversity. Transactions of the North American Wildlife and Natural Resources Conference. 48: 510–513.

Hubbard, John P. 1977. Importance of riparian ecosystems: biotic considerations. In: Johnson, R. Roy; Jones, Dale A., tech. coords. Importance, preservation and management of riparian habitat: a symposium. Gen. Tech. Rep. RM-43. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 14–18.

Hunter, Malcolm L. 1987. Managing forests for spatial heterogeneity to maintain biological diversity. Transactions of the North American Wildlife and Natural Resources Conference. 52: 60–69.

Jackson, Jerome A. 1987. The red-cockaded woodpecker. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1987. New York, NY: Academic Press: 479–494.

Johnson, R. Roy; Haight, Lois T.; Simpson, James H. 1977. Endangered species vs. endangered habitats: a concept. In: Johnson, R. Roy; Jones, Dale A., tech. coords. Importance, preservation and management of riparian habitat: a symposium; 1977 July 9; Tucson, AZ. Gen. Tech. Rep. RM-43. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 68–79.

Jordan, William R.; Gilpin, Michael E.; Aber, John D. 1987. Restoration ecology: ecological restoration as a technique for basic research. In: Jordan, William R.; Gilpin, Michael E.; Aber, John D., eds. Restoration ecology: a synthetic approach to ecological research. New York, NY: Cambridge University Press: 3–21.

Joyce, Linda A. [In press.] An analysis of the forage situation in the United States: 1989–2040. Gen. Tech. Rep. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station.

Joyce, Linda A.; Hoekstra, Thomas W.; Alig, Ralph J. 1986. Regional multiresource models in a national framework. Environmental Management. 10: 761–772.

Judy, R. D., Jr.; Seeley, P. N.; Murray, T. M.; Svirsky, S. C.; Whitworth, M. R.; Ischinger, L. S. 1984. 1982 national fisheries survey. Vol. 1. Techical report: initial findings. FWS/OBS 84/06. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 141 p.

Karr, James R. 1981. Assessment of biotic integrity using fish communities. Fisheries. 6: 21–27.

Karr, James R.; Fausch, Kurt D.; Angermeier, Paul L.; Yant, Philip R.; Schlosser, Isaac J. 1986. Assessing biological integrity in running waters: a method and its rational. Illinois Natural History Survey, Special Publication 5. 28 p.

Karr, James R.; Toth, Louis A.; Dudley, Daniel R. 1985. Fish communities of Midwestern rivers: a history of degradation. BioScience. 35: 90–95.

Kauffman, J. Boone; Krueger, W. C. 1984. Livestock impacts on riparian ecosystems and streamside management implications...a review. Journal of Range Management. 37: 430–438.

Kellert, Stephen R. 1980. Contemporary values of wildlife in American society. In: Shaw, William W.; Zube, Ervine H., eds. Wildlife values. Tucson, AZ: University of Arizona: 31–60.

Kelly, Dean. 1986. American woodcock. Administration report. 1986 breeding population status. Laurel, MD: U.S. Department of Interior, Fish and Wildlife Service. 9 p.

Kimball, Thomas, L.; Johnson Raymond E. 1978. The richness of American wildlife. In: Brokaw, Howard P., ed. Wildlife in America. Washington, DC: Council on Environmental Quality: 3–17.

Klopatek, Jeffery M.; Kitchings, J. Thomas. 1985. A regional technique to address land-use changes and animal habitats. Environmental Conservation. 12: 343–350.

Knuth, Barbara A. 1987. Educating tomorrow's professionals: an integrated approach. Transactions of the North American Wildlife and Natural Resources Conference. 52: 722–728.

Koehler, Gary. 1987. The bobcat. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1987. New York, NY: Academic Press: 399–409.

Krutilla, John V.; Fisher, Anthony. 1975. Economics of natural environments. Baltimore, MD: John Hopkins University Press. 292 p.

Ladd, Wilbur N.; Riedman, Marianne L. 1987. The southern sea otter. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1987. New York, NY: Academic Press: 457–478.

Landers, J. Larry. 1987. Prescribed burning for managing wildlife in southern pine forests. In: Dickson, James, G.; Maughan, O. Eugene, eds. Managing southern forests for wildlife and fish. Gen. Tech. Rep. SO-65. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 19–27.

Landres, Peter B. 1983. Use of the guild concept in environmental impact assessment. Environmental Management. 7: 393–398.

Langner, Linda L. 1987a. Hunter participation in fee access hunting. Transactions of the North American Wildlife and Natural Resources Conference. 52: 475–482.

Langner, Linda L. 1987b. Personal communication. Economic Research Service, Washington, DC.

Lee, Philip L. 1987. Personal communication. Letter of June 12, 1987. U.S. Department of Agriculture, Forest Service, Portland, OR.

Lennartz, Michael R.; Knight, Herbert A.; McClure, Joe P.; Rudis, Victor A. 1983. Status of red-cockaded woodpecker nesting habitat in the South. In: Wood, Don A., ed. Red-cockaded woodpecker symposium II. Tallahassee, FL: State of Florida Game and Fresh Water Fish Commission: 13–19.

Lennartz, M. R.; McClure, Joe P. 1979. Estimating the extent of red-cockaded woodpecker habitat in the Southeast. In: Frayer, W. E., ed. Forest resources inventories: vol. 1. Fort Collins, CO: Colorado State University: 48–62.

Leopold, Aldo. 1933. Game management. New York, NY: Charles Scribner's Sons. 481 p.

Lewis, John B. 1987. Success story: wild turkey. In: Kallman, Harmon, ed. Restoring America's wildlife 1937–1987. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service: 31–43.

Linscombe, R. Gregory. 1987. Personal communication. Quebec City, Quebec, Canada: Louisiana Department of Wildlife and Fisheries.

Linscombe, R. Gregory. 1988. A study of the current status and prospective trends in the furbearer resource and their management. Interagency agreement between USDA Forest Service and the Louisiana Department of Wildlife and Fisheries. [Data available from R. Gregory Linscombe, Louisiana Department of Wildlife and Fisheries, Route 4, Box 78, Darnell Road, New Iberia, LA 70560.]

Linscombe, Greg; Kinler, Noel. 1985. Fur harvest distribution in coastal Louisiana. In: Frederick, Byron C.; Swank, Phillip J.; Chabreck, Robert H., eds. Fourth coastal marsh and estuary management symposium. Louisiana Cooperative Fishery Research Unit and Louisiana Cooperative Wildlife Research Unit: 187–199.

Lund, Thomas A. 1980. American wildlife law. Berkeley, CA: University of California Press. 179 p.

Lyle, J. T. 1985. Design for human ecosystems. New York, NY: Van Nostrand Reinhold. 288 p.

Lyons, James R. 1987. Basic and applied social research needs in wildlife management. In: Decker, Daniel J.; Goff, Gary R., eds. Valuing wildlife: economic and social perspectives. Boulder, CO: Westview Press: 285–295.

MacArthur, R. A.; Geist, V.; Johnston, R. H. 1982. Cardiac and behavioral responses of mountain sheep to human disturbance. Journal of Wildlife Management. 46: 351–358.

MacPherson, Sandra L. 1987. History and status of the endangered Puerto Rican parrot. Endangered Species Technical Bulletin. 12(7): 6–7.

Mannan, R. William. 1980. Assemblages of bird species in western coniferous old-growth forests. In: DeGraff, Richard M., tech. coord. Management of western forests and grasslands for nongame birds. Gen. Tech. Rep. INT-86. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station: 357–368.

Mannan, R. William; Morrison, Michael L.; Meslow, E. Charles. 1984. The use of guilds in forest bird management. Wildlife Society Bulletin. 12: 426–430

Martin, William; Gum, Russell; Smith, Arthur. 1974. The demand for and value of hunting, fishing and general rural outdoor recreation in Arizona. Tech. Bull. 211. Tucson, AZ: Agriculture Experiment Station, University of Arizona. 56 p.

Maser, Chris; Thomas, Jack Ward. 1983. Introduction. In: Thomas, Jack Ward; Maser, Chris, tech. eds. Wildlife habitats in managed rangelands—the Great Basin of southeastern Oregon. Gen. Tech. Rep. PNW-160. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 15 p.

Matthiessen, Peter. 1987. Wildlife in America. Viking, NY: Elisabeth Sifton Books. 332 p.

McClure, Joe P.; Cost, Noel D.; Knight, Herbert A. 1979. Multiresource inventories—a new concept for forest survey. Res. Pap. SE-191. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 68 p.

McConnell, Kenneth E. 1984. Developing a forecasting model for fishing and hunting activities. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service, Division of Program Plans.

McKee, C. William. 1987. Economics of accommodating wildlife. In: Dickson, James, G.; Maughan, O. Eugene, eds. Managing southern forests for wildlife and fish. Gen. Tech. Rep. SO-65. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station: 1–5.

Melton, Brenda L.; Hoover, Robert L.; Moore, Richard L.; Pfankuch, Dale J. 1984. Aquatic and riparian wildlife. In: Hoover, R. L.; Wills, D. L., eds. Managing forest lands for wildlife. Denver, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Region: 261–301.

Menzel, B. W. 1983. Agricultural management practices and the integrity of instream biological habitat. In: Schaller, F. W.; Bailey, G. W., eds. Agricultural management and water quality. Ames, IA: Iowa State University Press: 305–329.

Miller, David L.; Angermeier, Paul L.; Hughes, Robert M. 1988. Regional application of an index of biotic integrity for use in water resource management. Fisheries. 13: 12–20.

Miller, G. C.; Graul, W. D. 1980. Status of sharp-tailed grouse in North America. In: Vohs, P. A.; Knopf, F. L., eds. Proceedings of the prairie grouse symposium. Stillwater, OK: University of Oklahoma: 18–28.

Miller, James E.; Holbrook, Herman L. 1983. Return of a native: the wild turkey flourishes again. In: U.S. Department of Agriculture, Yearbook of Agriculture: 116–173.

Miller, John R.; Hay, Michael J. 1981. Determinants of hunter participation: duck hunting in the Mississippi Flyway. American Journal of Agricultural Economics. 63: 677–684.

Miller, John; Hay, Michael. 1984. Estimating substate values of fishing and hunting. Transactions of the North American Wildlife and Natural Resources Conference. 49: 345–355.

Miller, Ronald R. 1980. The demand for the Colorado deer hunting experience. Fort Collins, CO: Department of Economics, Colorado State University. 164 p. Ph.D. dissertation.

Miller, Stephen A. 1984. Estimation of animal production numbers for national assessments and appraisals. Gen. Tech. Rep. RM-105. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 23 p.

Moore, Gary C.; Millar, John S. 1984. A comparative study of colonizing and longer established eastern coyote populations. Journal of Wildlife Management. 48: 691–699.

More, Thomas A. 1979. The demand for nonconsumptive wildlife uses: a review of the literature. Gen. Tech. Rep. NE-52. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 16 p.

Morgan, James K. 1971. Ecology of the Morgan Creek and East Fork of the Salmon River bighorn sheep herds and management of bighorn sheep in Idaho. Logan, UT: Utah State University. 156 p. M.S. thesis.

Moyle, Peter B.; Andrews, Rupert E.; Jenkins, Robert M.; Noble, Richard L.; Saila, Saul B.; Wick, William O. 1979. Research needs in fisheries. Transactions of the North American Wildlife and Natural Resources Conference. 44: 176–187.

Naisbitt, John. 1982. Megatrends: ten directions transforming our lives. New York, NY: Warner Books, Inc. 290 p.

National Academy of Sciences, National Research Council. 1982. Impacts of emerging agricultural trends on fish and wildlife habitat. Washington, DC: National Academy Press. 243 p.

National Association of Conservation Districts. 1979. Pasture and range improvement report. Ankeney, IA: National Association of Soil and Water Conservation Districts. 38 p.

National Shooting Sports Foundation. 1986. Hunting frequency and participation study. 7 p. [Available from the National Shooting Sports Foundation, Inc., P.O. Box 1075, 1075 Post Road, Riverside, CT 06878.]

New England Fishery Management Council. 1987. Fishery management plan for Atlantic salmon. Saugus, MA: New England Fishery Management Council. 64 p.

Nielsen, Larry A. 1987. Designing natural resource education: lessons from real professions. Transactions of the North American Wildlife and Natural Resources Conference. 52: 714–721.

Norse, Elliott A.; Rosenbaum, Kenneth L.; Wilcove, David S.; Wilcox, Bruce A.; Romme, William H.; Johnston, David W.; Stout, Martha L. 1986. Conserving biological diversity in our national forests. Washington, DC: The Wilderness Society. 116 p.

Northwest Power Planning Council. 1987. Columbia River Basin fish and wildlife program. Portland, OR: Northwest Power Planning Council. 246 p.

Norton, Bryan G., ed. 1986. The preservation of species: the value of biological diversity. Princeton, NJ: Princeton University Press: 305 p.

Noss, Reed F. 1987. From plant communities to landscapes in conservation inventories: a look at the Nature Conservancy (USA). Biological Conservation. 41: 11–37.

Nunley, G. L. 1978. Present and historical bobcat population trends in New Mexico and the West. Proceedings of the Vertebrate Pest Conference. 8: 77–84.

Nyberg, Brian J.; Harestad, Alton S.; Bunnell, Fred L. 1987. "Old growth" by design: managing young forests for old-growth wildlife. Transactions of the North American Wildlife and Natural Resources Conference. 52: 70–81.

Oak Ridge National Laboratory. 1981. Personal communication. Map depicting distribution of threatened and endangered animal species. Oak Ridge Geographics, Oak Ridge, TN.

Oatis, P.; Henry, S.; Iwanowicz, R.; Greenwood, J.; Cookson, J.; Lanier, J.; Kimball, D.; Rizzo, B.; Stotle, L. 1985. Restoration of Atlantic salmon to the Merrimack river. 1985 through 1999. A planning document of the Merrimack River. Policy and technical committee. Concord, NH: U.S. Fish and Wildlife Service, Fisheries Assistance.

Odum, Eugene P. 1971. Fundamentals of ecology. Philadelphia, PA: W. B. Sanders Company. 574 p.

Office of Technology Assessment. 1984. Wetlands: their use and regulation. OTA-0-206. Washington, DC: Government Printing Office.

Office of Technology Assessment. 1985. Technologies to benefit agriculture and wildlife. OTA-BP-F-34. Washington, DC: U.S. Congress, Office of Technology Assessment. 137 p.

Office of Technology Assessment. 1987. Technologies to maintain biological diversity. Washington, DC: U.S. Government Printing Office. 334 p.

Ohmart, Robert D.; Anderson, Bertin W. 1986. Riparian habitat. In: Cooperrider, Allen Y.; Boyd, Raymond J.; Stuart, Hanson R., eds. Inventory and monitoring of wildlife habitat. Denver, CO: U.S. Department of Interior, Bureau of Land Management, Service Center: 169–193.

Owen, Ray B., Jr., chairman. 1977. American woodcock. In: Sanderson, Glen C., ed. Management of migratory shore and upland game birds in North America. Washington, DC: International Association of Fish and Wildlife Agencies: 149–186.

Paradiso, John L. 1986. Audubon's crested caracara, one of Florida's most distinctive raptors, proposed for listing. Endangered Species Technical Bulletin. 11(7): 1–4.

Parker, Nick C.; Stevens, Verl. 1988. Aquaculture: an overview for 1988. Transactions of the North American Wildlife and Natural Resources Conference. 53: 561–563.

Partridge, Linda. 1978. Habitat selection. In: Krebs, J. R.; Davies, N. B., eds. Behavioural ecology: an evolutionary approach. Sunderland, MA: Sinauer Associates, Inc.: 351–376.

Pearce, John B. 1985. Estuarine habitat enhancement and restoration. Transactions of the North American Wildlife and Natural Resources Conference. 50: 457–464.

Peek, James M. 1986. A review of wildlife management. Englewood Cliffs, NJ: Prentice-Hall. 486 p.

Peterson, George L.; Loomis, John B.; Sorg, Cindy F. [n.d.] Trends in the value of outdoor recreation. Unpublished Staff Paper. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 14 p.

Peterson, Rolf O. 1986. Gray wolf. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1986. New York, NY: The National Audubon Society: 951–967.

Phinney, Lloyd A. 1986. Chinook salmon of the Columbia River basin. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1986. New York, NY: Academic Press: 715–741.

Platt, Dwight R. 1983. Preservation of the tallgrass prairie: opportunities for action. Transactions of the North American Wildlife and Natural Resources Conference. 48: 551–556.

Platts, William S. 1979. Livestock grazing and riparian/stream ecosystems—an overview. In: Cope, Oliver B., ed. Forum—grazing and riparian/stream ecosystems; 1978 November 3–4; Denver, CO. Vienna, VA: Trout Unlimited, Inc.: 39–45.

Platts, William S. 1986. Managing riparian stream habitats. In: Wyoming water 1986 and streamside zone conference. Laramie, WY: University of Wyoming: 59–62.

Poole, Daniel A.; McCabe, Richard E. 1987. Wildlife tomorrow. In: Restoring America's wildlife 1937–1987. Washington DC: U.S. Department of Interior, Fish and Wildlife Service: 325–340.

Poole, Daniel A.; Trefethen, James B. 1978. The maintenance of wildlife populations. In: Brokaw, Howard P., ed. Wildlife in America. Washington, DC: Council on Environmental Quality: 3–17.

Porter, R. D.; White, C. M. 1977. Status of some rare and lesser known hawks in western United States. In: Proceedings of the ICBP world conference on birds of prey; 1975; Vienna. Washington, DC: Government Printing Office. 442 p.

Prescott-Allen, Christine; Prescott-Allen, Robert. 1987. The first resource. New Haven, CT: Yale University Press. 529 p.

Prouty, Mike. 1987. A new program for riparian research. Forest Research West. April: 7–10.

Raml, Teresa. 1988. Personal communication. Letter of June 29, 1988. U.S. Department of Agriculture, Forest Service, Wildlife and Fisheries Staff, Washington, DC.

Randall, Alan; Peterson, George L. 1984. The valuation of wildland benefits: an overview. In: Peterson, George L.; Randall, Alan, eds. Valuation of wildland resource benefits. Boulder, CO: Westview Press: 1–52.

Raveling, Dennis G. 1984. Geese and hunters of Alaska's Yukon Delta: management problems and political dilemmas. Transactions of the North American Wildlife and Natural Resources Conference. 49: 555–575.

Raybourne, Jack W. 1987. The black bear: home in the highlands. In: Kallman, Harmon, ed. Restoring America's wildlife, 1937–1987. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service: 105–117.

Ream, C. H. 1979. Human-wildlife conflicts in backcountry: possible solutions. In: Ittner, Ruth; Potter, Dale R.; Agee, James K.; Anschell, Susie, eds. Proceedings, Recreational impacts on wildlands. R-6-001-1979. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region: 153–163.

Reiger, George. 1978. Hunting and trapping in the new world. In: Brokaw, Howard P., ed. Wildlife and America. Washington, DC: Council on Environmental Quality: 42–52.

Resources for the Future. 1980. RFF fishable water survey. [Available from Resources for the Future, 1616 P Street NW, Washington, DC 20036.]

Risser, Paul G.; Karr, James R.; Forman, Richard T. T. 1984. Landscape ecology: direction and approaches. Illinois Natural History Survey Special Publication No. 2. Champaign, IL: Illinois Natural History Survey. 18 p.

Robbins, Chandler S.; Bystrak, Danny; Geissler, Paul H. 1986. The breeding bird survey: its first fifteen years, 1965–1979. Resour. Publ. 157. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 196 p.

Roe, H. B.; Ayers, Q. C. 1954. Engineering for agricultural drainage. New York, NY: McGraw-Hill Book Co. 501 p.

Rosenthal, Donald H.; Loomis, John B.; Peterson, George L. 1984. The travel cost model: concepts and applications. Gen. Tech. Rep. RM-109. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 10 p.

Rotenberry, John T. 1986. Habitat relationships of shrub-steppe birds: even "good" models cannot predict the future. In: Verner, Jared; Morrison, Michael L.; Ralph, C. John, eds. Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. Madison, WI: The University of Wisconsin Press: 217–221.

Rudis, Victor A.; Birdsey, Richard A. 1986. Forest resource trends and current conditions in the lower Mississippi Valley. Resour. Bull. SO-116. New Orleans, LA: U.S. Department of Agriculture, Forest Service, Southern Forest Experiment Station. 7 p.

Ruff, Robert L.; Isaac, Thomas A. 1987. Public access and fee hunting on private nonindustrial forests in Wisconsin. Transactions of the North American Wildlife and Natural Resources Conference. 52: 483–495.

Russell, Milton. 1987. Environmental protection for the 1990's and beyond. Environment. 29: 12–15, 34–38.

Saling, Col. Neil E. [n.d.]. District Engineer for U.S. Army Corps of Engineers, Alaska District. Statement before the Senate Committee on Environmental and Public Works, Anchorage, AK.

Sample, V. Alaric. 1987. Improving the link between RPA assessment findings and the RPA Program: the view from OMB. Renewable Resources Journal. 5: 6–12.

Samson, Fred B. 1980. Island biogeography and the conservation of nongame birds. Transactions of the North American Wildlife and Natural Resources Conference. 45: 245–251.

Sanderson, Glen C.; Ables, Ernest D.; Sparrowe, Rollin D.; Grieb, Jack R.; Harris, Lawrence D.; Moen, Aaron N. 1979. Research needs in wildlife. Transactions of the North American Wildlife and Natural Resources Conference. 44: 166–175.

Schenck, Eric W.; Arnold, Wayne; Brown, Edward K.; Witter, Daniel J. 1987. Commercial hunting and fishing in Missouri: management implications of fish and wildlife "markets." Transactions of the North American Wildlife and Natural Resources Conference. 52: 516–529.

Schmidt, John L. 1978. Early management: intentional and otherwise. In: Schmidt, John L.; Gilbert, Douglas L., eds. Big game of North America: ecology and management. Harrisburg, PA: Stackpole Books: 257–270.

Schneegas, Edward R. 1967. Sage grouse and sagebrush control. Transactions of the North American Wildlife and Natural Resources Conference. 32: 270–274.

Schonewald-Cox, Christine. 1986. Diversity, germplasm and natural resources. In: Kim, Ke Chung; Knutson, Lloyd, eds. Foundations for a national biological survey. Lawrence, KS: Association of Systematics Collections: 45–54.

Schonewald-Cox, Christine M.; Chambers, Steven M.; MacBryde, Bruce; Thomas, W. Lawrence, eds. 1983. Genetics and conservation. Menlo Park, CA: The Benjamin/Cummings Publishing Company, Inc. 722 p.

Schwegman, John E. 1983. State natural area programs. Transactions of the North American Wildlife and Natural Resources Conference. 48: 491–494.

Schweitzer, Dennis L.; Hoekstra, Thomas W.; Cushwa, Charles T. 1981. Lessons from past national assessments of wildlife and fish: information and coordination needs for the future. Transactions of the North American Wildlife and Natural Resources Conference. 46: 147–155.

Schweitzer, Dennis L.; Stone, Robert N. 1987. Economics, elephants and snarks: predicting future values. Western Wildlands: 16–19.

Scott, J. Michael; Sincock, John L. 1985. Hawaiian birds. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1985. New York, NY: The Audubon Society: 549–562.

Scotter, George W. 1980. Management of wild ungulate habitat in the western United States and Canada: a review. Journal of Range Management. 33: 16–27.

Seitz, William K.; Streeter, Robert G.; Kirby, Ronald E.; Taylor, Alan R.; Cortese, Thomas J.; Cross, Diana H. 1987. Increasing communication between research and development scientists and operational managers—the U.S. Fish and Wildlife Service approach. Transactions of the North American Wildlife and Natural Resources Conference. 52: 405–417.

Sheffield, Raymond M. 1981. Multiresource inventories: techniques for evaluating nongame bird habitat. Res. Pap. SE-218. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station. 28 p.

Shelton, Napier. 1987. What about our nongame birds. Defenders: 25–29.

Short, Henry L. 1986. Rangelands. In: Cooperrider, Allen Y.; Boyd, Raymond J.; Stuart, Hanson R., eds. Inventory and monitoring of wildlife habitat. Denver, CO: U.S. Department of Interior, Bureau of Land Management, Service Center: 93–122.

Simpson, S. G. 1988. Use of the Missouri River in South Dakota by Canada geese in fall and winter, 1953–1984. In: Weller, Milton W., ed. Waterfowl in winter. Minneapolis, MN: University of Minnesota Press: 529–540.

Sisson-Lopez, Jill. 1979. An analysis of the U.S. fur trade. Final Report for the USDA Forest Service. Cooperative Agreement 16-773-CA. [Report on file at the Rocky Mountain Forest and Range Experiment Station, 240 West Prospect Road, Fort Collins, CO 80526-2098.]

Skoog, Ronald O. 1979. Native claims settlements and resource management in Alaska. Transactions of the North American Wildlife and Natural Resources Conference. 44: 567–572.

Smith, Dixie R., tech. coord. 1975. Symposium on the management of forest and range habitats for nongame birds. Gen. Tech. Rep. WO-1. Washington, DC: U.S. Department of Agriculture, Forest Service. 343 p.

Smith, R. A.; Alexander, R. B.; Wolman, M. G. 1987. Water-quality trends in the nation's rivers. Science. 235: 1607–1615.

Sorg, Cindy F.; Loomis, John B. 1984. Empirical estimates of amenity forest values: a comparative review. Gen. Tech. Rep. RM-107. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 23 p.

Sorg, Cindy F.; Loomis, John B.; Donnelly, Dennis. 1982. The net economic value of cold and warmwater fishing in Idaho. Memo. U.S. Department of Agriculture, Forest Service, Fort Collins, CO.

Southeastern Association of Fish and Wildlife Agencies. 1980–1982, 1984, 1986. Vital statistics. Raleigh, NC: North Carolina Wildlife Resource Commission.

Sowell, B. F.; Krysl, L. J.; Hubbert, M. E.; Plumb, G. E.; Jewett, T. K.; Smith, M. A.; Appelgate, S. L.; Waggoner, J. W. 1983. Wyoming wild horse and cattle grazing research. Rangelands. 5: 259–262.

Spies, Thomas A.; Franklin, Jerry F. 1988. Old growth and forest dynamics in the Douglas-fir region of western Oregon and Washington. Natural Areas Journal. 8: 190–200.

Stalmaster, M. V.; Newman, J. R. 1978. Behavioral responses of wintering bald eagles to human activity. Journal of Wildlife Management. 42: 506–513.

Starfield, A. M.; Bleloch, A. L. 1986. Building models for conservation and wildlife management. New York, NY: Macmillan Publishing Company. 253 p.

Steiner, Frederick; Roberts, John. 1987. Prospect: public trust doctrine. Landscape Architecture: 112, 116, 118.

Stoddart, Laurence A.; Smith, Arthur D.; Box, Thadis W. 1975. Range management. New York: McGraw-Hill Book Company. 532 p.

Stoll, John R. 1986. Methods for measuring the net contribution of recreation to national economic development. In: The President's commission of Americans outdoors. A literature review. Values and benefits. Washington, DC: U.S. Government Printing Office: 19–33.

Stolte, L. W. 1982. A strategic plan for the restoration of the Atlantic salmon to the Connecticut River basin. Laconia, NH: U.S. Fish and Wildlife Service, Fishery Assistance. 84 p.

Stolte, Lawrence. 1986. The Atlantic Salmon. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1986. New York, NY: The Audubon Society: 692–714.

Streeter, Robert G. 1987. Lessons from megatrends: an educational tool for entering the 21st century. Transactions of the North American Wildlife and Natural Resources Conference. 52: 697–706.

Sweeney, James M.; Wolters, Gale L. 1986. Techniques for future decision-making in range, wildlife, and fisheries management. In: Crowley, John J., ed. Research for tomorrow. 1986 yearbook of agriculture. Washington, DC: U.S. Department of Agriculture. 336 p.

Swift, Bryan L. 1984. Status of riparian ecosystems in the United States. Water Resources Bulletin. 20: 223–228.

Szaro, Robert C. 1986. Guild management: and evaluation of avian guilds as a predictive tool. Environmental Management. 10: 681–688.

Taber, Richard D. 1983. Toward the progress of wildlife conservation in North America. Transactions of the North American Wildlife and Natural Resources Conference. 48: 460–479.

Talbot, Lee M. 1987. The ecological value of wildlife to the well-being of human society. In: Decker, Daniel J.; Goff, Gary R., eds. Valuing wildlife: economic and social perspectives. Boulder, CO: Westview Press: 179–186.

Tedder, P. L.; La Mont, Richard N.; Kincaid, Jonna C. 1987. The timber resource inventory model (TRIM): a projection model for timber supply and policy analysis. Gen. Tech. Rep. PNW-202. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 82 p.

Thomas, Jack Ward, tech. ed. 1979. Wildlife habitats in managed forests, the Blue Mountains of Oregon and Washington. Agric. Handb. 553. Washington, DC: U.S. Government Printing Office. 512 p.

Thomas, Jack Ward. 1986. Wildlife-habitat modeling—cheers, fears, and introspection. In: Verner, Jared; Morrison, Michael L.; Ralph, C. John, eds. Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. Madison, WI: The University of Wisconsin Press: xix–xxv.

Thomas, Jack Ward; Bryant, Larry D. 1987. The elk. In: DiSilvestro, Roger L., ed. Audubon Wildlife Report 1987. New York, NY: Academic Press Inc.: 495–507.

Thomas, Jack Ward; Maser, Chris; Rodiek, Jon E. 1979. Riparian zones. In: Thomas, Jack Ward; Maser, Chris, tech. eds. Wildlife habitats in managed rangelands—the Great Basin of southeastern Oregon. Gen. Tech. Rep. PNW-80. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Forest and Range Experiment Station. 18 p.

Thomas, Jack Ward; Ruggiero, Leonard F.; Mannan, R. William; Schoen, John W.; Lancia, Richard A. 1988. Management and conservation of old-growth forests in the United States. Wildlife Society Bulletin. 16: 252–262.

Tiner, Ralph W. 1984. Wetlands of the United States: current status and recent trends. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 59 p.

Tomlinson, R. E.; Smith, P.; McKibben R. 1987. Agricultural cropping practices and possible effects on mourning dove populations in the Western Management Unit. [Unpublished Report.] Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 18 p.

Trost, Robert E.; Sharp, David E.; Kelly, Sean T.; Caswell, F. Dale. 1987. Duck harvests and proximate factors influencing hunter activity and success during the period of stabilized regulations. Transactions of the North American Wildlife and Natural Resources Conference. 52: 216–232.

U.S. Department of Agriculture. [Various years.] Agricultural statistics. U.S. Department of Agriculture. Washington, DC: U.S. Government Printing Office.

U.S. Department of Agriculture, Forest Service. 1965. Timber trends in the United States. Forest Resource Report No. 17. Washington, DC: U.S. Government Printing Office. 235 p.

U.S. Department of Agriculture, Forest Service. 1965–1977. Annual wildlife report. Washington, DC: Division of Wildlife Management.

U.S. Department of Agriculture, Forest Service. 1974. The outlook for timber in the United States. Forest Resource Report 20. Washington, DC: U.S. Government Printing Office. 374 p.

U.S. Department of Agriculture, Forest Service. 1978–1985. Wildlife and fish habitat management in the Forest Service. Washington, DC: Wildlife and Fisheries.

U.S. Department of Agriculture, Forest Service. 1979. The 1979 wildlife and fish data base. [Data base stored at the Rocky Mountain Forest and Range Experiment Station, 240 West Prospect Road, Fort Collins, CO 80526–2098.]

U.S. Department of Agriculture, Forest Service. 1981. An assessment of the forest and range land situation in the United States. Forest Resource Report 22. Washington, DC: U.S. Government Printing Office. 352 p.

U.S. Department of Agriculture, Forest Service. 1982. An analysis of the timber situation in the United States, 1952–2030. Forest Resource Report 23. Washington, DC: U.S. Government Printing Office. 499 p.

U.S. Department of Agriculture, Forest Service. 1985a. Forest Service resource inventory: an overview. Washington DC: U.S. Department of Agriculture, Forest Service, Forest Resource Economics Research Staff. 29 p.

U.S. Department of Agriculture, Forest Service. 1985b. Wildlife and fish habitat management in the Forest Service. Washington, DC: Wildlife and Fisheries. 154 p.

U.S. Department of Agriculture, Forest Service. 1986a. National Forest System threatened and endangered species program—a brief. [Data available from USDA Forest Service, Wildlife and Fisheries Staff, Washington, DC.]

U.S. Department of Agriculture, Forest Service. 1986b. Final environmental impact statement: 1985–2030 Resources Planning Act program. FS-403. Washington, DC: U.S. Department of Agriculture, Forest Service.

U.S. Department of Agriculture, Forest Service. 1987. Report of the Forest Service: fiscal year 1986. Washington DC: U.S. Department of Agriculture, Forest Service. 172 p.

U.S. Department of Agriculture, Forest Service. 1988. The South's fourth forest: alternatives for the future. Forest Resource Report 24. Washington, DC: U.S. Department of Agriculture, Forest Service. 512 p.

U.S. Department of Agriculture, Soil Conservation Service. 1987. The second RCA appraisal. Soil, water, and related resources on nonfederal land in the United States: analysis of condition and trends. [Review Draft.] Washington, DC: U.S. Department of Agriculture.

U.S. Department of Agriculture, Soil Conservation Service; Iowa State University Statistical Laboratory. 1987. Basic statistics, 1982 national resource inventory. Statistical Bulletin-756. Washington DC: U.S. Department of Agriculture, Soil Conservation Service. 153 p.

U.S. Department of Commerce, Bureau of Census. 1984a (and earlier years). 1982 census of agriculture. Vol. 1. Geographic area series. Part 41. United States summary and state data. AC82–A–51. Washington, DC: U.S. Government Printing Office. 420 p.

U.S. Department of Commerce, Bureau of Census. 1984b. Projections of the population of the United States, by age, sex, and race: 1983–2080. Current Population Reports. Series P-25, No. 952. Washington DC: U.S. Government Printing Office.

U.S. Department of Commerce, Bureau of Economic Analysis. 1985. 1985 OBERS BAE regional projections. Washington, DC: U.S. Government Printing Office.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1971–1975. Fishery statistics of the United States. Washington, DC: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1976a. Fisheries of the United States, 1975. Washington, DC: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 100 p.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1976b. Fishery statistics of the United States, 1973. Washington, DC: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 458 p.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1977. Fishery statistics of the United States, 1974. Washington, DC: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 424 p.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1978. Fishery statistics of the United States, 1975. Washington, DC: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 418 p.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1979. Fisheries of the United States, 1978. Washington, DC: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 120 p.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1980a. Fisheries of the United States, 1979. Washington, DC: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 131 p.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1980b. Fishery statistics of the United States, 1976. Washington, DC: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 419 p.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1981–1983. Fisheries of the United States. Washington, DC: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1984a. Fisheries of the United States, 1983. Washington, DC: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 121 p.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1984b. Fishery statistics of the United States, 1977. Washington, DC: U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 407 p.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. 1985–1987. Fisheries of the United States. Washington, DC: U.S. Department of Commerce National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

U.S. Department of Commerce, National Technical Information Service. 1987. National acid precipitation assessment program (NAPAP) interim assessment: the causes and effects of acidic deposition. Vol. 1. Executive Summary. Springfield, VA: U.S. Department of Commerce, National Technical Information Service.

U.S. Department of the Interior, Bureau of Commercial Fisheries. 1967–1969. Fishery statistics of the United States. Washington, DC: U.S. Department of Interior, Bureau of Commerical Fisheries.

U.S. Department of the Interior, Bureau of Land Management. 1966–1988. Public land statistics. Washington, DC: U.S. Government Printing Office.

U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. 1966. Waterfowl status report, 1966. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. 96 p.

U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. 1967. Waterfowl status report, 1967. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. 144 p.

U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. 1968a. Waterfowl status report, 1968. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. 158 p.

U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. 1968b. National survey of needs for hatchery fish. Publication 63. Washington, DC. U.S. Department of Agriculture, Fish and Wildife Service, Bureau of Sport Fisheries and Wildlife.

U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. 1969. Waterfowl status report, 1969. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. 153 p.

U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. 1971. Waterfowl status report, 1970. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. 157 p.

U.S. Department of the Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. 1972. Waterfowl status report, 1972. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service, Bureau of Sport Fisheries and Wildlife. 146 p.

U.S. Department of the Interior, Fish and Wildlife Service. [n.d.]a. Quantification of private/public-owned wetlands. [Data available from USDI Fish and Wildlife Service, National Wetland Inventory, Washington, DC.]

U.S. Department of the Interior, Fish and Wildlife Service. [n.d.]b. 1980 national survey of fishing, hunting and wildlife-associated recreation. Memo. Division of Program Plans. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service.

U.S. Department of the Interior, Fish and Wildlife Service. 1974. Migratory game bird briefing book. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 47 p.

U.S. Department of the Interior, Fish and Wildlife Service. 1975. Waterfowl status report, 1973. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 105 p.

U.S. Department of the Interior, Fish and Wildlife Service. 1977. 1975 national survey of hunting, fishing, and wildlife-associated recreation. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 91 p.

U.S. Department of the Interior, Fish and Wildlife Service. 1980a. Waterfowl status report, 1975. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 86 p.

U.S. Department of the Interior, Fish and Wildlife Service. 1980b. Waterfowl status report, 1976. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 88 p.

U.S. Department of the Interior, Fish and Wildlife Service. 1981a. Waterfowl status report, 1978. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 96 p.

U.S. Department of the Interior, Fish and Wildlife Service. 1981b. Animal damage control program national summary, 1980. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service.

U.S. Department of the Interior, Fish and Wildlife Service. 1982a. Nongame migratory bird species with unstable or decreasing population trends in the United States. 24 p. [Report on file at the Office of Migratory Bird Management and Patuxent Wildlife Research Center.]

U.S. Department of the Interior, Fish and Wildlife Service. 1982b. Waterfowl status report, 1979. Office of Migratory Bird Management. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 96 p.

U.S. Department of the Interior, Fish and Wildlife Service. 1983. Proposed reclassification of the peregrine falcons in North American. Federal Register. 48(41): 8796–8802.

U.S. Department of the Interior, Fish and Wildlife Service. 1984. Restoration of Atlantic salmon to New England rivers. Draft Environmental Impact Statement. DES. 84/37.

U.S. Department of the Interior, Fish and Wildlife Service. 1985. Environmental assessment: proposed hunting regulations on the eastern population of woodcock. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 17 p.

U.S. Department of the Interior, Fish and Wildlife Service. 1986a. New hope for the southern sea otter. Endangered Species Technical Bulletin. 11(10–11): 5–7.

U.S. Department of the Interior, Fish and Wildlife Service. 1986b. Northern aplomado falcon (*Falco femoralis septentrionalis*). Endangered Species Technical Bulletin. 11(3): 1.

U.S. Department of the Interior, Fish and Wildlife Service. 1987a. Draft supplemental environmental impact statement: issuance of annual regulations permitting the sport hunting of migratory birds. Washington, DC: U.S. Department of Interior, Fish and Wildlife Service. 250 p.

U.S. Department of the Interior, Fish and Wildlife Service. 1987b. Endangered Species Technical Bulletin. 12(7): 1.

U.S. Department of the Interior, Fish and Wildlife Service. 1987c. Endangered species information system. [Data available from ESIS Project Leader, U.S. Fish and Wildlife Service, Office of Endangered Species, Broyhill Building, Suite 500, Washington DC 20240.]

U.S. Department of the Interior, Fish and Wildlife Service. 1988a. Endangered Species Technical Bulletin. 13(11–12): 12.

U.S. Department of the Interior, Fish and Wildlife Service. 1988b. 1985 national survey of fishing, hunting, and wildlife-associated recreation. Washington, DC. 167 p.

U.S. Department of the Interior, Fish and Wildlife Service. 1988c. National recreational fisheries policy. Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service. 20 p.

U.S. Department of the Interior, Fish and Wildlife Service and Canadian Wildlife Service. 1986a. North American Waterfowl Management Plan. 31 p.

U.S. Department of the Interior, Fish and Wildlife Service and Canadian Wildlife Service. 1986b. Status of Waterfowl and Fall Flight Forecasts. 36 p.

U.S. Department of the Interior, Fish and Wildlife Service; U.S. Department of Commerce, Bureau of Census. 1982. 1980 national survey of fishing, hunting and wildlife-associated recreation. Washington, DC: U.S. Government Printing Office. 156 p.

Van Ballenberghe, Victor. 1986. Legislation, litigation and allocation: a case history of subsistence hunting in Alaska. Transactions of the North American Wildlife and Natural Resources Conference. 51: 107–115.

Van Horne, B. 1983. Density as a misleading indicator of habitat quality. Journal of Wildlife Management. 47: 893–901.

Van Vleck, Gordon K. 1984. Funding for fish and wildlife resources. Cal-Neva Wildlife Transactions: 1–6.

Vaske, Jerry J.; Graefe, Alan R.; Kuss, Fred R. 1983. Recreation impacts: a synthesis of ecological and social research. Transactions of the North American Wildlife and Natural Resources Conference. 48: 96–107.

Verburg, Edwin A.; Charbonneau, John J.; Mangun, William R.; Llewellyn, Lynn G. 1987. The importance of fish and wildlife values to the profession. In: Decker, Daniel J.; Goff, Gary R., eds. Valuing wildlife: economic and social perspectives. Boulder, CO: Westview Press: 49–62.

Verner, Jared. 1984. The guild concept applied to management of bird populations. Environmental Management. 8: 1–14.

Verner, Jared. 1985. Assessment of counting techniques. In: Johnston, Richard F., ed. Current ornithology, vol. 2. Plenum Publishing Corporation: 247–302.

Verner, Jared. 1986. Future trends in management of nongame wildlife: a researcher's viewpoint. In: Hale, James B.; Best, Louis B.; Clawson, Richard L., eds. Management of nongame wildlife in the Midwest: a developing art: 149–171.

Verner, J.; Boss, A. S. 1980. California wildlife and their habitats: western Sierra Nevada. Gen. Tech. Rep. PSW-37. Berkeley, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Forest and Range Experiment Station. 439 p.

Verner, Jared; Morrison, Michael L.; Ralph, C. John, eds. 1986. Wildlife 2000: modeling habitat relationships of terrestrial vertebrates. Madison, WI: The University of Wisconsin Press. 470 p.

Waddell, Karen L. 1989. Personal communication. USDA, Forest Service, Pacific Northwest Station, Forestry Sciences Laboratory. Portland, OR.

Wagner, Frederic H. 1978. Livestock grazing and the livestock industry. In: Brokaw, Howard P., ed. Wildlife and America. Washington, DC: Council on Environmental Quality: 121–145.

Wagner, Frederic H. 1983. Status of wild horse and burro management on public rangelands. Transactions of the North American Wildlife and Natural Resources Conference. 48: 116–133.

Wagner, Frederic H. 1985. Progress and problems, 1934–1984, in improvement of wildlife habitat. Proceedings: National celebration 50th anniversary Taylor Grazing Act. U.S. Department of the Interior, Bureau of Land Management. 51–58.

Wagner, Frederic H. 1988. Personal communication. College of Natural Resources, Utah State University. Logan, UT.

Walkinshaw, L. H.; Faust, W. R. 1974. Some aspects of Kirtland's warbler breeding biology. Jack-Pine Warbler. 52: 65–75.

Wallmo, Olaf C. 1978. Mule and black-tailed deer. In: Schmidt, John L.; Gilbert, Douglas L., eds. Big game of North America: ecology and management. Harrisburg, PA: Stackpole Books: 31–41.

Walsh, Richard G.; Harpman, David A.; John, Kun H.; McKean, John R.; LeCroy, D. Lauren. 1987. Long-run forecasts of participation in fishing, hunting, and nonconsumptive wildlife recreation. Tech. Rep. 50. Fort Collins, CO: Colorado State University, Colorado Water Resources Research Institute. 81 p.

Washburne, R. F.; Cole, D. N. 1983. Problems and practices in wilderness management: a survey of managers. Res. Pap. INT-304. Ogden, UT: U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 56 p.

Weber, Michael. 1986. Federal marine fisheries management. In: DiSilvestro, Roger L., ed. Audubon wildlife report 1986. New York, NY: The National Audubon Society: 267–344.

Weller, Milton W. 1986. Marshes. In: Cooperrider, Allen Y.; Boyd, Raymond J.; Stuart, Hanson R., eds. Inventory and monitoring of wildlife habitat. Denver, CO: U.S. Department of the Interior, Bureau of Land Management, Service Center: 201–224.

Weller, Milton W. 1988. Issues and approaches in assessing cumulative impacts on waterbird habitat in wetlands. Environmental Management. 12: 695–701.

West, Patric C. 1986. Social benefits of outdoor recreation: sociological perspectives and implications for planning and policy. In: The President's commission of Americans outdoors. A literature review. Values and benefits. Washington, DC: U.S. Government Printing Office: 93–102.

Wharton Econometric Forecasting Associates. 1985. Wharton long-term forecast to the year 2040 assuming U.S. Bureau of Census middle series population projections. Special report to the Forest Service. Washington, DC: U.S. Department of Agriculture.

White, Ronald J. 1987. Big game ranching in the United States. Mesilla, NM: Wild Sheep and Goat International. 355 p.

Wiggers, Ernie P.; Rootes, William A. 1987. Lease hunting: views of the nation's wildlife agencies. Transactions of the North American Wildlife and Natural Resources Conference. 52: 525–529.

Wildlife Conservation Fund of America, The. 1987. 1987 survey of state wildlife agency revenue. Columbus, OH: The Wildlife Conservation Fund of America.

Wildlife Management Institute. 1987. Outdoor News Bulletin. 41(20).

Wildlife Management Institute Staff. 1978. The future. In: Schmidt, John L.; Gilbert, Douglas L., eds. Big game of North America: ecology and management. Harrisburg, PA: Stackpole Books: 417–424.

Wilkes, Brian. 1977. The myth of the non-consumptive user. The Canadian Field-Naturalist. 91: 343–349.

Williams, E. S.; Thorne, E. T.; Appel, M. J. G.; Belitsky, D. W. 1988. Canine distemper in black-footed ferrets (*Mustela nigripes*) from Wyoming. Journal of Wildlife Diseases. 24: 385–398.

Wilson, E. O., ed. 1988. Biodiversity. Washington, DC: National Academy Press. 521 p.

Wolf, Robert E. 1982. The goals of the authors of the RPA. In: Hewett, Charles E.; Hamilton Thomas E., eds. Forests in demand: conflicts and solutions. Boston, MA: Auburn House Publishing Company: 137–146.

Wolfe, Michael L. 1978. Habitat changes and management. In: Schmidt, John L.; Gilbert, Douglas L., eds. Big game of North America: ecology and management. Harrisburg, PA: Stackpole Books: 349–368.

Wood, Gene W.; Causey, M. Keith; Whiting, R. Montague, Jr. 1985. Perspectives on American woodcock in the southern United States. Transactions of the North American Wildlife and Natural Resources Conference. 50: 573–585.

Yoakum, James D. 1978. Pronghorn. In: Schmidt, John C.; Gilbert, Douglas L., eds. Big game of North America: ecology and management. Harrisburg, PA: Stackpole Books: 103–121.

APPENDIX A: GLOSSARY

Anadromous.—Species of fish that mature in the ocean, and then ascend streams to spawn in freshwater.

Animal unit month (AUM).—The amount of forage required for a 1,000 pound cow, or the equivalent, for 1 month.

Archipelago.—Any large body of water with many islands.

Assessment regions.—Regions used in this and other resource assessment documents and include the:

- **Northern.**—Assessment region encompassing the states of Connecticut, Delaware, Iowa, Illinois, Indiana, Massachusetts, Maryland, Maine, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Vermont, Wisconsin, West Virginia. This includes Forest Service Region 9.
- **Pacific Coast.**—Assessment region encompassing the states of Alaska, California, Hawaii, Oregon, and Washington. This includes Forest Service Regions 5, 6, and 10.
- **Rocky Mountain.**—Assessment region encompassing the states of Arizona, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, South Dakota, Utah, and Wyoming. This includes Forest Service Regions 1, 2, 3, and 4.
- **Southern.**—Assessment region encompassing the states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and Virginia. This includes Forest Service Region 8.

Big game.—Large wild animals hunted, or potentially hunted, for sport or food including deer, elk, bear, pronghorn, and wild turkey.

Biotic factors.—Environmental influences caused by plants or animals.

Category 1.—Taxa for which the FWS currently has substantial information to support the biological appropriateness of proposing to list the species as endangered or threatened and the development of proposed rules is anticipated.

Category 2.—Taxa for which information now in the possession of the FWS indicates that proposing to list the species is possibly appropriate but conclusive biological data is not currently available to support development of proposed rules.

Coldwater fishing.—Includes freshwater trout, kokanee, and anadromous fishes such as salmon and steelhead.

Commercial timberland.—Forestland which is producing or capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. (Note: Areas qualifying as commercial timberland have the capability of producing in excess of 20 cubic feet per year of industrial wood in natural stands. Currently, inaccessible and inoperable areas are included.)

Commercial value.—Income derived from the sale or trade of wild animals or their products or from direct and controlled use of wild animals and their progeny.

Community.—A group of populations of plants and animals in a given place; ecological unit used in a broad sense to include groups of various sized and degrees of integration.

Critical habitat.—Air, land, or water area which, if destroyed or degraded, would appreciably decrease the likelihood of survival and recovery of a threatened or endangered species or a segment of its population.

Cropland.—Land under cultivation within the last 24 months including cropland harvested, crop failures, cultivated summer fallow, idle cropland used only for pasture, orchards and land in soil improving crops, but excluding land cultivated in developing improved pasture.

Cumulative impacts.—The impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over time.

Ecological value.—The contribution of wild animals to productive ecosystems.

Ecosystem.—A complete, interacting system of organisms considered together with their environment.

Endangered species.—Any species of animal or plant which is in danger of extinction throughout all or a significant portion of its range. Designated by the U.S. Fish and Wildlife Service.

Estuarine wetlands.—Wetlands found along the U.S. coastline and associated with estuaries or brackish tidal waters.

Existence value.—Valuing an environment regardless of the fact that one may never demand in situ the services it provides.

Exotic.—Foreign; not native.

Flat.—A level landform composed of unconsolidated sediments, usually mud or sand. Flats may be irregularly shaped or elongate and continuous with the shore, whereas bars are generally elongate, parallel to the shore, and separated from the shore by water.

Forest industry lands.—Lands owned by companies or individuals operating wood-using plants.

Forestland.—Land at least 10% stocked by forest trees of any size, or formally having such cover, and not currently developed for other uses.

Forest type.—A category of forest defined by its vegetation (particularly its composition) and/or locality (environmental) factors.

- **Aspen-birch.**—Forests in which aspen, balsam poplar, paper birch, or gray birch, singly or in combination, comprise a plurality of the stocking. (Common associates include maple and balsam fir.)
- **Elm-ash-cottonwood.**—Forest in which elm, ash, or cottonwood, singly or in combination, comprise a plurality of the stocking. (Common associates include willow, sycamore, beech, and maple.)
- **Fir-spruce.**—Forests in which true firs (*Abies* spp.), Engelmann spruce, or Colorado blue spruce, singly or in combination, comprise a plurality of the stocking. (Common associates are mountain hemlock and lodgepole pine.)

Hemlock-Sitka spruce.—Forests in which western hemlock and/or Sitka spruce comprise a plurality of the stocking. (Common associates include Douglas-fir, silver fir, and western redcedar.)

Lodgepole pine.—Forests in which lodgepole pine comprises the stocking. (Common associates include subalpine fir, western white pine, Engelmann spruce, aspen, and larch.)

Maple-beech-birch.—Forests in which 50% or more of the stand is maple, beech, or yellow birch, singly or in combination. (Common associates include hemlock, elm, basswood, and white pine.)

Oak-gum-cypress.—Bottomland forests in which tupelo, blackgum, sweetgum, oaks, or southern cypress, singly or in combination, comprise a plurality of the stocking except where pines comprise 25% to 50% in which case the stand would be classified as oak-pine. (Common associates include cottonwood, willow, ash, elm, hackberry, and maple.)

Oak-hickory.—Forests in which upland oaks or hickory, singly or in combination, comprise a plurality of the stocking except where pines comprise 25% to 50%, in which case the stand would be considered oak-pine. (Common associates include yellow-poplar, elm, maple, and black walnut.)

Oak-pine.—Forest in which hardwoods (usually upland oaks) comprise a plurality of the stocking but in which southern pines comprise 25% to 50% of the stocking. (Common associates include hickory and yellow-poplar.)

Pinyon-juniper.—Forest in which pinyon pine and/or juniper comprise a plurality of the stocking.

Guilds.—A group of species exploiting a common resource base in a similar fashion.

Habitat.—Place where an animal finds the required arrangement of food, cover, and water to meet its biological needs.

Hardwoods.—Dicotyledonous trees, usually broad-leaved and deciduous.

Indicator species.—Any species, groups of species, or species habitat elements selected to focus management attention for the purpose of resource production, population recovery, maintenance of population viability, or ecosystem diversity.

Interspecific competition.—Competition between two or more different species.

Juxtaposition.—The minimum geographic interspersion of habitat requirements that must occur if a habitat is to be barely suitable for a species.

Lacustrine wetlands.—Wetlands and deepwater habitats situated in topographic depressions or dammed river channels. Each area must exceed 20 acres or have depths in excess of 2 meters or have an active wave-formed or bedrock shoreline feature.

Migratory birds.—Birds regularly moving seasonally from one region of climate to another for feeding or breeding.

Minimum viable population (MVP).—The number of individuals required to achieve a specific level of viability.

Nominal dollars.—Value of output in a given period in the prices of that period or in current dollars.

Nonconsumptive use.—Activities which do not result in the death or attempted death of an individual animal.

Nongame.—Native vertebrate species that are not consumptively taken for sport, food, fur, or profit.

Nonpoint source pollution.—Pollution that is diffuse in both origin and in time and points of discharge and depend heavily on weather conditions such as rainstorms or snowmelt. Pollutants can originate on natural source areas or on areas affected by man's activities.

Old-growth.—A stand that is past full maturity and showing decadence; the last state in forest succession.

Palustrine emergent wetlands.—Wetlands dominated by herbaceous vegetation including certain grasses, cattails, rushes, and sedges. Often referred to as "marsh," "wet meadow," "fen," and "inland salt marsh."

Palustrine forested wetlands.—Wetlands dominated by trees taller than 20 feet. They occur mostly in the eastern half of the United States and Alaska and include such types as black spruce bogs, cedar swamps, red maple swamps, and bottomland hardwood forests.

Palustrine nonvegetated wetlands.—Wetlands with little or no vegetation other than aquatic beds.

Palustrine open water wetlands.—Small inland open water bodies which are not part of the lacustrine system.

Palustrine scrub-shrub wetlands.—Wetlands dominated by woody vegetation less than 20 feet tall. Commonly referred to as "bog," "pocosin," "shrub-carr," or "shrub swamp."

Palustrine vegetated wetlands.—Broad categorization of wetlands include emergent, scrub-shrub, and forested wetlands.

Palustrine wetlands.—Interior wetlands which largely consist of freshwater, although inland salt and brackish marshes exist in arid and semiarid areas.

Pasture.—Land which is currently improved for grazing by cultivation, seeding, fertilization, or irrigation.

Pelagic.—Occurring in open water and away from the bottom.

Point source pollution.—Any discernible, confined conduit, including pipes, ditches, channels, sewers, tunnels, vessels, and other floating craft from which pollutants are discharged.

Poletimber stands.—Stands at least 10% stocked with growing stock trees of which half or more is sawtimber and/or poletimber trees with poletimber stocking exceeding that of sawtimber.

Population.—A group of individuals of a single species.

Primary nonresidential.—Trips 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.

Proposed species.—Species officially proposed for listing by the Fish and Wildlife Service or the National Marine Fisheries Service as threatened or endangered. Designated by the U.S. Fish and Wildlife Service.

Range condition.—The departure of a site's vegetation composition from that expected under the climax plant community.

Rangeland.—Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs, including land revegetated naturally or artificially that is managed like native vegetation. Rangelands include natural grasslands, savannas, shrublands, most deserts, tundra, alpine communities, coastal marshes, and wetlands that are less than 10% stocked with forest trees of any size.

Real dollars.—Attempts to isolate changes in physical output in the economy between time periods by valuing all goods in the two periods at the same prices, or in constant dollars.

Recreational value.—Benefits of pleasure, adventure, and enhanced physical and mental health from outdoor activities involving the pursuit or sometimes accidental enjoyment of wildlife.

Riparian.—The abiotic and biotic components found within the area defined by the banks and adjacent areas of water bodies, water courses, and seeps and springs the waters of which provide soil moisture sufficiently in excess of that otherwise available locally so as to provide a more moist habitat than that of contiguous flood plains, and uplands.

Saplings.—Live trees of commercial species 1.0 inch to 5.0 inches in diameter at breast height and of good form and vigor.

Sawtimber stands.—Stands at least 10% occupied with growing stock trees, with half or more of total stocking in sawtimber or poletimber trees, and with sawtimber stocking at least equal to poletimber stocking.

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 such as camping, driving, or boating.

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

Seedlings.—Established live trees of commercial species less than 1.0 inch in diameter at breast height and of good form and vigor.

Seedling and sapling stands.—Stands at least 10% occupied with growing stock trees of which more than half of the stocking is saplings and/or seedlings.

Sensitive species.—Species which have been identified by a Forest Service regional forester for which population viability is a concern.

Seral.—Series of stages that follow one another in a usually predictable sequence of ecological succession. Each seral stage is a community with its own characteristics.

Small game.—Smaller-sized wild animals such as rabbits, quail, grouse, and pheasants which are hunted, or potentially hunted, for sport or food. This does not include waterfowl, other migratory birds, and animals generally considered to be pests or varmints.

Snag.—A standing dead tree from which the leaves and most of the limbs have fallen and is more than 20 feet high. Dead trees less than 20 feet are called stubs.

Softwoods.—Coniferous trees, usually evergreen, having needles or scalelike leaves.

Stand-size class.—Classification of forestland based on the predominant size of timber present, that is, sawtimber, poletimber, or seedlings and saplings.

Succession.—Progressive development of a biotic community involving replacement of species and modification of the physical environment until a community with a relatively stable species composition is reached.

Threatened species.—Any species of animal or plant which is likely to become an endangered species within the foreseeable future throughout all or a portion of its range.

User-day.—Any combination of 12 hour days such as one person participating in an activity for 12 hours or 12 persons participating in an activity for 1 hour each.

Urban areas.—Areas within the legal boundaries of cities and towns; suburban areas developed for residential, industrial, or recreational purposes; school yards, cemeteries, roads, railroads, airports, beaches, powerlines, and other rights-of-way, or other land not included in any other specified land use class.

Viability.—The state of being capable of living, growing, or developing.

Warmwater fishing.—Includes largemouth and smallmouth bass, panfish such as bluegill and crappie, walleye, northern pike, muskie, catfish, bullheads, etc.

Wetlands.—Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil, or (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of the year.

Wilderness.—An area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which (1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticed; (2) has outstanding opportunities for solitude or a primitive and unoccupied type of recreation; (3) has at least 5,000 acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition, and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value (from Wilderness Act 1964).

APPENDIX B: LATIN NAMES

BIRDS

Bittern, American	*Botaurus lentiginosus*
Bittern, Least	*Ixobrychus exilis*
Bluebird, Eastern	*Sialia sialis*
Bobolink	*Dolichonyx oryzivorus*
Bobwhite, Northern	*Colinus virginianus*
Bobwhite, Masked	*Colinus virginianus ridgwayi*
Bunting, Lark	*Calamospiza melanocorys*
Bunting, Lazuli	*Passerina amoena*
Bunting, Painted	*Passerina ciris*
Canvasback	*Aythya valisineria*
Caracara, Crested	*Caracara plancus*
Cardinal, Northern	*Cardinalis cardinalis*
Chat, Yellow-breasted	*Icteria virens*
Chickadee, Boreal	*Parus hudsonicus*
Chukar	*Alectoris chukar*
Condor, California	*Gymnogyps californianus*
Cormorant	*Phalacrocorax* spp.
Cowbird, Brown-headed	*Molothrus ater*
Crane, Whooping	*Grus americana*
Curlew, Long-billed	*Numenius americanus*
Dickcissel	*Spiza americana*
Dove, Common-Ground	*Columbina passerina*
Dove, Mourning	*Zenaida macroura*
Dove, Rock	*Columba livia*
Duck, American Black	*Anas rubripes*
Duck, Wood	*Aix sponsa*
Eagle, Bald	*Haliaeetus leucocephalus*
Eagle, Southern Bald	*Haliaeetus leucocephalus leucocephalus*
Egret	*Ardeidae*
Egret, Reddish	*Egretta rufescens*
Falcon, Northern aplomado	*Falco femoralis septentrionalis*
Falcon, Peregrine	*Falco peregrinus*
Falcon, Prairie	*Falco mexicanus*
Finch, House	*Carpodacus mexicanus*
Flicker, Northern	*Colaptes auratus*
Flycatcher, Alder	*Empidonax alnorum*
Flycatcher, Olive-sided	*Contopus borealis*
Flycatcher, Scissor-tailed	*Tyrannus forficatus*
Flycatcher, Willow	*Empidonax traillii*
Gadwall	*Anas strepera*
Goldfinch, American	*Carduelis tristis*
Goose, Aleutian Canada	*Branta canadensis leucapareia*
Goose, Cackling	*Branta canadensis minima*
Goose, Dusky Canada	*Branta canadensis occidentalis*
Grosbeak, Black-headed	*Pheucticus melanocephalus*
Grouse, Blue	*Dendragapus obscurus*
Grouse, Ruffed	*Bonasa umbellus*
Grouse, Sage	*Centrocercus urophasianus*
Grouse, Sharp-tailed	*Tympanuchus phasianellus*
Grouse, Spruce	*Dendragapus canadensis*
Gull, Franklin's	*Larus pipixcan*
Harrier, Northern	*Circus cyaneus*
Hawk, Cooper's	*Accipiter cooperii*
Hawk, Ferruginous	*Buteo regalis*
Hawk, Sharp-shinned	*Accipiter striatus*
Heron	*Ardeidae*
Heron, Little blue	*Egretta caerulea*
Ibis	*Threskiornithidae*

BIRDS

Jay, Blue	*Cyanocitta cristata*
Jay, Gray	*Perisoreus canadensis*
Junco, Dark-eyed	*Junco hyemalis*
Kingfisher, Belted	*Ceryle alcyon*
Kinglet, Ruby-crowned	*Regulus calendula*
Kite, Snail	*Rostrhamus sociabilis*
Lark, Horned	*Eremophila alpestris*
Mallard	*Anas platyrhynchos*
Meadowlark, Eastern	*Sturnella magna*
Meadowlark, Western	*Sturnella neglecta*
Merlin	*Falco columbarius*
Mockingbird, Northern	*Mimus polyglottos*
Oriole, Orchard	*Icterus spurius*
Osprey	*Pandion haliaetus*
Owl, Burrowing	*Athene cunicularia*
Owl, Great Horned	*Bubo virginianus*
Owl, Screech	*Otus* spp.
Owl, Spotted	*Strix occidentalis*
Parrot, Thick-billed	*Rhynchopsitta pachyrhyncha*
Parrot, Puerto Rican	*Amazona vittata*
Pelican, Brown	*Pelecanus occidentalis*
Pheasant, Ring-necked	*Phasianus colchicus*
Phoebe, Eastern	*Sayornis phoebe*
Pintail, Northern	*Anas acuta*
Plover, Snowy	*Charadrius alexandrinus*
Prairie-Chicken, Greater	*Tympanuchus cupido*
Ptarmigan	*Lagopus* spp.
Quail, California	*Callipepla californica*
Quail, Gambel's	*Callipepla gambelii*
Quail, Mountain	*Oreortyx pictus*
Quail, Scaled	*Callipepla squamata*
Rail, Black	*Laterallus jamaicensis*
Redhead	*Aythya americana*
Robin, American	*Turdus migratorius*
Sandpiper, Upland	*Bartramia longicauda*
Sapsucker, Yellow-bellied	*Sphyrapicus varius*
Scaup	*Aythya* spp.
Shoveler, Northern	*Anas clypeata*
Shrike, Loggerhead	*Lanius ludovicianus*
Snipe, Common	*Gallinago gallinago*
Sparrow, Baird's	*Ammodramus bairdii*
Sparrow, Black-throated	*Amphispiza bilineata*
Sparrow, Chipping	*Spizella passerina*
Sparrow, Field	*Spizella pusilla*
Sparrow, Grasshopper	*Ammodramus savannarum*
Sparrow, Henslow's	*Ammodramus henslowii*
Sparrow, House	*Passer domesticus*
Sparrow, Lark	*Chondestes grammacus*
Sparrow, LeConte's	*Ammodramus leconteii*
Sparrow, Savannah	*Passerculus sandwichensis*
Sparrow, Song	*Melospiza melodia*
Sparrow, Vesper	*Pooecetes gramineus*
Sparrow, White-throated	*Zonotrichia albicollis*
Starling, European	*Sturnus vulgaris*
Swallow, Barn	*Hirundo rustica*
Swallow, Cliff	*Hirundo pyrrhonota*
Swan, Trumpeter	*Cygnus buccinator*
Tanager, Western	*Piranga ludoviciana*
Teal, Blue-winged	*Anas discors*
Teal, Green-winged	*Anas crecca*

BIRDS

Tern, Gull-billed	*Sterna nilotica*
Tern, Roseate	*Sterna dougallii*
Thrasher, Curve-billed	*Toxostoma curvirostre*
Thrush, Wood	*Hylocichla mustelina*
Titmouse, Tufted	*Parus bicolor*
Towhee, Rufous-sided	*Pipilo erythrophthalmus*
Turkey, Wild	*Meleagris gallopavo*
Veery	*Catharus fuscescens*
Verdin	*Auriparus flaviceps*
Vireo, Bell's	*Vireo bellii*
Vireo, Red-eyed	*Vireo olivaceus*
Vireo, Warbling	*Vireo gilvus*
Warbler, Bachman's	*Vermivora bachmanii*
Warbler, Blue-winged	*Vermivora pinus*
Warbler, Golden-cheeked	*Dendroica chrysoparia*
Warbler, Kirtland's	*Dendroica kirtlandii*
Warbler, Nashville	*Vermivora ruficapilla*
Warbler, Pine	*Dendroica pinus*
Warbler, Prairie	*Dendroica discolor*
Warbler, Prothonotary	*Protonotaria citrea*
Warbler, Tennessee	*Vermivora peregrina*
Warbler, Worm-eating	*Helmitheros vermivorus*
Wigeon, American	*Mareca americana*
Woodcock, American	*Scolopax minor*
Woodpecker, Ivory-billed	*Campephilus principalis*
Woodpecker, Pileated	*Dryocopus pileatus*
Woodpecker, Red-cockaded	*Picoides borealis*
Wood-Pewee	*Contopus* spp.
Wren, Bewick's	*Thryomanes bewickii*
Wren, Cactus	*Campylorhynchus brunneicapillus*
Wren, Carolina	*Thryothorus ludovicianus*
Wren, Sedge	*Cistothorus platensis*
Wren, Winter	*Troglodytes troglodytes*

MAMMALS

Bat, Gray	*Myotis grisescens*
Bat, Indiana	*Myotis sodalis*
Bat, Virginia big-eared	*Plecotus townsendii virginianus*
Bear, Black	*Ursus americanus*
Bear, Grizzly	*Ursus arctos*
Beaver	*Castor canadensis*
Bison also Buffalo	*Bison bison*
Boar, also European wild	*Sus scrofa*
Bobcat	*Lynx rufus*
Caribou, Woodland	*Rangifer tarandus caribou*
Cottontail	*Sylvilagus* spp.
Coyote	*Canis latrans*
Deer	*Odocoileus* spp.
Deer, Black-tailed	*Odocoileus hemionus columbianus*
Deer, Columbian white-tailed	*Odocoileus virginianus columbianus*
Deer, Key	*Odocoileus virginianus clavium*
Deer, Mule	*Odocoileus hemionus*
Deer, Desert Mule	*Odocoileus hemionus crooki*
Deer, Sitka black-tailed	*Odocoileus hemionus sitkensis*
Deer, White-tailed	*Odocoileus virginianus*
Elk	*Cervus elaphus*
Ferret, Black-footed	*Mustela nigripes*
Fox, Gray	*Urocyon cinereoargenteus*

MAMMALS

Fox, Northern Swift	*Vulpes velox hebes*
Fox, Red	*Vulpes vulpes*
Fox, San Joaquin Kit	*Vulpes macrotis mutica*
Goat, Mountain	*Oreamnos americanus*
Gopher, Pocket	*Geomyidae*
Hare	*Lepus* spp.
Jackrabbit	*Lepus* spp.
Jackrabbit, Black-tailed	*Lepus californicus*
Jackrabbit, White-tailed	*Lepus townsendii*
Jaguarundi	*Felis yagouaroundi*
Javelina	*Dicotyles tajacu*
Lion, Mountain	*Felis concolor*
Lynx	*Lynx candensis*
Manatee	*Trichechus manatus*
Marmot, Yellow-bellied	*Marmota flaviventris*
Mink	*Mustela vison*
Moose	*Alces alces*
Mouse, House	*Mus musculus*
Muskrat	*Ondatra zibethicus*
Nutria	*Myocastor coypus*
Ocelot	*Felis pardalis*
Opossum, Virginia	*Didelphus virginiana*
Otter, Sea	*Enhydra lutris*
Panther, Florida	*Felis concolor coryi*
Peccary, Collared	*Tayassu tajacu*
Pig	*Sus scrofa*
Pika	*Ochotona princeps*
Prairie Dog	*Cynomys* spp.
Prairie Dog, Utah	*Cynomys parvidens*
Pronghorn	*Antelocapra americana*
Pronghorn, Sonoran	*Antelocapra americana sonoriensis*
Raccoon	*Procyon lotor*
Rat, Giant Kangaroo	*Dipodomys ingens*
Rat, Kangaroo	*Dipodomys* spp.
Rat, Norway	*Rattus norvegicus*
Ringtail	*Bassariscus astutus*
Sheep, Bighorn	*Ovis canadensis*
Sheep, Dall	*Ovis dalli*
Sheep, Desert bighorn	*Ovis canadensis merriam*
Skunk	*Mustelidae*
Squirrel	*Sciurus* spp.
Squirrel, Fox	*Sciurus niger*
Squirrel, Gray	*Sciurus carolinensis*
Squirrel, Northern flying	*Glaucomys sabrinus*
Wolf, Gray	*Canis lupus*
Wolf, Eastern Timber	*Canis lupus lycaon*
Wolf, Red	*Canis rufus*
Wolf, Texas red	*Canis rufus rufus*
Wolverine	*Gulo gulo*

FISH

Alewife	*Alosa pseudoharengus*
Bass, Largemouth	*Micropterus salmoides*
Bass, Smallmouth	*Micropterus dolomieui*
Bass, Striped	*Morone saxatilis*
Bass, White	*Morone chrysops*
Buffalo	*Ictiobus* spp.
Bullhead	*Ictalurus* spp.
Carp	*Cyprinus carpio*
Catfish	*Ictalurus* spp.

FISH	
Catfish, Walking	*Clarias batrachus*
Chubs	*Coregonus* spp.
Crappie	*Pomixis annularis*
	Pomixis nigromaculatus
Gar	*Lepisosteus* spp.
Paddlefish	*Polyodon spathula*
Perch, White	*Morone americana*
Perch, Yellow	*Perca flavescens*
Pickerel	*Esox* spp.
Pike	*Esox* spp.
Salmon, Chinook	*Oncorhynchus tshawytscha*
Salmon, Chum	*Oncorhynchus keta*
Salmon, Coho	*Oncorhynchus kisutch*
Salmon, Pink	*Oncorhynchus gorbuscha*
Salmon, Sockeye	*Oncorhynchus nerka*
Sauger	*Stizostedion canadense*
Shad	*Alosa sapidissima*
Shad, Gizzard	*Dorosoma cepedianum*
Sheepshead	*Aplodinotus grunniens*
Smelt	*Osmeridae*
Suckers	*Catostomidae*
Trout, Greenback cutthroat	*Salmo clarki stomias*
Trout, Lahontan cutthroat	*Salmo clarki henshawi*
Trout, Steelhead	*Salmo gairdneri*
Tullibee	*Coregonus* spp.
Walleye	*Stizostedion vitreum*
Whitefish	*Coregonus* spp.
REPTILES	
Crocodile, American	*Crocodylus acutus*
Hawksbill	*Eretmochelys imbricata*
Tortoise, Desert	*Gopherus agassizii*
Turtle, Ridley Sea	*Lepidochelys* spp.
Rattlesnake, New Mexico ridge-nosed	*Crotalus willardi obscurus*
CRUSTACEANS	
Crab, Blue	*Callinectes* spp.
Crab, King	*Paralithodes camschatica*
	Paralithodes platypus
	Lithodes acquispina
Crab, Snow	*Chionoecetes bairdi*
PLANTS[1]	
Alder, Red	*Alnus rubra*
Aspen	*Populus* spp.
Beech	*Fagus grandifolia*
Creosote	*Larrea tridentata*
Elm	*Ulmus* spp.
Fir, Douglas	*Pseudotsuga menziesii*
Larch	*Larix* spp.
Maple	*Acer* spp.
Maple, Red	*Acer rubrum*
Mesquite	*Prosopis juliflora*
Pine, Lodgepole	*Pinus contorta*
Pine, Ponderosa	*Pinus ponderosa*
Pine, Western white	*Pinus monticola*
Redwood	*Sequoia sempervirens*
Sweetgum	*Liquidambar styraciflua*
Sycamore	*Platanus* spp.
Tupelo	*Nyssa* spp.

[1]*For a complete list of plants associated with forage and range ecosystems, refer to Joyce (in press).*

APPENDIX C: TRENDS IN WILDLIFE AND FISH POPULATIONS, USE, AND HARVEST ON NATIONAL FOREST SYSTEM LANDS

Table C-1.—Trends in selected big game populations on NFS lands in the North.

Year	Moose	Deer	Gray wolf	Black bear	Turkey
1965	3,920	467,000	900	11,800	38,200
1966	4,100	414,000	620	11,000	20,000
1967	4,300	442,000	800	10,000	21,000
1968	4,200	396,000	360	8,100	24,000
1969	4,000	363,000	360	9,100	29,000
1970	3,800	338,000	450	8,800	18,000
1971	3,800	304,000	450	7,600	21,000
1972	4,800	297,000	520	8,300	31,000
1973	5,100	281,000	480	8,900	29,000
1974	5,200	298,000	480	8,900	28,000
1975	2,200	312,000	420	8,900	29,000
1976	2,500	290,000	600	9,400	30,000
1977	3,000	323,000	580	8,600	33,000
1978	2,710	314,114	574	9,547	42,656
1979	3,320	307,985	322	16,659	44,933
1980	3,245	315,109	378	9,226	50,772
1981	3,780	320,512	347	10,820	50,017
1982	5,485	317,962	348	10,070	39,384
1983	6,978	318,042	348	12,097	39,438
1984	6,589	326,619	345	11,800	34,319

Source: USDA Forest Service (1965–1977, 1978–1985).

Table C-2.—Trends in selected big game populations on NFS lands in the South.

Year	Deer	Turkey	Black bear	Wild (feral) pig
1965	248,000	41,800	3,100	1,300
1966	265,000	52,000	3,800	1,400
1967	277,000	55,000	4,000	1,600
1968	289,000	57,000	4,000	1,600
1969	280,000	59,000	3,400	1,400
1970	284,000	69,000	2,700	860
1971	285,000	74,000	3,100	1,500
1972	303,000	85,000	2,800	2,500
1973	286,000	81,000	2,900	2,400
1974	307,000	85,000	2,500	2,600
1975	306,000	77,000	2,600	2,000
1976	309,000	82,000	2,600	2,200
1977	301,000	86,000	2,800	2,500
1978	303,060	95,382	2,853	2,282
1979	289,280	104,662	3,230	1,522
1980	298,330	111,185	4,015	1,710
1981	279,886	115,866	3,958	1,525
1982	265,164	122,730	2,432	1,684
1983	275,526	124,133	3,027	1,954
1984	280,504	123,187	3,722	2,415

Source: USDA Forest Service (1965–1977, 1978–1985).

Table C-3.—Trends in selected big game populations on NFS lands in the Rocky Mountains.

Year	Moose	Pronghorn	Elk	Peccary	Mountain lion	Turkey	Deer	Mountain goat	Bighorn sheep	Caribou	Bear
1965	12,250	47,100	268,000	24,000		75,400	1,742,100	9,990	11,533	140	44,800
1966	12,400	42,700	266,000	27,000		84,400	1,609,200	10,330	11,343	140	46,105
1967	12,990	40,600	280,000	28,000		81,800	1,642,900	10,490	12,237	100	46,200
1968	12,770	34,900	263,000	22,000		69,000	1,617,600	9,670	10,825	115	44,125
1969	11,450	34,900	270,000	24,000		69,000	1,612,100	9,670	10,825	85	43,930
1970	13,640	32,900	274,000	21,000		66,900	1,595,900	9,720	11,000	85	43,630
1971	13,400	34,900	275,000	21,000		65,300	1,560,900	9,360	11,190	90	43,560
1972	14,020	37,800	276,000	21,000		53,600	1,518,900	9,340	11,480	80	45,390
1973	13,970	34,500	272,300	20,000	5,000	55,200	1,184,700	8,910	11,680	70	43,591
1974	14,820	38,900	282,000	21,000	5,540	56,100	1,352,200	8,640	11,870	60	43,570
1975	15,300	41,500	292,000	21,000	5,390	54,800	1,219,950	8,260	12,900	45	43,025
1976	15,770	39,900	293,000	21,000	5,670	52,400	1,102,930	7,280	13,130	45	43,415
1977	15,700	44,800	323,000	21,000	6,030	52,600	1,120,680	7,900	13,790	40	42,220
1978	16,027	54,789	307,989	20,183	6,288	54,617	1,118,451	8,242	14,334	41	40,840
1979	16,091	43,332	302,443	19,273	6,197	55,205	1,097,746	7,592	15,016	30	41,670
1980	16,640	43,379	298,404	21,277	6,452	57,702	1,099,797	8,067	15,757	30	42,835
1981	16,504	42,747	332,573	22,187	6,776	57,456	1,198,656	8,086	16,936	25	43,931
1982	15,987	45,275	346,783	23,746	7,027	59,105	1,289,533	7,713	17,512	15	41,247
1983	15,722	54,464	362,593	24,701	7,320	61,363	1,238,384	7,650	17,586	20	42,157
1984	15,566	52,704	371,759	25,783	7,608	65,689	1,197,102	7,915	17,658	17	44,552

Source: USDA Forest Service (1965–1977, 1978–1985).

Table C-4.—Trends in selected big game populations on NFS lands in the Pacific Coast.

Year	Moose	Pronghorn	Gray wolf	Elk	Turkey	Deer	Mountain goat	Bighorn sheep	Caribou	Bear
1965	4,515	3,000	1,900	92,820	2,710	1,564,900	21,800	2,015	6	55,301
1966	4,720	3,100	1,800	91,050	3,600	1,511,900	20,400	2,390	10	56,300
1967	3,920	3,000	2,000	94,250	3,400	1,633,100	20,100	3,460	50	54,303
1968	5,020	3,000	2,300	87,540	4,200	1,535,700	21,300	3,500	60	53,404
1969	5,316	3,400	2,100	90,400	4,600	1,436,300	20,800	2,980	75	51,102
1970	6,415	4,000	2,102	87,900	5,000	1,392,000	20,900	2,715	40	52,102
1971	5,615	4,200	2,100	90,500	4,900	1,316,000	20,200	2,440	170	50,002
1972	6,015	4,100	1,400	92,100	5,200	1,172,900	20,000	2,590	200	47,002
1973	5,620	4,700	1,004	93,600	5,300	1,045,600	20,000	2,630	280	43,620
1974	5,400	3,600	804	103,700	4,900	1,035,000	19,000	2,590	300	43,912
1975	4,618	4,300	800	104,700	4,200	972,000	18,100	2,560	355	46,003
1976	4,518	4,700	750	107,900	4,400	999,000	15,900	2,630	355	46,702
1977	4,630	5,300	702	107,190	3,900	980,000	16,300	3,310	355	45,004
1978	4,586	5,181	700	106,931	6,318	1,042,222	16,387	3,412	355	45,289
1979	4,492	5,320	825	102,864	5,773	972,035	13,929	3,236	355	48,149
1980	4,901	5,457	825	96,599	6,514	955,724	13,760	3,279	255	47,052
1981	4,853	5,482	842	95,298	6,798	991,747	14,179	2,937	255	46,956
1982	5,298	5,506	867	100,817	6,934	1,031,711	13,711	3,663	503	48,591
1983	4,925	5,217	767	99,605	7,386	981,992	15,651	3,762	6	40,804
1984	4,091	5,376	817	93,853	8,144	933,556	17,237	2,744	306	46,406

Source: USDA Forest Service (1965–1977, 1978–1985).

Table C-5.—National and regional trends in nonconsumptive user days on NFS lands.

Year	National	North	Rocky South	Pacific Mountain	Coast
1980	1,342,500	120,000	150,800	525,000	546,700
1981	1,550,770	127,100	205,600	633,600	584,400
1982	1,474,500	114,300	194,300	591,900	574,000
1983	1,277,400	115,700	179,900	537,100	444,700
1984	1,277,700	106,400	200,000	536,500	434,800

Source: USDA Forest Service (1980–1985).

Table C-6.—Trends in migratory bird user-days on NFS lands by assessment region.

Year	National	North	South	Rocky Mountain	Pacific Coast
1966	649,000	199,000	113,000	161,000	176,000
1967	614,000	188,000	113,000	158,000	155,000
1968	573,000	188,000	94,000	136,000	155,000
1969	574,000	201,000	94,000	127,000	152,000
1970	585,000	198,000	86,000	129,000	172,000
1971	621,000	232,000	90,000	147,000	152,000
1972	675,000	231,000	96,000	173,000	175,000
1973	657,000	229,000	92,000	163,000	173,000
1974	769,500	242,200	122,800	194,400	210,100
1975	775,300	276,400	117,400	183,100	198,400
1976	757,700	272,300	112,800	160,900	211,700
1977	813,900	232,600	111,700	222,300	247,300
1978	818,100	242,000	111,700	203,500	260,900
1979	801,500	241,800	118,000	209,800	231,900
1980	723,100	226,500	117,100	205,800	173,700
1981	796,700	234,500	123,000	222,200	217,000
1982	757,600	201,800	128,000	215,800	212,000
1983	613,700	198,600	122,700	197,200	95,200
1984	578,800	188,300	100,200	196,300	94,000

Source: USDA Forest Service (1965–1977, 1978–1985).

Table C-7.—Big game user-days on national forests by assessment region.

Year	National	North	South	Rocky Mountain	Pacific Coast
1966	9,916,000	963,000	1,871,000	4,007,000	3,075,000
1967	9,253,000	1,059,000	1,400,000	3,831,000	2,963,000
1968	9,449,000	1,083,000	1,535,000	3,725,000	3,106,000
1969	10,034,000	1,072,000	1,593,000	4,043,000	3,326,000
1970	10,075,000	1,123,000	1,550,000	4,072,000	3,330,000
1971	10,032,000	1,030,000	1,747,000	4,106,000	3,149,000
1972	9,076,000	781,000	1,818,000	3,787,000	2,690,000
1973	9,373,000	889,000	1,836,000	4,012,000	2,636,000
1974	9,742,500	917,100	1,818,000	4,105,200	2,902,200
1975	9,813,400	1,014,400	1,877,600	4,101,400	2,820,000
1976	9,415,300	1,129,300	1,855,500	3,677,200	2,753,300
1977	9,738,000	1,236,500	1,951,900	3,961,200	2,588,400
1978	9,632,700	1,223,500	1,934,200	3,673,000	2,802,000
1979	10,186,400	1,218,500	2,023,000	4,138,900	2,806,000
1980	10,445,800	1,333,400	1,960,600	4,111,600	3,040,200
1981	10,875,200	1,354,400	2,091,000	4,584,600	2,845,200
1982	10,875,900	1,296,500	2,120,800	4,520,300	2,938,300
1983	11,148,100	1,345,000	2,130,100	4,697,900	2,975,100
1984	10,612,000	1,222,500	2,006,600	4,561,800	2,821,100

Source: USDA Forest Service (1966–1984).

Table C-8.—Trends in small game user-days on the national forests by assessment region.

Year	National	North	South	Rocky Mountain	Pacific Coast
1965	3,891,000	1,075,000	1,202,000	546,000	350,000
1966	3,535,000	924,000	1,405,000	706,000	500,000
1967	3,252,000	866,000	1,271,000	620,000	495,000
1968	3,227,000	792,000	1,343,000	590,000	501,800
1969	3,436,000	897,000	1,423,000	594,000	522,000
1970	3,488,000	880,000	1,480,000	617,000	511,000
1971	3,646,000	920,000	1,575,000	635,000	516,000
1972	3,378,000	768,000	1,592,000	593,000	425,000
1973	3,713,000	948,000	1,664,000	638,000	469,000
1974	3,719,000	956,000	1,593,500	678,100	491,400
1975	3,834,100	1,015,200	1,635,800	686,500	496,600
1976	3,899,400	1,090,400	1,612,500	664,300	532,200
1977	3,965,100	1,031,600	1,690,900	746,100	496,500
1978	4,195,400	1,042,300	1,729,100	807,500	616,500
1979	4,340,000	1,007,500	1,792,800	866,000	673,700
1980	4,711,000	1,279,400	1,925,300	914,100	592,200
1981	4,741,100	1,180,700	1,906,300	1,044,600	609,500
1982	4,601,700	1,113,700	1,807,100	1,019,600	661,300
1983	4,367,300	1,101,100	1,757,100	951,000	557,500
1984	4,056,500	984,200	1,690,300	882,500	498,700

Source: USDA Forest Service (1965–1977, 1978–1985).

Table C-9.—Warm- and coldwater fishing user-days on national forests, by region.

Year	National		North		South		Rocky Mountain		Pacific Coast	
	Warm	Cold	Warm	Cold	Warm	Cold	Warm	Cold	Warm	Cold
1967	2,457,000	12,248,000	904,000	686,000	1,154,000	596,000	291,000	4,973,000	108,000	5,993,000
1968	2,385,000	11,530,000	807,000	609,000	1,196,000	541,000	254,000	4,806,000	128,000	5,574,000
1969	2,862,000	11,554,000	1,141,000	662,000	1,275,000	571,000	311,000	4,982,000	135,000	5,339,000
1970	3,019,000	11,751,000	1,294,000	579,000	1,281,000	595,000	306,000	4,979,000	138,000	5,598,000
1971	3,188,000	11,917,000	1,353,000	646,000	1,334,000	582,000	230,000	5,156,000	271,000	5,533,000
1972	3,102,000	11,600,000	1,072,000	623,000	1,391,000	619,000	243,000	5,205,000	396,000	5,153,000
1973	3,314,000	12,000,000	1,125,000	619,000	1,433,000	672,000	360,000	5,444,000	396,000	5,265,000
1974	3,568,700	12,021,300	1,404,000	690,600	1,422,600	776,600	337,900	5,338,900	404,200	5,218,200
1975	4,432,200	11,783,800	1,601,800	661,100	2,095,800	741,800	373,100	5,196,800	361,500	5,184,100
1976	4,152,800	11,772,800	1,352,400	705,400	2,053,600	735,600	389,400	5,186,400	357,400	5,145,400
1977	3,894,200	11,834,700	1,335,300	680,200	2,194,900	690,600	226,000	6,123,100	138,000	4,340,800
1978	4,118,500	12,059,200	1,384,500	698,600	2,181,800	723,200	265,600	5,870,400	286,600	4,767,000
1979	3,937,700	11,649,500	1,231,400	625,300	2,126,200	799,800	293,400	5,959,100	286,700	4,825,300
1980	4,328,800	12,358,600	1,330,500	622,100	2,327,700	823,100	331,500	6,027,500	339,100	4,885,900
1981	4,096,400	12,402,300	1,389,200	640,400	2,047,900	798,300	326,900	6,215,200	332,400	4,748,400
1982	4,089,400	11,989,100	1,387,200	664,100	2,034,800	774,500	324,900	5,898,300	342,500	4,561,200
1983	4,119,400	11,402,600	1,428,100	658,000	2,010,900	764,600	282,800	5,371,700	397,600	4,248,300
1984	4,046,700	11,125,600	1,327,600	639,500	1,966,900	787,400	351,100	5,365,800	401,100	4,332,900

Source: USDA Forest Service (1965–1977, 1978–1985).

Table C-10.—Harvest trends for selected big game species on NFS lands in the North.

Year	Deer	Turkey	Black bear
1965	62,000	450	760
1966	66,000	2,100	900
1967	60,000	1,700	970
1968	68,000	2,100	650
1969	62,000	2,100	890
1970	54,000	2,900	850
1971	41,000	3,100	760
1972	29,000	3,600	770
1973	37,000	3,300	730
1974	39,000	4,200	650
1975	43,000	3,600	670
1976	44,000	4,600	790
1977	45,000	4,100	760
1978	51,597	5,217	1,147
1979	53,900	4,895	1,268
1980	54,329	5,596	1,262
1981	54,484	7,675	1,278
1982	60,607	7,444	1,356
1983	56,564	7,377	1,255
1984	61,348	4,291	1,401

Source: USDA Forest Service (1965–1977, 1978–1985).

Table C-11.—Harvest trends for selected game species on NFS lands in the South.

Year	Deer	Turkey	Black bear
1965	20,000	2,300	230
1966	32,000	4,800	370
1967	32,000	5,500	420
1968	34,000	4,700	500
1969	32,000	5,800	560
1970	33,000	6,800	310
1971	36,000	7,200	370
1972	36,000	6,600	310
1973	34,000	6,000	300
1974	36,000	6,900	300
1975	39,000	5,400	210
1976	41,000	6,400	230
1977	41,000	6,800	330
1978	39,739	7,969	264
1979	39,705	9,552	310
1980	41,908	11,241	359
1981	41,859	11,605	310
1982	45,728	10,816	282
1983	49,120	11,569	364
1984	48,788	10,432	450

Source: USDA Forest Service (1965–1977, 1978–1985).

Table C-12.—Harvest trends in selected big game species on NFS lands in the Rocky Mountains.

Year	Moose	Pronghorn	Elk	Pecarry	Mountain lion	Turkey	Deer	Mountain goat	Bighorn sheep	Black bear
1965	1,450	10,670	50,100	2,300		6,450	295,470	624	380	4,849
1966	1,420	7,900	47,000	2,900		6,805	342,230	604	365	4,734
1967	1,530	7,490	50,400	3,800		6,380	294,520	588	316	5,103
1968	1,610	7,340	50,800	4,600		5,650	309,000	620	362	4,730
1969	1,590	6,930	57,800	3,000		4,910	325,860	615	370	5,301
1970	1,380	5,940	61,500	3,400		3,886	300,570	600	286	4,616
1971	1,570	6,290	58,400	3,000		4,170	298,160	550	380	4,453
1972	1,725	6,260	50,800	2,600		5,500	254,480	517	290	4,451
1973	1,911	6,480	53,500	2,300	522	3,660	243,600	480	298	4,178
1974	2,050	6,840	63,600	2,500	579	4,985	228,990	540	357	4,056
1975	1,950	7,480	12,000	2,300	680	4,415	191,450	460	80	918
1976	2,050	8,270	63,600	2,500	700	6,030	159,245	380	409	4,621
1977	1,740	9,070	55,400	3,000	660	4,670	140,540	420	399	4,362
1978	2,036	9,790	60,753	2,148	691	4,724	170,753	409	402	4,406
1979	1,815	7,852	58,194	2,595	652	5,335	177,301	376	448	4,341
1980	1,840	5,724	60,108	2,608	649	6,126	169,118	394	505	4,300
1981	1,663	5,814	58,204	3,742	619	6,024	177,557	361	505	4,655
1982	1,716	7,252	64,985	3,506	741	6,975	203,055	347	528	4,003
1983	1,609	9,307	65,824	3,865	936	7,406	191,309	263	596	3,995
1984	1,396	10,716	64,172	3,671	862	7,038	212,130	280	682	4,377

Source: USDA Forest Service (1965–1977, 1978–1985).

Table C-13.—Harvest trends in selected big game species on NFS lands in the Pacific Coast.

Year	Moose	Pronghorn	Gray wolf	Elk	Mountain lion	Turkey	Deer	Mountain goat	Bighorn sheep	Caribou	Black bear
1965	760	90	280	18,060		0	133,420	800	10	0	3,560
1966	470	110	230	14,300		36	109,200	660	25		4,030
1967	340	90	240	16,120		30	141,280	880	40	0	3,901
1968	470	110	290	13,120		90	126,680	770	38	0	3,510
1969	730	90	230	13,100		80	143,500	850	56	0	3,430
1970	840	120	240	13,160		40	105,800	900	57	0	3,660
1971	750	130	250	15,090		60	96,820	800	79	0	2,690
1972	720	220	210	11,040		85	77,290	690	24	0	3,040
1973	500	300	92	11,915	143	235	61,560	920	23	6	3,160
1974	410	270	65	14,018	73	80	72,060	770	25	12	3,020
1975	210	220	100	15,031	121	90	65,000	800	25	40	3,280
1976	161	185	120	17,025	102	90	69,700	640	12	85	3,170
1977	161	370	80	15,030	120	100	63,100	610	13	80	3,090
1978	217	329	77	18,923	146	110	97,246	550	18	27	2,971
1979	327	263	110	18,077	169	122	83,085	605	57	30	3,117
1980	115	284	81	16,689	152	127	77,507	639	25	33	3,108
1981	295	274	88	21,288	138	177	81,526	537	28	38	3,086
1982	371	296	98	18,619	167	189	91,887	510	26	42	2,975
1983	375	305	87	18,188	127	189	68,621	638	32	0	2,795
1984	365	315	147	15,772	111	186	68,590	620	38	42	2,740

Source: USDA Forest Service (1965–1977, 1978–1985).

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