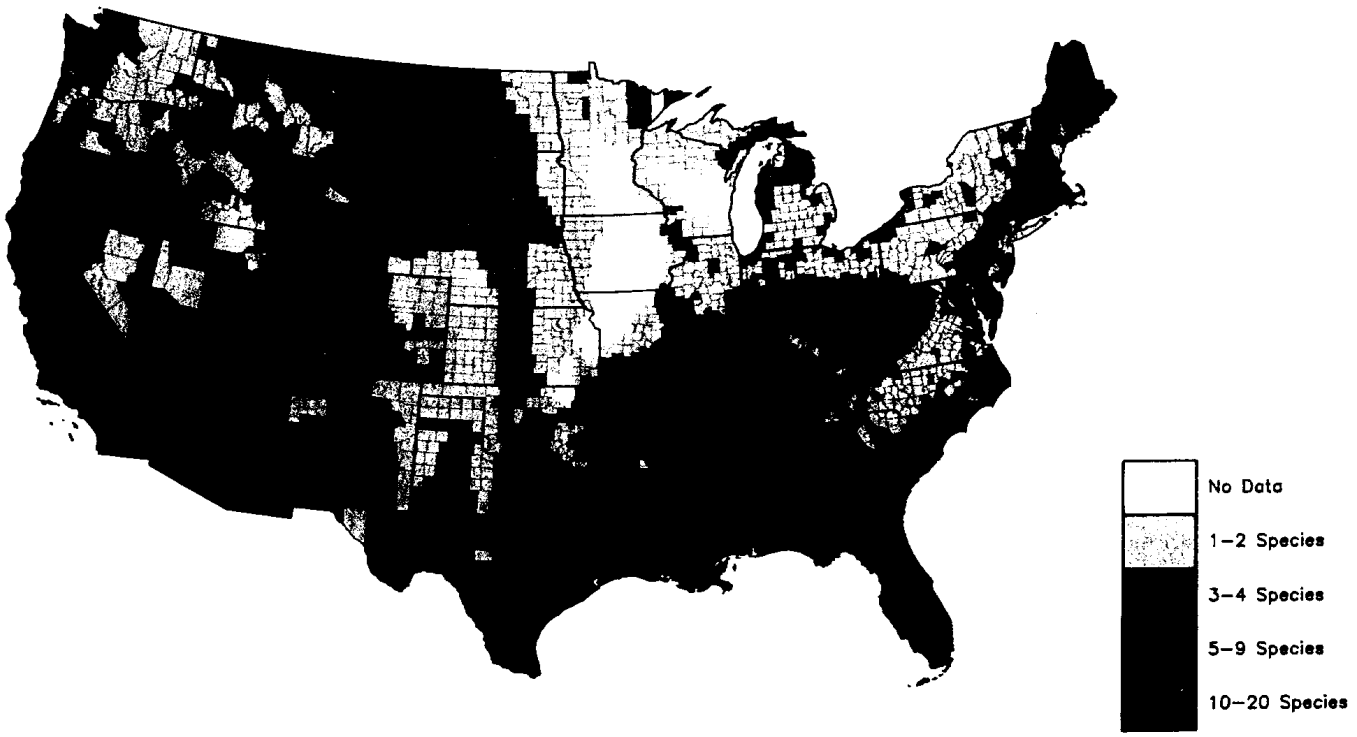


Source: Oak Ridge National Laboratory (pers. comm. 1981)

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.

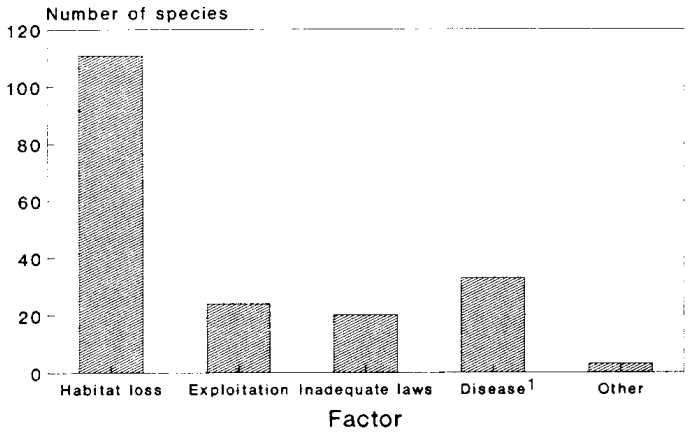
The red-cockaded woodpecker is on the threatened and endangered species list primarily because its habitat has been deteriorating through loss of older loblolly/shortleaf and longleaf/slash pine forests under which fires frequently burn to reduce the hardwood understory (Lennartz and McClure 1979). The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

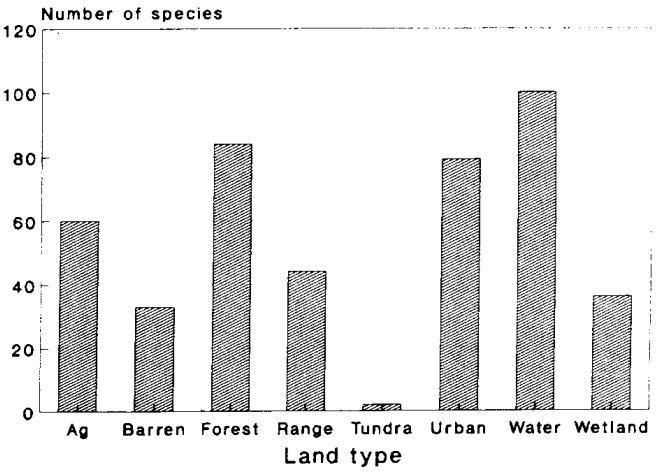
For example, a high number of threatened or endangered species associate with urbanland, primarily because urbanland uses superimpose other land types and represent a drastic modification of the original habitats. For some species, urbanland represent a significant mortality factor attributable to the 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.

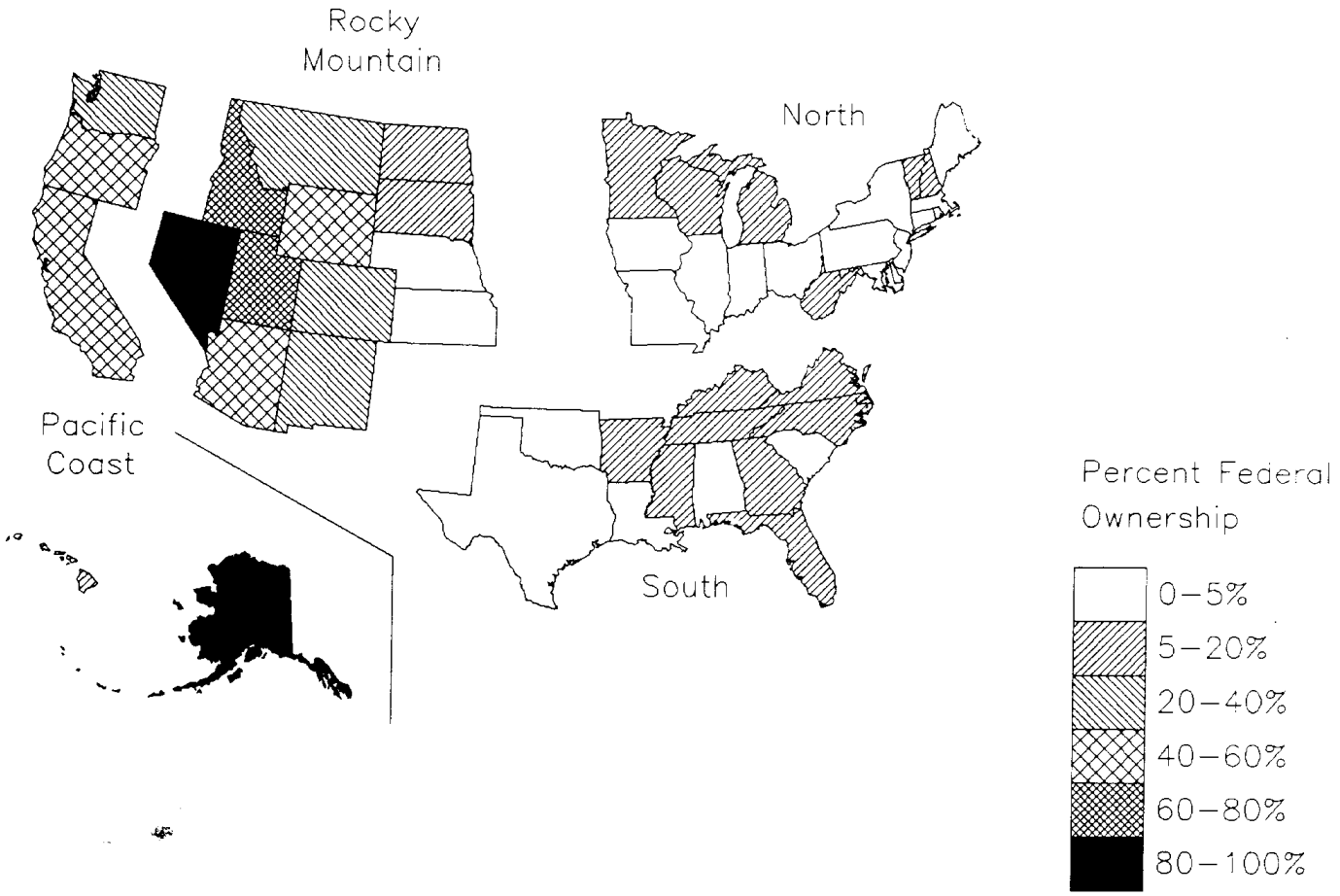
The following discussion documents the recent history of wildlife and fish on public lands in general, and specifically on Forest Service (FS) and Bureau of Land Management (BLM) lands. These two agencies are emphasized because they administer the majority of federal lands and because they are directed 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%.

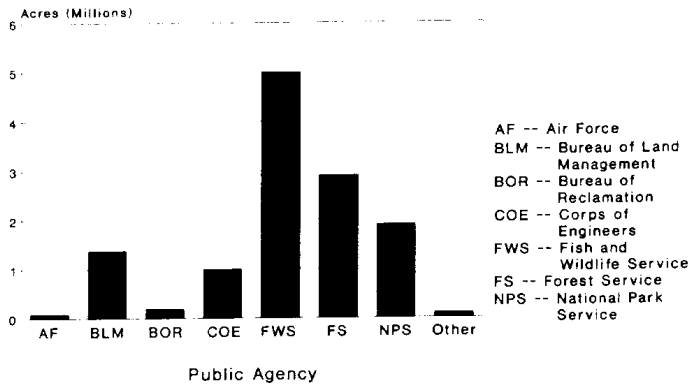
No standard national inventory permits an assessment of wetland trends in the FS. However, the Public Land Statistics published by the BLM do report wetland acreage. The number of wetland acres under the BLM's jurisdiction have declined since 1979 (table 24). This trend is not a reflection of actual 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.

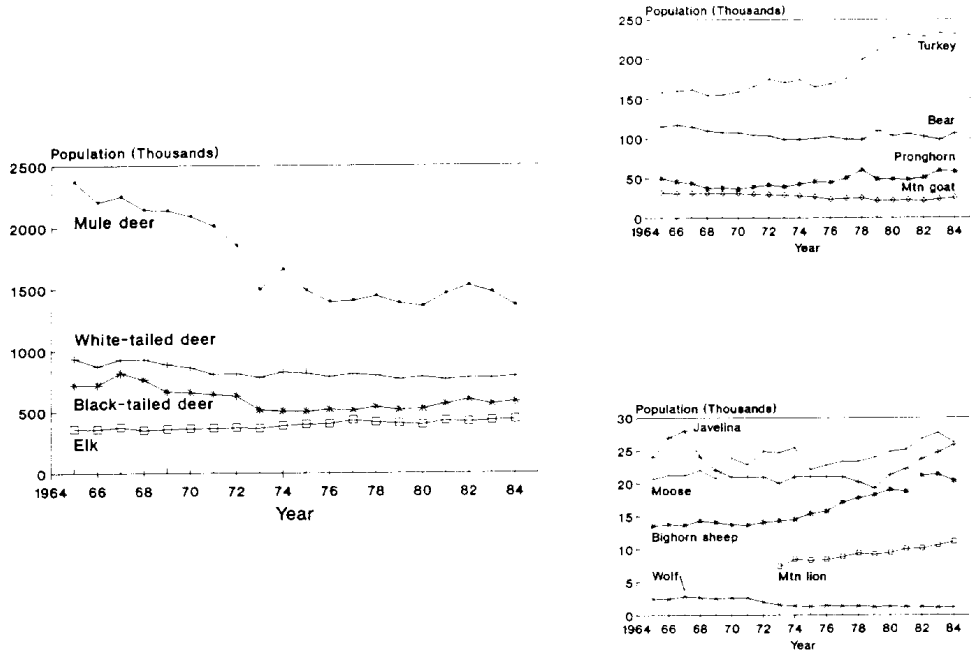
Big game populations in the NFS have, in general, remained stable or increased over the recent historical period of this report (fig. 40). The mule deer, including the black-tailed deer subspecies, is an exception. It declined during the late 1960's through the mid-1970's. This decline was range-wide 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).

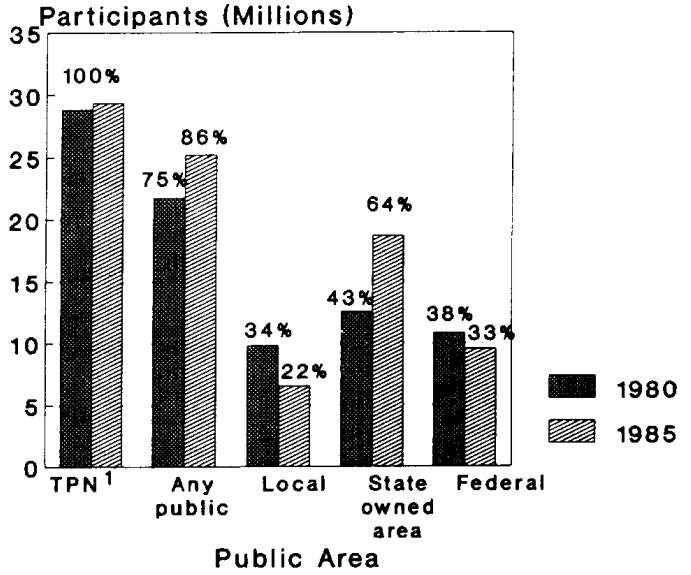
Recreational Use of Wildlife and Fish on Public Lands

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).

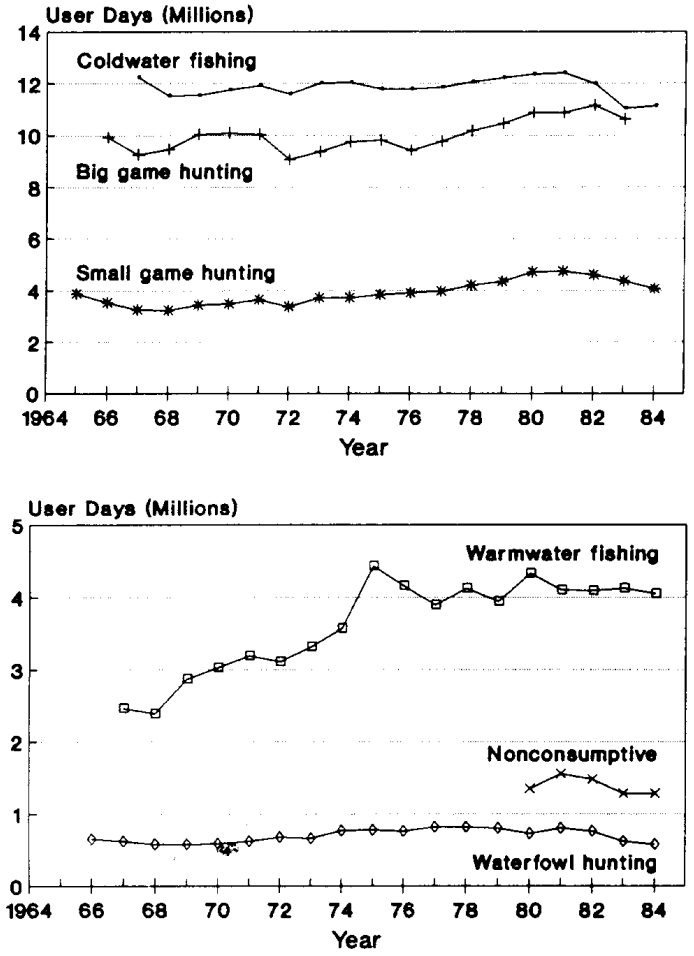
total nonconsumptive user-days on NFS lands peaked in 1981 at 1.55 million user-days and declined to approximately 1.27 million user-days in 1984 (fig. 42). Although this trend is surprising given increased public interest in nonconsumptive recreational activities, participation in primary nonresidential 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.

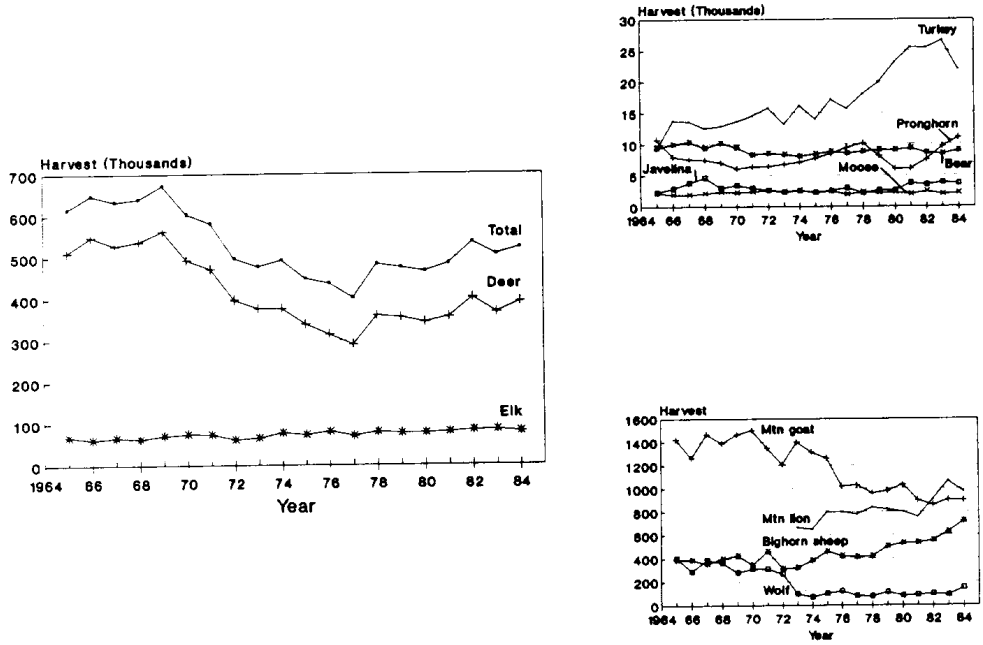
Total big game harvests on FS lands declined from 1965 through 1977, followed by a gradual increase through 1984. This observed trend is dominated by the historical harvest of deer which account for approximately 75% of the total number of big game animals harvested (fig. 43). Harvests of elk, turkey,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

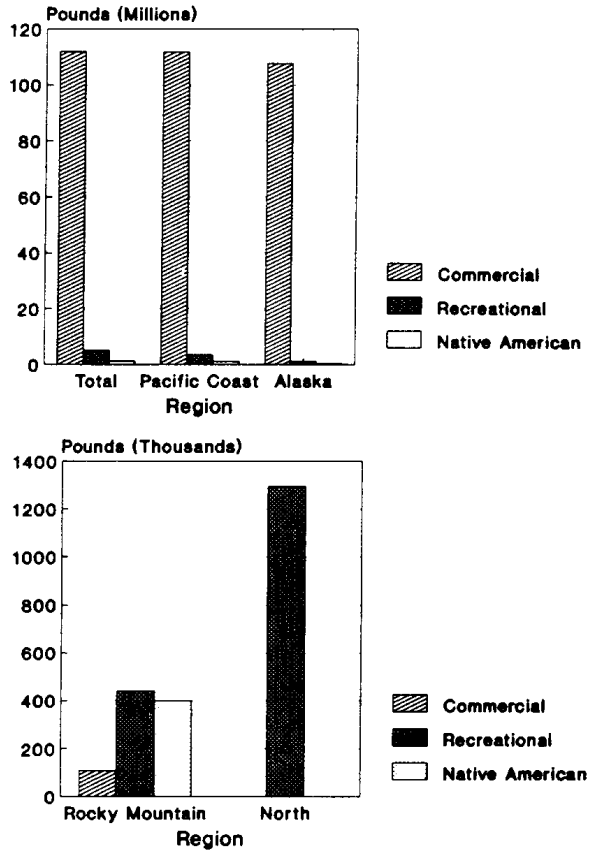
Figure 43.—Trends in harvest of selected big game species on NFS lands.

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.

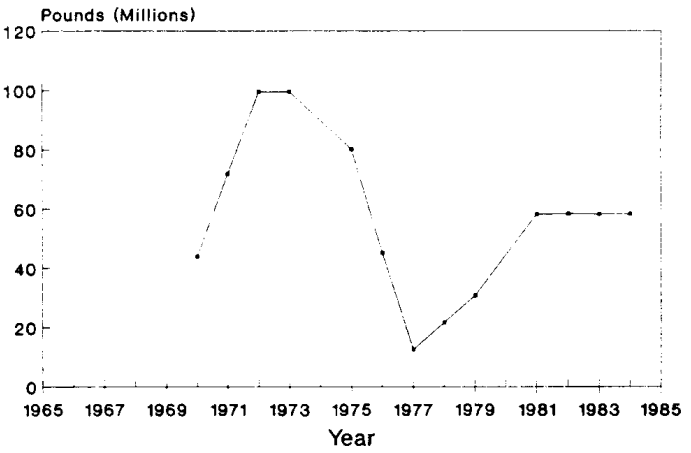
For national forests, information on fish harvests are categorized as commercial, recreational, and Native American. The largest segment of the harvest is taken by commercial fishing. The total salmon harvest for the nation was about 700 million pounds, of which 15% (112 million pounds) was attributable 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).

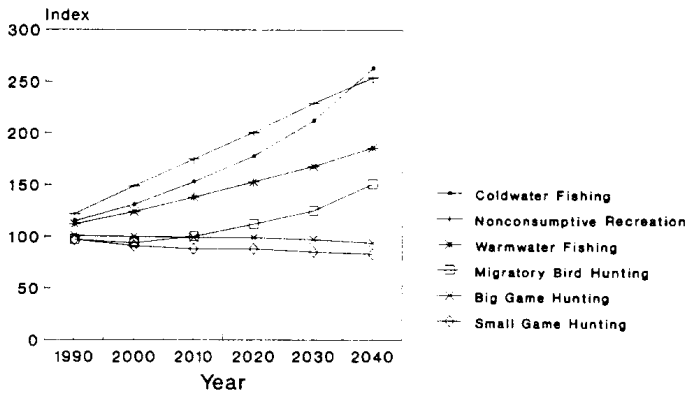
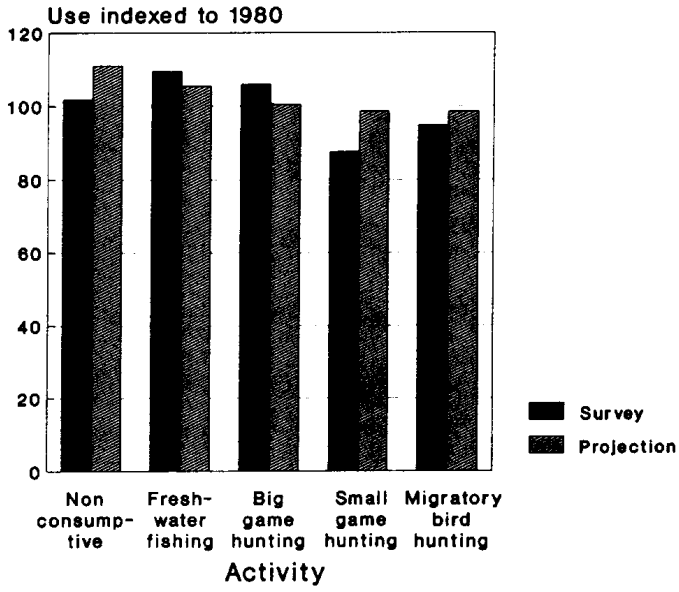


Figure 46.—Projected participation in major wildlife and fish associated recreational activities (Base=1980=100).

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)

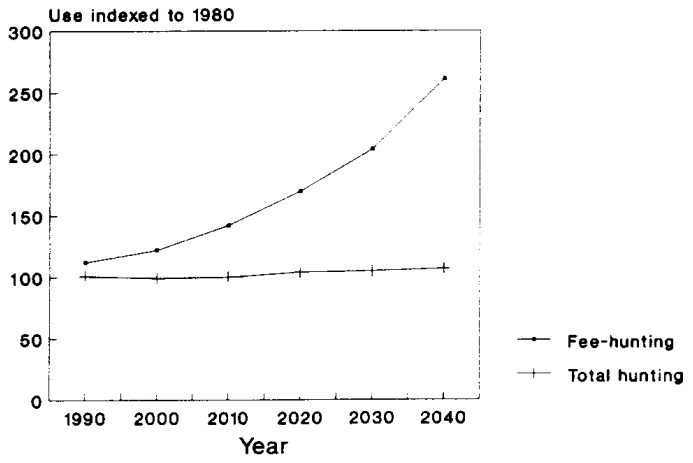


Figure 48.—Projected participation in fee-hunting compared to total hunting.

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.

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

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.*

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.

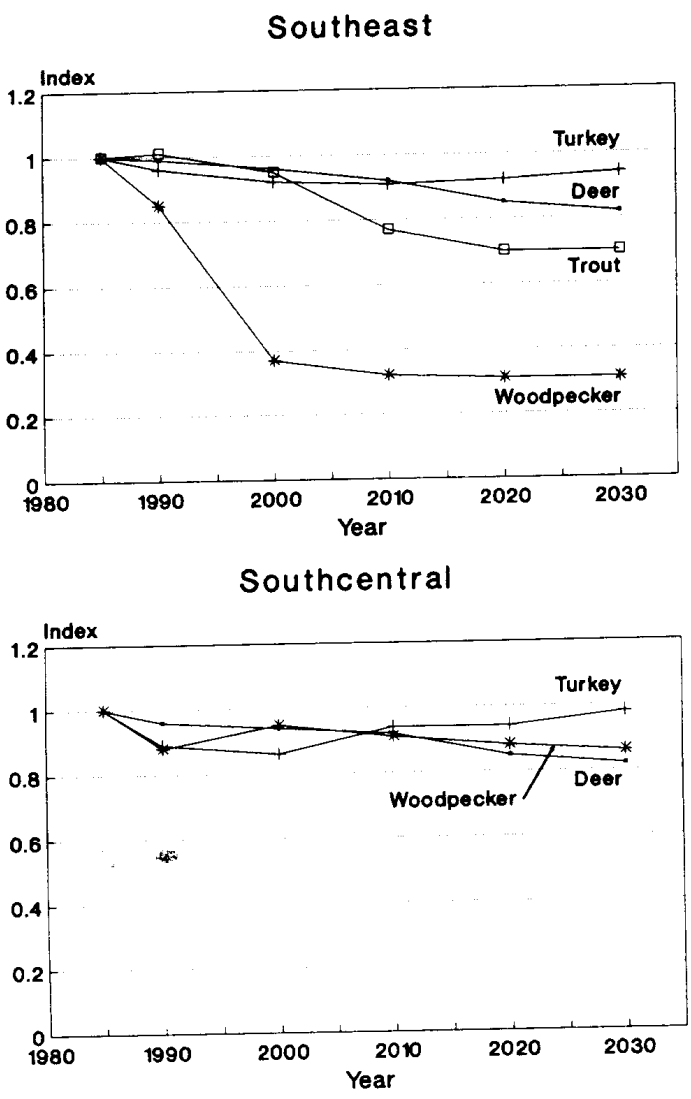
In light of these assumptions, projections were made for a baseline condition representing the likely future demand for timber products and what level of timber management would be required to ensure that timber supplies would meet that demand. The land area changes under this likely future baseline 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.

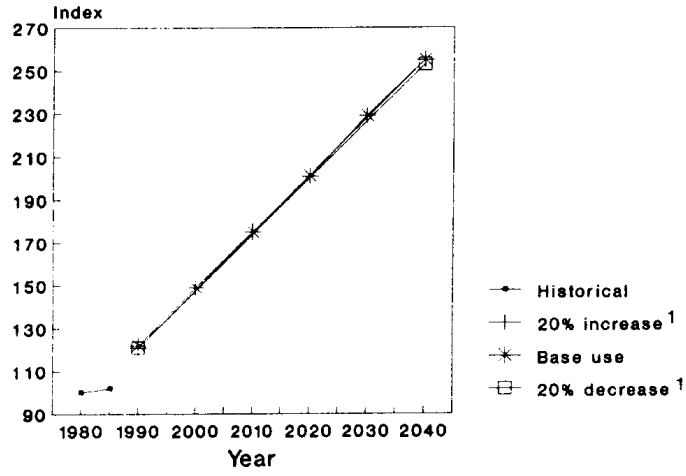
In addition to the statistical criteria used in selecting resource supply variables, data availability also limited the full suite of potentially important resource supply indicators that could be examined. For example, the actual land area open to the recreating public would be a better indicator of 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

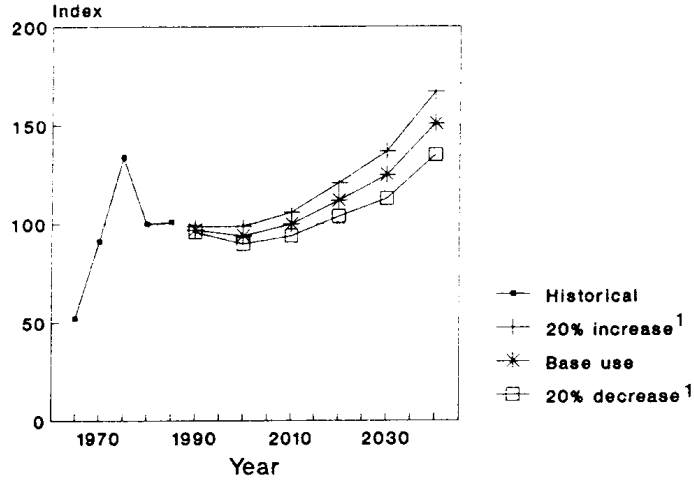
Primary nonresidential nonconsumptive wildlife recreation was not sensitive to a 20% change in the amount of forest, pasture, and range (fig. 50). Hay and McConnell (1984) also found that resource availability was not an important factor explaining participation in nonconsumptive wildlife recreation. 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)

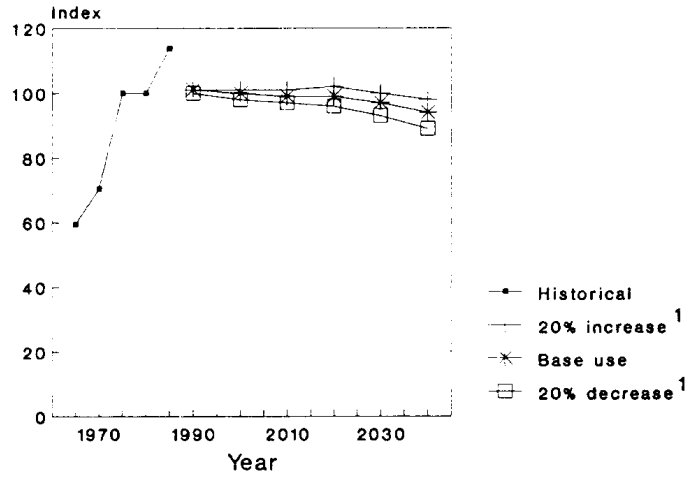
Figure 51.—Sensitivity of migratory bird hunting activities to changes in resource supply (Base = 1980 = 100).

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



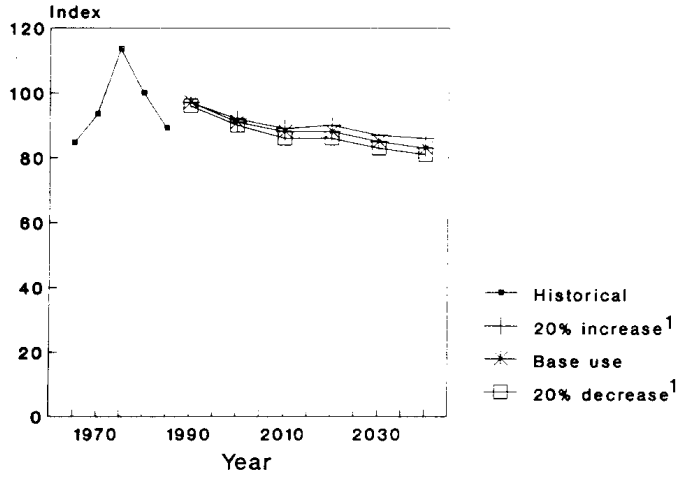
[1]Use based on 20% increase or decrease in resource inventories.

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.

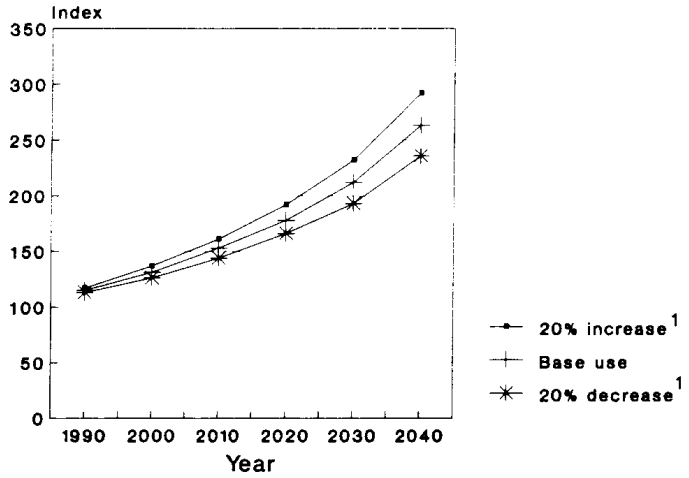
NOTE.--Historical trends based on participants 12 years old and older

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).

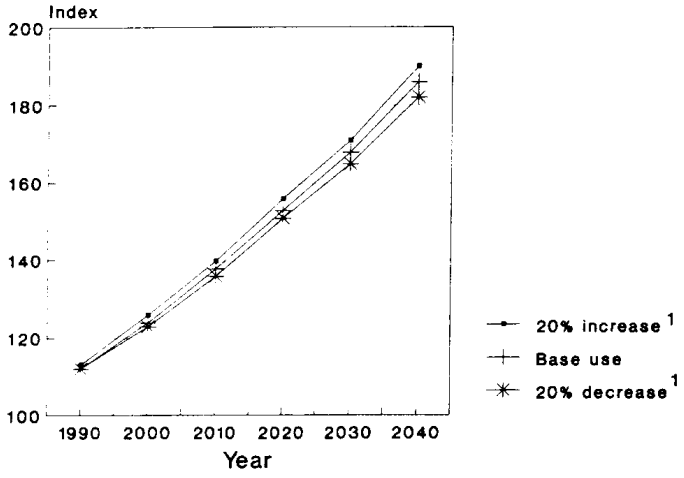
Recreational Fishing

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).

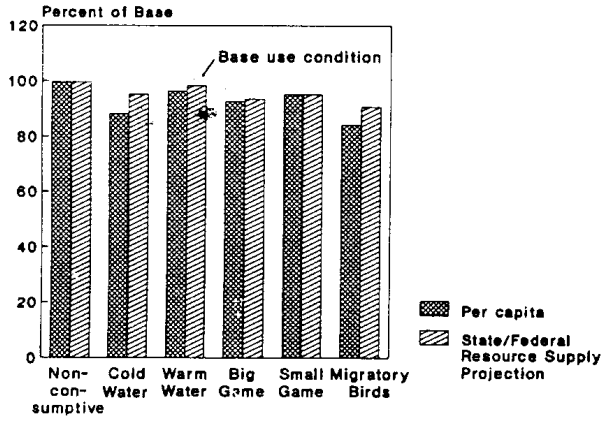


Figure 56.—Comparison of resource use projections under per capita availability and state/federal projection of future resource supplies as a percentage of base use conditions at 2040 (Base = 1980 = 100).

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 decisionmaking 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