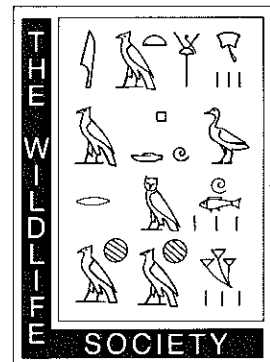
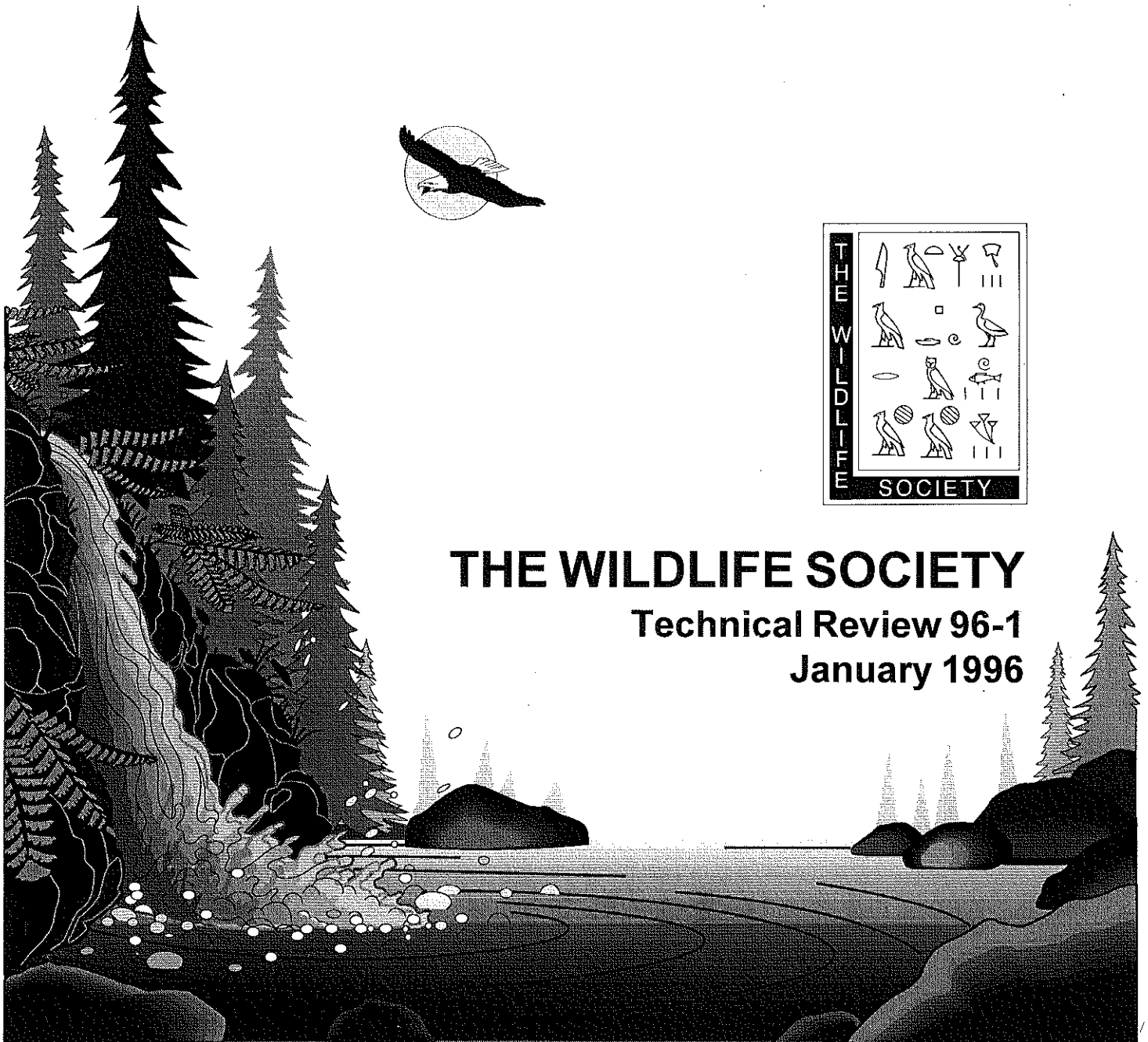


# WILDLIFE MANAGEMENT IN NORTH AMERICAN WILDERNESS



**THE WILDLIFE SOCIETY**

Technical Review 96-1

January 1996

# Wildlife Management in North American Wilderness

## The Wildlife Society

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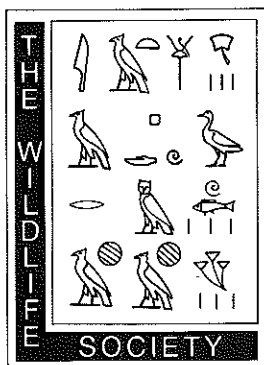
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## Foreword

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Presidents of The Wildlife Society occasionally appoint ad hoc committees to study and report on selected conservation issues. The reports ordinarily appear in 2 related series called either Technical Review (formerly "White Paper") or Position Statement. The review papers present technical information and the views of the appointed committee members, but not necessarily the views of their employers. Position statements are based on the review papers, and the preliminary versions ordinarily are published in **The Wildlifer** for comment by society members. Following the comment period, revision, and Council's approval, the statements are published as official positions of The Wildlife Society.

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## Table of Contents

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Foreword .....	<i>i</i>
Acknowledgments .....	<i>i</i>
Synopsis .....	1
Introduction .....	1
Wilderness Designations .....	2
Wilderness and Ecosystem Management .....	10
Size and Spacing of Wilderness Areas .....	10
Fire and Other Natural Disturbances .....	11
Human Use Problems .....	12
Wildlife Management Issues .....	13
Recommendations .....	16
Research Needs .....	17
Literature Cited .....	19
Appendix .....	23

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## SYNOPSIS

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The Wildlife Society Council anticipates increasing interest and concerns with the designation and management of wilderness in North America. Wilderness has been suggested as having a role in meeting newly articulated objectives for maintaining biodiversity. Wildlife populations and their management in wilderness may receive additional scrutiny and debate in light of these new objectives. An overview of wildlife management in North American wilderness is an important first step in considering future directions or policies regarding wilderness management. These directions and policies should apply to lands in the U.S. designated under the Wilderness Act, and to many other areas managed largely for wilderness values including some land managed by the National Park Service and some large state parks and reserves. It should also apply to similarly managed and designated lands in Canada.

Wildlife management in wilderness faces many difficult challenges. While solutions to these challenges might be complex, some direction can be suggested. Wilderness areas need to be managed as ecologically complete areas, or as part of a plan for an ecologically complete area that may include surrounding public or private lands. They should be managed to provide a natural range of habitat diversity. In many areas, this may involve restoring the integrity of natural processes. In these actions, an adaptive management approach should be used. The biodiversity in wilderness areas should be monitored. Some wilderness areas are managed by more than one agency. Agency management should be closely coordinated. Livestock grazing in wilderness should be managed so as to be compatible with wilderness goals.

Similarly, human use of wilderness should not compromise wilderness values. In some wilderness areas, especially small areas in the Eastern U.S., ungulate population control may be needed. Finally, sufficient funding to maintain wilderness areas should be secured.




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## INTRODUCTION

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Wilderness, in Old English, referred to the place of wild deer (*Spurr 1966*). Architects of wilderness philosophy have freely used wildlife to define wilderness aesthetically and biologically. Aldo Leopold (*1969:199*) wrote: "Only those able to see the pageant of evolution can be expected to value its theater, the wilderness, or its outstanding achievement, the grizzly." For Sigurd Olson (*1961:5*), "The singing wilderness has to do with the calling of loons, northern lights, and the great silences of land lying north of Lake Superior." The close conceptual link between wildlife and wilderness is summed up by Lois Crisler (*1958:38*) as follows: "Great wilderness has two characteristics, remoteness, and the presence of wild animals in something like pristine variety and numbers. Remoteness cannot be imitated with cheap materials: and the wilderness without wild animals is mere scenery."

The North American public's current appreciation for wilderness and its wildlife is reflected in our cultural icons of spectacular wild animals, burgeoning public visitation of parks and wilderness, media attention to wilderness issues and commercialization of things wild. But, for people of European culture, this appreciation is a recent phenomenon. Ancient Greek, Roman, Hebrew, and Nordic peoples regarded wilderness as cursed land, dark and foreboding -- the opposite of paradise (*Nash 1982*). European pioneers brought with them their cultural and religious beliefs, beliefs that guided them in their settlement of a pristine continent. The pastoral landscape and its livestock were desirable and good: the wilderness and its denizens were hostile, fit only to be subdued and conquered. On his trip to Michigan Territory in 1831, the French philosopher Alexis De Tocqueville observed in Americans that living in the wilderness produced a bias against it (*Nash 1982*). This pattern persists to the present day (*Hendee et al. 1978, Graham 1978, Brocke et al. 1990*) as the principal political support for wilderness and wilderness wildlife values tends to be urban rather than rural.

In the late 1800's, citizens across the continent reacted to the problems of exploitation and the industrial age. Urban pollution was rampant. Pristine forests had given way to charred landscapes as fires followed logging. Many populations of large animals all but disappeared while some species became extinct. Clearly, something was drastically wrong when bison that covered the plains were reduced to bone piles and passenger pigeons that once darkened the sky simply vanished. Reacting to stark reality, the public was receptive to a new paradigm—a wilderness paradigm provided by visionaries including

Henry Thoreau and John Muir (*Nash 1982*). Rather than serving as an object of exploitation, wilderness could provide spiritual, aesthetic and recreational benefits while serving as an ecological yardstick against which the environmental impact of humans could be measured.

The wilderness agenda rapidly gained public support and momentum. Through the efforts of farsighted individuals, wild lands were preserved for posterity beginning with Yellowstone National Park in 1872 and the Adirondack Forest Preserve in New York state in 1885. President Theodore Roosevelt effected the legal protection of 52 million hectares of public land, much of it later classified as wilderness. In 1939, Robert Marshall of the U.S. Forest Service developed regulations defining wilderness and restricting economic development on 5.5 million ha of land under the Service's jurisdiction. Marshall and Leopold were charter members of the Wilderness Society in 1935. A landmark in wilderness philosophy was the publication in 1949 of Leopold's classic book, "A Sand County Almanac." In a single stroke, Leopold articulated philosophical and ecological foundations for wilderness management; foundations that guide professionals to the present day. In view of the close conceptual relationships of wilderness and wildlife, perhaps it is not a coincidence that Leopold also fathered modern wildlife management.




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## WILDERNESS DESIGNATIONS

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### LEGAL MANDATES IN THE UNITED STATES

In the United States, wild lands are managed under a variety of laws that provides many degrees of restricting development and preserving natural ecosystems. In this continuum of landscape protection, land managed under the Wilderness Act of 1964, and most land managed under the mandates of the National Park Service, constitute a federal wilderness preservation system. A few state reserves, notably Adirondack Preserve of New York and Anza Borrego Desert State Park of California, are large enough to be included with federal wilderness and Park Service lands as the main wilderness preservation system of the United States.

"In the 28 years since President Johnson signed the Wilderness Act on September 3, 1964, Congress has set aside one out of every seven acres of federal land, or 95 million acres, as wilderness" (*McQueen 1992:1*). The debates over past designations have been considerable (*Allin 1990, McQueen 1992*), and will continue with future proposed wilderness designations. Considerable land areas are presently in a "roadless" designation, that provides additional de facto wilderness, and are the subject of considerable controversy. The language of the Wilderness Act clearly emphasizes aesthetics and the relative absence of human influence, both past and present, in the wilderness. Spurr (*1966*) summed up this emphasis as follows: "Wilderness - is a poetic and deep-felt concept, but is primarily sociological rather than ecological in implication . . ." At the outset, we must recognize that the concept of man as distinct and different from other forms of life is hardly a defensible thesis in modern biology.

It is difficult to argue that all other forms of life interacting in a given ecosystem are natural, while man, if he exists in that ecosystem, is unnatural. Spurr's point gets at the heart of the dilemma facing the wilderness wildlife biologist - namely that biologists must deal with and manage a biological wilderness following natural laws, while the "wilderness clientele" perceives the mission as largely sociological, centered on aesthetic ideas.

Conceptually, the most important passage in the Act is the following: "A wilderness, in contrast with those areas where man and his own works dominate the landscape, is hereby recognized as an area where the earth and its community of life are untrammelled by man, where man himself is a visitor and does not remain." This passage is augmented by a legal working definition [Section 2(c)] as follows: "Wilderness is -- an area of undeveloped land retaining its primeval character and influence, without permanent improvements or habitation, and which (1) generally appears to have been affected primarily by the forces of nature, with man's imprint substantially unnoticeable, (2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation, (3) has at least 5,000 acres of land or is of sufficient size to make practical its preservation, and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value" (*Hendee et al. 1978*).

The strict criteria set forth in the Wilderness Act were met by 54 wilderness areas in existence under U.S. Forest Service jurisdiction, covering 9.1 million acres. These lands formed the core of the National Wilderness Preservation System (*Hendee et al. 1978*) to be, "... adminis-

tered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness . . ." The Act had permanently protected existing wilderness areas established by administrative actions - actions that might have been reversed by the same process (*Trefethen 1975*). The Act's original provisions affected lands administered by three U.S. Federal agencies, namely the Forest Service, U.S. Department of Agriculture, and the National Park Service and Fish and Wildlife Service, both in the U.S. Department of the Interior. In 1976, Bureau of Land Management (BLM) lands were added to the system.

At the core of the wilderness definition, both in its common perceptions and in the Wilderness Act of 1964, is the premise that the wilderness character of any natural area is compromised by the human presence, both past and present. According to the Act's key passages, any substantial evidence of former human presence, e.g., logging or settlement, however minor that evidence might be today, would disqualify a potential area as wilderness in the National Wilderness Preservation System (although a number of existing specified commercial activities in wilderness areas could continue. For details, see below). However, in the eastern United States (lands lying east of the 100th meridian) only four areas were classified as wilderness under the strict guidelines set forth by the Wilderness Act (*Hendee et al. 1978*). Under political pressure from eastern conservationists, Congress enacted legislation (*Public Law 93-622*) in 1975 referred to as the Eastern Wilderness Act (the legislation actually has no title), with the following key provision: "To further the purpose of the Wilderness Act by designating certain acquired lands for inclusion in the National Wilderness Preservation System, to provide for study of certain additional lands for such inclusion, and for other purposes" (*Hendee et al. 1978*). In full view of the "imperfections" of eastern wild areas, this act nonetheless provided for incorporation of approximately 332,000 acres of eastern wild lands in the National Wilderness Preservation System. The recognition that "scars" of historical human presence were faster to heal in well-watered eastern forests probably favored the bill's passage.

The Wilderness Act and subsequent legislation (including the National Forest Management Act of 1976 and the Federal Land Policy and Management Act of 1976) emphasize the preservation of natural features, including species, and natural forces or processes in wilderness areas. Consequently, the Bureau of Land Management Manual, BLMM8660.11.A, states, "BLM must foster a natural distribution of native species . . . by ensuring that natural ecosystems and ecological processes continue to function." Likewise, the Forest Service seeks to "maintain wilderness in such a manner . . . that plants and animals

develop and respond to natural forces" (FSM2320.2.2) and to "provide an environment where the forces of natural selection and survival . . . determine what numbers of wildlife species will exist" (FSM2323.31.1).

The Wilderness Act allows certain "grandfathered uses" of wilderness areas to continue, in the pre-existing manner and degree, after wilderness designation. These uses are mining and grazing and the use of aircraft and motorboats (*Keiter 1988*). Also, wild horses or burros may be considered part of the natural wilderness system, although their numbers will be controlled by human intervention -- according to the U.S. Bureau of Land Management's interpretation of conflicting mandates of the Wilderness Act and the Wild Horse and Burro Act. (See BLM Manual 8560.37.C.) While these interpretations of the Act are intended to preserve natural ecological conditions, other sections of the Act are interpreted to allow for numerous, mostly limited, uses of wilderness. Other activities that are allowed include control of fire, insects, diseases, and predators, hiking and camping, hunting, fishing and trapping, rangeland improvements, and scientific studies. The Forest Service Manual (FSM2320.6) admits that "absolute wilderness" is impossible because of these mandated uses of the wilderness resource. Recognizing these limitations, the Forest Service and BLM manuals require that impacts of human activities upon the wilderness resource be minimized. The U.S. Forest Service Manual interprets the Congressional mandates for wilderness management in an inconsistent, confusing, and incomplete way. It does not provide a clear direction for the many wilderness plans yet to be written (*Bailey and Woolever 1992*).

The Wilderness Act requires the appropriate managing agency to manage each area, ". . . for such purposes for which it may have been established and also to preserve its wilderness character." (Section 4(b)). The Act further states, "Nothing in this act shall be construed as affecting the jurisdiction or responsibilities of the several states with respect to the wildlife and fish in the national forests." (Section 4(d) (8)) (*Posewitz et al. 1991*.)

#### Park Service Mandates

The Organic Act which established Yellowstone National Park (1872) provided for preservation of the Park's resources and "retention in their natural condition." A Congressional Act (1916) established the National Park Service and identified the purposes of national "parks, monuments, and reservations . . . to conserve the scenery and the natural and historic objects and the wildlife . . . and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." Leopold et al. (1963)

stated, "As a primary goal . . . that the biotic associations within each park be maintained or . . . recreated, as nearly as possible in the condition that prevailed when the area was first visited by the white man." "Above all other policies, the maintenance of naturalness should prevail."

These statements identify completeness of species as a component of naturalness. Their emphasis on naturalness of environments, the aggregate of natural phenomena, and biotic associations indicate that processes such as fire, succession and retrogression, predation, disease, population fluctuations and movements, and evolution are also components of naturalness. They identify the advent of European humans as a benchmark, unique in America, for defining natural. Wilderness is most natural when the impacts of European man have been minimized. However, the implication of a static "vignette of primitive America" (*Leopold et al. 1963*) has been rejected and replaced by the concept of a dynamic fragment of North America, evolving unimpaired "to the extent possible" by the impacts of modern society (*Despain et al. 1986:8*). These policies apply primarily to national parks, preserves, monuments, lakeshores, and seashores.

Whereas the Wilderness Act allows numerous uses that may jeopardize "absolute wilderness," the mandates and policies of the National Park Service are more strict in preserving naturalness.

However, the Park Service must find compromises between its dual mandates for preserving while promoting use and enjoyment of park resources. Primary uses of the parks have been various forms of outdoor experience, public education, and scientific research. Limited sport fishing

occurs in most parks; hunting and trapping occur in several Park Service units, especially in Alaska. These deviations from "naturalness" usually accommodate activities that predated park designation. Some parks contain transportation facilities and other structures that predated park designation or were constructed before a strong park preservation policy evolved. The trend has been to remove facilities in parks whenever this has been feasible. Portions of 42 Park Service areas have been designated under the Wilderness Act to prevent future expansion of roads and recreational facilities. Also, 27 Park Service areas have been designated as biosphere reserves. The national parks, preserves, monuments, lakeshores, and seashores are managed largely as wilderness, with emphasis upon preserving natural features, including natural biological diversity. These Park Service areas are important components of the wilderness preservation system of the United States.

## LEGAL MANDATES IN CANADA

Most of northern Canada is currently in a wilderness state. An unpublished review of the Canadian scene indicates that 72% of the country remains roadless (defined as land areas more than 16 km from a public road) (*Hummel 1989*).

However, very few wilderness areas are legally mandated and protected (Table 1). The wilderness areas located on provincial lands are established under acts passed by provincial legislatures. In addition, most National Parks (administered by the federal government: Table 2) are primarily zoned as wilderness (*Hummel 1989*). All wilderness areas prohibit motorized vehicles with the exception of those in the Province of British Columbia.

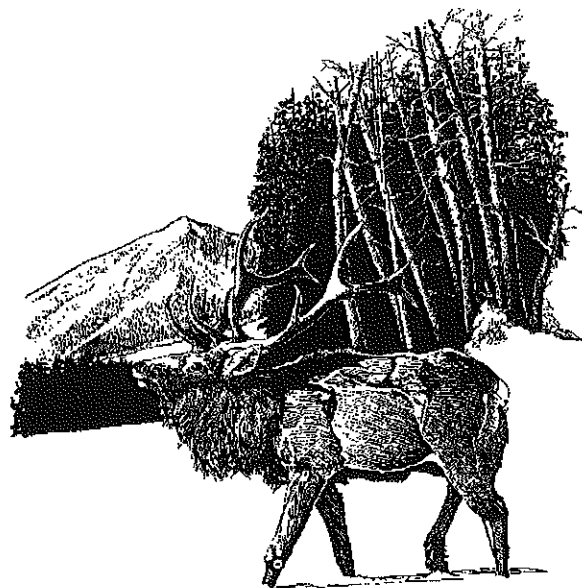




Table 1. A comparison of the number and size of wilderness areas in Canada\*.

Province or Territory	Number of Wilderness Areas	Total Area in sq. km (Range)
Alberta	4	5607 (153-4598)
British Columbia	3	1110 (110-680)
Manitoba	1	186
New Brunswick	0	
Newfoundland	1	1070
Nova Scotia	0	
Northwest Territories	0	
Ontario	37	618
Prince Edward Island	0	
Quebec	0	
Saskatchewan	3	634 (192-224)
Yukon	0	
Canada	46	9225

\*From Hummel (1989) with updates from respective provinces.

Table 2. A comparison of the number and area of National Parks in Canada's provinces and territories.

Province or Territory	Number of National Parks	Total Area in sq. km (Range)
Alberta	4.8*	54,085 (194 - 44,807)
British Columbia	6	9,220 (388 - 3,050)
Manitoba	1	2,976
New Brunswick	2	445 (205 - 239)
Newfoundland	2	2,338 (396 - 1,942)
Nova Scotia	2	1,332 (381 - 950)
Northwest Territories	3.2*	74,698 (4,765 - 37,775)
Ontario	5	2,171 (1 - 1,878)
Prince Edward Island	1	26
Quebec	3	935 (151 - 544)
Saskatchewan	2	4,781 (906 - 3,875)
<u>Yukon</u>	<u>2</u>	<u>32,183 (10,168 - 22,015)</u>
Total	34	185,240 (1 - 44,807)

\*Wood Buffalo National Park is shared between Alberta (80%) and the Northwest Territories (20%).

Table 3. Distribution of wilderness reserves<sup>1</sup> areas in the United States.

<u>Region</u>	<u>Wilderness (sq. km)</u>	<u>Proportion of Land (%)</u>
Alaska	326,835	21.8
Hawaii	1,102	6.5
Western States (11)	170,431	5.5
Central States (11)	9,918	0.4
Eastern States (26)	33,293	1.5

<sup>1</sup>Designated under the Wilderness Act; and the National Parks, Monuments, Preserves, Lakeshores, and Seashores.

Table 4. Administrative wilderness reserves<sup>1</sup> in the United States.

<u>Region</u>	<u>Reserves</u>	<u>FS</u>	<u>Administration<sup>2</sup></u>		
			<u>BLM</u>	<u>FWS</u>	<u>NPS</u>
Alaska	49	15	0	21	13
Hawaii	3	0	0	0	3
Western States (11)	364	36	66	17	45
Central States (11)	51	28	0	11	12
<u>Eastern States (26)</u>	<u>143</u>	<u>93</u>	<u>0</u>	<u>27</u>	<u>23</u>
Total	610	172	66	76	96

<sup>1</sup>Designated under the Wilderness Act; and the National Parks, Monuments, Preserves, Lakeshores, and Seashores.

<sup>2</sup>FS = Forest Service; BLM = Bureau of Land Management; FWS = Fish and Wildlife Service; NPS = National Park Service.

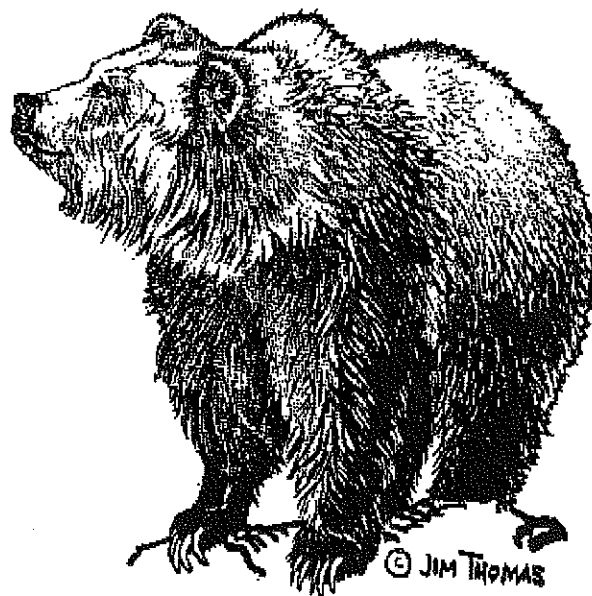


Table 5. Largest wilderness reserves<sup>1</sup> in each region of the United States.

<u>Alaska</u> Reserves > 404,858 hectares:	(10 <sup>3</sup> hectares)
Selawik, Kobuk, Gates of Arctic, Noatak	6,898
Wrangell-St. Elias, Russell Fjord	5,481
Arctic Nat. Wildl. Refuge	3,239
Denali Nat. Park	2,440
Katmai Nat. Park, Becharof	1,818
Lake Clark Nat. Park	1,637
Glacier Bay, Endicott River	1,369
Bering Land Bridge	1,127
Yukon Charley Nat. Park	1,022
Togiak	919
Misty Fjords	867
Kenai Fjords, Kenai	818
Aleutian Islands	526
Andreafsky	526
Innoko	502
<u>Hawaii</u>	
Hawaii Volcanoes Nat. Park	93
<u>Western States</u> Reserves >202,429 hectares:	
Yellowstone, Gr. Teton, Absaroka Complex	2,151
F. Church, River NR., Selway, Bitterroot Cplx.	1,587
Yosemite, Sequoia, Kings Cyn. Complex	1,235
Glacier N.P., Bob Marshall Complex	1,032
Death Valley Nat. Mon.	837
N. Cascades N.P., Glacier Pk. Complex	646
Grand Cyn. N.P., Saddle Mtn.	510
Olympic Nat. Park Complex	409
Aldo Leopold, Gila	308
Bridger, Fitzpatrick, Popo Agie	295
Joshua Tree Nat. Mon.	227
Paysaten	215
Trinity Alps	210
<u>Central States</u> Reserves >40,486 hectares:	
Boundary Waters	440
Badlands Nat. Park	98
Voyageurs Nat. Park	88
Padre Island Nat. Seashore	53
Buffalo Nat. River, Leatherwood	45
<u>Eastern States</u> Reserves >40,486 hectares:	
Adirondack Preserve	@1,093
Everglades Nat. Park, Big Cypress Pr.	856
Isle Royale Nat. Park	232
Grt. Smoky Mtns. Nat. Park	211
Okefenokee	143
Shenandoah Nat. Park	79

<sup>1</sup>Designated under the Wilderness Act, National Parks, Monuments, Preserves, Lakeshores, and Seashores, and the Adirondack Preserve. Contiguous areas combined into wilderness complexes.

Table 6. Sizes of wilderness reserves<sup>1</sup> in the United States.

Region	Reserves in Each Size Category (405 hectares)							
	No.	<10	10-49	50-99	100-199	200-499	500-999	1000+
Alaska	42	9	3	3	0	6	7	14
Hawaii	3	2	0	0	0	1	0	0
West <sup>2</sup>	289	42	139	37	37	21	5	8
Central <sup>2</sup>	50	27	14	4	2	2	0	1
East <sup>2</sup>	133	75	46	6	1	1	2	2
Total	517	155	202	50	40	31	14	25

<sup>1</sup>Designated under the Wilderness Act; National Parks, Monuments, Preserves, Lakeshores, and Seashores; and the Adirondack Preserve. Contiguous areas are combined into 42 wilderness complexes.



Wildlife management activities in these areas vary among jurisdictions and include, but are not limited to, range improvement, hunting, trapping, and transplanting wildlife.

## WILDERNESS AREAS IN THE UNITED STATES



### Distribution

Currently, about 60% of the land in the United States' wilderness preservation system is in Alaska, where almost 22% of the state is reserved in areas set aside from development activities (Table 3). In the contiguous United States, 80% of reserved wilderness occurs in 11 western states, where about 5.5% of the land is reserved. More than 10% of Washington is wilderness.

In contrast, there is relatively little wilderness in 26 eastern states and very little wilderness in 11 central states (Table 3). Six states have essentially no federal wilderness, and 8 states have less than 131 square km of wilderness. There is a large area, from Nebraska, Kansas, and Oklahoma eastward to Rhode Island, with no wilderness.

### Administration

Of 610 federal wilderness designations in the United States, the Forest Service administers 61%, with the remainder administered by the Bureau of Land Management (BLM), the Fish and Wildlife Service, and the National Park Service (Table 4). All BLM wilderness is in the West, and 47 of the 66 BLM wilderness areas are in Arizona. Some wilderness units are contiguous. These form 42 wilderness complexes for which administration is shared by more than one agency.

### Size

More than half of the nation's largest wilderness reserves (>200,000 ha) are in Alaska (Table 5). In the contiguous states, 73% of 472 reserves are <20,000 ha and 30% are <4,200 ha. Moreover, in the central and eastern states, 88% of 183 reserves are <20,000 ha and 56% are <4,200 ha (Table 6).

Many fairly large wilderness areas in the United States have linear, and therefore narrow, shapes. The mean width of wilderness areas in Colorado is 9.6 km; the mean width of wilderness areas in Arizona is 5.6 km (Bailey and Woolever 1992).

Consequently, few wilderness reserves contain the year-round ranges of indigenous, large mammals. These populations move, often seasonally, across wilderness boundaries, creating conflicts among agencies with differing mandates and goals for managing the populations.

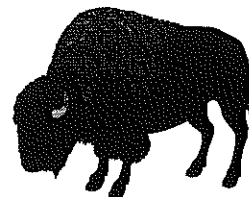
## WILDERNESS AREAS IN CANADA



Of the few designated wilderness areas in Canada, all are located on provincial lands. Portions of Canada's national parks are managed as wilderness areas though not officially designated as such. The most significant difference between provincial wilderness areas and national parks is the prohibition of hunting in National Parks, with the exception of Wood Buffalo National Park.

Ecological reserves have been established in many provinces to protect representative or unique natural features. Most prohibit vehicular travel and hunting. The majority are small in area (*e.g.*, British Columbia has 120 ecological reserves totaling 1,558 square km; Quebec has 38 ecological reserves totaling 413 square km; Alberta has 13 ecological reserves totaling 271 square km) and, as such, are relatively insignificant from a wildlife management perspective. However, they do provide ecological benchmarks and control areas for research and education.

The bulk of legislated wilderness areas in Canada are small, with only 4 exceeding 600 square km (see Table 1). A 1987 survey of major mammal populations throughout western Canada's parks concluded that the national parks were simply too small to support the diversity of species originally found in the regions in which the parks were established. Only the largest aggregations of parkland in western Canada "Banff, Jasper, Kootenay, and Yoho on the Alberta/ British Columbia border" had not experienced any appreciable loss of wildlife (Hummel 1989). Together with adjacent provincial parks of British Columbia and wilderness areas of Alberta, the Rocky Mountain National Parks embrace some 50,000 square km dedicated to wildlands and wildlife (Hummel 1989).



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## WILDERNESS AND ECOSYSTEM MANAGEMENT

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Much of the nation was intensively developed before most national parks were designated and before the Wilderness Act. Moreover, designating parks and wilderness has been, and continues to be, an opportunistic political process. Controversial areas, usually with economically valuable resources, have often been avoided. Areas historically impacted by development have been disqualified. Consequently, despite the Wilderness Act's emphasis on preserving natural ecosystems, the federal wilderness system, including many National Park Service lands, provides neither a balanced nor complete representation of ecosystems. Little wilderness and few large wilderness areas exist in the central and eastern United States (Tables 1, 3). Some major ecosystems are abundantly represented in the system while others are scarce or absent.

Noss (1990:49) noted: "Only 5 (2%) of 261 Bailey-Kuchler ecosystem types in the United States and Puerto Rico are represented in designated wilderness in units of 1 million ha or more, all of these in Alaska. Only 50 (19%) of these ecosystem types are represented in units of at least 100,000 ha." Davis (1988) as cited by Noss (1990) stated that 104 of these ecosystems (40%) are not protected by the Wilderness Act.

Ecosystem management has as one of its primary ecological objectives, the maintenance of biodiversity and ecosystem integrity. Wilderness areas should be assessed and incorporated into ecosystem management planning. However, the ecosystems presently occurring in wilderness areas may have been influenced by human factors such as alterations of fire regimes, and may be confounded by restrictions in management options in wilderness areas. Properly implemented ecosystem management, that meets its ecological objectives, should eliminate the necessity for legally designated biological reserves, leaving the purpose of wilderness designations to that of providing wilderness recreational experiences. In some regions, wilderness areas have provided important reserves for such species as grizzly bears which can be negatively affected by human expanded role in conservation of biodiversity is a controversial issue.

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## SIZE AND SPACING OF WILDERNESS AREAS

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The size and spatial arrangement of wilderness areas influence their ecological integrity. Size and isolation of large areas from roads and other disturbances may be critical to species negatively affected by human interaction (Schoenfeld and Hendee 1978), especially those with large home ranges. Wilderness areas may also provide habitat for late successional species whose habitat may be restricted in areas managed for commodities or early-successional species. Other species assemblages that may be positively affected by wilderness areas in some locations include obligate forest-interior species, for example some neotropical migrant passerine birds (Robbins et al. 1989).

Defining a standard by which a wilderness area can be judged large enough to serve as a dynamic, functional, ecological unit (Patten 1991) is difficult. The Greater Yellowstone Ecosystem (GYE) comprises "the largest, single, essentially intact functional 'natural ecosystem' in the lower forty-eight" (Patten 1991:21), but is not large enough to avoid size-dependent impacts on population viability and resource conflict (Craighead 1991), in part because GYE is governed by several jurisdictions, with only a portion managed as wilderness.

Population viability is an issue for wildlife in which the abundance of freely-interbreeding individuals is limited, such that loss of genetic diversity or demographic or environmental variability result in an unacceptably high probability that local extinction will occur over some time interval of interest (Shaffer 1981). If a wilderness area comprises the principal or only habitat for a species of wildlife, then population viability can become an issue for the global extinction of the species. More commonly, a wilderness area will be but one component of available habitat. Salwasser (1988) has suggested the viability of some species (e.g., northern spotted owl) can be used as indicators of ecosystem integrity, and integrators of resource management across noncontiguous and differently managed areas.

This concept is important because it is unrealistic to expect wilderness areas to provide all the annual needs for all species, especially those that are wide ranging (Salwasser 1988). For example, the Bob Marshall wilderness complex is composed of 0.8 million ha. Each wildlife species has its own habitat needs that may or may not be accommodated even in such a large area (Posewitz et al. 1991). Eighty

percent of the elk population of this wilderness area relies in winter on nonwilderness lands on the periphery of the wilderness. These lands are in mostly private ownership, and nearly all are open for some development. So while the wilderness offers important seasonal summer-fall use areas, it doesn't reflect the total habitat needs of elk. Critical habitat needs are even larger for species such as top carnivores, bull trout, and migratory birds.

Island biogeographic theory (MacArthur and Wilson 1967) predicts that extinction will occur more frequently, and recolonization less rapidly, for habitat "islands" that are small and isolated from the "mainland" (i.e., *pools of potential colonists*), than for larger or more "connected" habitats. There is no agreement on general rules for how "small" or "isolated" habitats have to be for population viability to be of concern, or how "large" or "connected" they need to be to reduce concerns. Much uncertainty exists about the applicability of island biogeographic theory to terrestrial vertebrates; in any event, answers to the above questions will depend on the sizes, mobilities, and home ranges of species.

The size and spatial arrangement of wilderness areas can interact with human disturbance and human-wildlife conflicts. Clearly, areas that are small, and in particular those that are bounded by developed communities or areas having greater human access, have a greater proportion of exposed area than do large areas, particularly those bordered by undeveloped or inaccessible terrain. Fragmentation of wilderness areas, especially by private or multiple-use public inholdings, similarly creates more opportunities for human access, and thus disturbance of and conflict with human-sensitive wildlife, especially some large mammals.

Fragmentation of wildlife habitats, and the existence of barriers to movements such as roads, developments, and waterways can have negative consequences for some wildlife populations. At the same time, fragmentation and "edge" will enhance habitat suitability for many early successional, edge-dependent, and generalist species.

## FIRE AND OTHER NATURAL DISTURBANCES



Fire, whether "natural" (e.g., *lightning-caused*) or anthropogenic (e.g., *accidentally or deliberately set*), almost certainly has had a profound impact on the development of vegetative communities, and thus on their faunal dependents. Some vegetative communities are fire-dependent, including several pine-dominated ecosystems such as

lodgepole, longleaf, and jackpines in the western, southeastern, and Great Lakes regions, respectively. In addition to fire-obligate systems, fire plays important roles in forming vegetative mosaics through the creation of open patches (e.g., Knight 1991) and at least temporarily can enhance vegetative productivity and nutritional quality of grasses, forbs, and browse species important to wildlife (e.g., Van Dyke et al. 1991). Regeneration of early successional areas may provide critical components of the habitat for many wildlife species in wilderness areas.

Conversely, suppression of fire is thought to disrupt natural development of plant and animal communities in several ways. If completely successful, fire suppression would eliminate fire-dependent species, and "fire-climax" ecosystems. Fire suppression can create large fuel accumulations compared to that which occurs in the presence of more frequent fires, resulting in rarer but more intense and larger burns. These larger burns can have different consequences for the resulting vegetative and animal communities, for example resulting in greater plant mortality and creation of more uniform conditions. The small size of many wilderness areas containing many ecosystem types precludes them from having natural disturbance regimes. Christensen (1988) added the concern that disturbance regimes in many ecosystem types occurring in wilderness areas are largely influenced by disturbances, such as fires, originating in other ecosystem types outside the wilderness areas, and if these areas are not allowed to function naturally, this will influence the dynamics of the wilderness area. Bailey and Woolever (1992) stated that many small wilderness areas need active management for disturbance factors in order to maintain a natural combination of successional stages. However, they found discrepancies between the BLM and the Forest Service in management directives for wilderness areas. "While an objective of wilderness is to permit lightning-caused fires to play, as nearly as possible, their natural ecological role in wilderness (FSM2324.21.10), prescribed ignitions may be used only to reduce unnatural buildups of fuels" (2324.22.6). This may preclude use of "prescribed ignitions to maintain the natural ecological roles of fire. Fortunately, the BLM Manual recognizes these other roles of fire (BLMM8560.35.3a) and allows "prescribed ignitions for maintaining fire-dependent ecosystems, sustaining a primary wilderness value, or promoting endangered species" (BLMM8560.34.C.4). "Manipulation of vegetation or wildlife habitat may be used to enhance or perpetuate the wilderness resource where natural processes have been unsuccessful, or to correct abnormal conditions resulting from human influence" (BLMM8560.34.C.2-4, FSM2323.35a). However, strict interpretation of FSM2324.22.6 would indicate that prescribed ignition of fire may not be used to manipulate vegetation for these purposes. Manipulation of habitats within wilderness

areas has also been delayed by the lack of completed wilderness management plans; and may be limited by a low federal priority and budget for wilderness.

It may not be politically or sociologically feasible to let natural processes hold sway totally uncontrolled in small natural areas or along the periphery of large wilderness tracts bordering private land. In such cases, control may be necessary. The effects of natural forces such as fire may have to be artificially reproduced. For example, well-executed controlled burns can insure the continued existence of local fire-dependent biotic communities, including prairie, shrub, or forest types. Some areas altered by past fire exclusion policies may present management challenges. Control of wildlife diseases such as brucellosis and rabies may be locally necessary, especially where wilderness borders on agricultural land.

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## HUMAN USE PROBLEMS

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### Recreational Use

Wilderness areas, by definition, present a potentially conflicting dichotomy of public expectations and management concerns. Such lands are expected to maintain their natural character, where human impacts are substantially unnoticeable, and provide "outstanding opportunities for solitude" (1964 *Wilderness Act*), while being powerfully attractive to a growing public interested in wilderness recreation. Recreational use of these areas has increased dramatically since the establishment of the wilderness system.

Increased human use of wilderness areas brings on a suite of wildlife management challenges that influence not only the natural character of the wilderness areas and their resident wildlife, but have implications for human safety. Wildlife species can be displaced from important habitats or modify their behavior to avoid areas of high human use. Disturbance during periods when animals are particularly sensitive (i.e., rearing seasons, periods of nutritional stress, etc.) can negatively influence wildlife populations. Wildlife can become habituated to humans and the unnatural food sources they provide. Large carnivores, bears in particular, are potential threats to humans that may be exacerbated by increased contact with humans, their food, and their garbage. Pets and packstock can introduce diseases and parasites into wild populations.

Management guidelines and enabling legislation for wilderness emphasize aesthetic values, solitude, and minimization of the visual effects of human presence.

These key themes in wilderness philosophy have evolved in response to urbanization and the pervasive presence of humans in most landscapes.

However, care must be exercised in managing wilderness to include the human presence, to the extent that wilderness values are not compromised. Humans have been an integral component of natural landscapes for many millennia. Human interactions with wilderness wildlife should be fostered through legal and biologically sound activities that do not degrade the wilderness experience. These activities may include wildlife viewing and photography, hunting, trapping, and/or fishing. Fostering human interactions with wilderness and its wildlife will ensure further public support for the existence of wilderness. It will also promote participation of private landowners in wildlife management activities surrounding publicly owned wilderness areas.

Human visitations of some wilderness areas and national parks have increased dramatically in recent years. Effective solutions have been developed to minimize human conflicts with dangerous wildlife, and to control negative impacts on wilderness resources. Most solutions to minimize human presence and impact are administrative, usually redistributing or controlling human use. Bear-human conflicts, sometimes resulting in serious injury or death, are a reality in some parks and wildernesses. Rerouting of hiking trails away from bear-frequented areas, including some lakes, streams, and high-country foraging areas have proven successful.

### Livestock Grazing

The Wilderness Act and subsequent legislation allow grazing, as a "grandfathered use," of wilderness areas to continue in the manner and degree that existed prior to designation of a wilderness area (Keiter 1988, Hendee et al. 1990). In 1987, 35% of all wilderness areas in the United States had grazing by domestic sheep and/or cattle (Reed et al. 1988). There are also a few horse allotments in wilderness areas (Hendee et al. 1990:361). Most of this wilderness grazing occurs in western states, and the proportion of wilderness areas with grazing must now exceed 35% because many Arizona wilderness areas have been designated since 1987. Apparently, the Bureau of Land Management and Forest Service do not routinely compile and report statistics on grazing in wilderness areas.

In recent years, some domestic sheep allotments in wilderness have been converted to cattle allotments. Generally, this has not been a controversial change. Grazing facilities (fences, line cabins, water developments) that existed before wilderness designation may be main-



tained, improved, or replaced in wilderness areas; emergency use of motorized equipment is allowed to rescue sick animals or to provide emergency feed (*Hendee et al. 1990:114*). Prescribed use of fire is allowed for maintaining livestock grazing in wilderness if it was practiced prior to wilderness designation (BLM 8560.37.A.3, FSM 2323.266.5)

Grazing is often considered a "nonconforming use" of wilderness. However, wilderness designation may not be used as a reason for reducing or eliminating grazing (*Hendee et al. 1990*). Potential negative impacts of grazing upon native wildlife include (1) forage competition, (2) degradation of soil and vegetation, especially in riparian areas, (3) watershed effects, (4) introduction of diseases, (5) introduction of exotic plants, and (6) predator control. Potential beneficial effects include (1) development of water sources where water is unnaturally limited for

wildlife, and perhaps (2) maintenance of early-successional stages that are required by disturbance-adapted wildlife.

Many disease organisms are shared by wildlife, especially wild ungulates, and livestock. The most serious and frequent disease problem has been pneumonia in bighorn sheep following contact with domestic sheep. There are 28 reports of declines or die-offs of bighorn following exposure to domestic sheep (*Goodson 1982, Onderka and Wishart 1988, Onderka et al. 1988, Desert Bighorn Council Technical Staff 1990, Foreyt 1990, Callan et al. 1991*). In all cases, bighorns died while domestic sheep remained healthy. Grazing by cattle also appears to be a disease threat to bighorn (*Jessup 1985, Onderka et al. 1988, Spraker and Adrian 1990*); but few problems have been documented, probably because cattle and bighorn ranges rarely overlap significantly.

Impacts of grazing on wildlife habitat in wilderness areas will vary depending upon the species of livestock and the intensity, timing, and duration of grazing. Much of the wildlife literature on effects of grazing upon fish, wildlife, and biological diversity emphasizes negative effects. Positive effects have also been documented.

#### Mining and Oil and Gas Developments

Additional grandfathered uses of wilderness areas are mining and oil and gas developments. Beum (1990) reported that 9% of wilderness areas in 1987 contained active mining claims. Valid claims staked before 1984 can be worked at any time. In addition, motorized equipment can be used in the mining if it is deemed "essential." Reclamation of abandoned claims, as for all mining activities on federal lands, remains a problem. Similarly, many oil and gas leases issued prior to designations of wilderness areas could become operational within wilderness areas. In

Canada, the Province of British Columbia is the only jurisdiction that allows mineral, gas, and petroleum exploration and development in wilderness areas. Such developments appear to be contrary to the primary objectives of wilderness designations.

#### Environmental Contaminants

Environmental contaminants, in particular air and water-borne chemical contamination, have the potential for seriously affecting wilderness areas. Except for specific instances of point-source pollution (e.g., chemical spills at a particular site), there exist few good data on the long-term and cumulative impacts of such environmental insults. Possible long-term impacts of air pollution include tree mortality, and resulting shifts in vegetative community composition (e.g., *Grigal 1988*), with obvious implications for dependent fauna. Lake and wetland acidification from acid precipitation is well-documented, and has been particularly serious in northeastern wilderness areas such as the Adirondacks, requiring management intervention to restore disrupted aquatic systems, even with the cessation of further inputs (*Schofield 1988*). More recent concerns have arisen about the potential for long-term disruption of vegetative and animal communities with rising global temperatures.

Research directed at the monitoring of relatively pristine systems, such as wilderness areas, can serve as important control areas in ultimately understanding these problems.

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## WILDLIFE MANAGEMENT ISSUES

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While substantial amounts of land have been given wilderness status and protection, this alone has not assured maintenance or enhancement of the wildlife values associated with these lands. Numerous problems have been identified that have limited wildlife benefits as well as attainment of biological diversity goals from wilderness areas.

#### Exotics in Wilderness Areas

A major threat to native species and ecosystems is the planned and unplanned introduction of exotic species. Exotics can be considered as both Eurasian or other foreign species released in North America, or North American species transported by humans to new locations where they did not occur naturally. Wilderness areas are not immune to the problems of exotics. Exotics can be major problems by competing with native species, and in this way altering the natural species composition, and in

extremes, ecosystem processes. They may also interbreed with similar native species, changing gene pools and even appearances and behaviors of native species. Wright (1992) discussed problems with many exotic mammals in U.S. National Parks. Even greater threats exist from the spread of exotic plant species, which may change the structure of plant communities. Everglades National Park is threatened by many exotics, which may require active removal to maintain native plant communities and their associated fauna.

Wood Buffalo National Park in Canada was established in 1922 to protect wood bison. Plains bison were introduced later, and disease transmission and genetic contamination from these animals are risks to the wood bison population as is further agricultural development outside the park (*The Wood Bison Recovery Team 1987*). This serves to illustrate that even the second largest park in the world (44,807 sq. km) is not immune from problems brought about by poor wildlife management planning. Thus, a major issue may develop in wilderness management concerning the active role of managers in removing exotic species. Acceptable methods of control will need to be researched and discussed, and appropriate policies established to deal with this threat.

### **Wildlife Population Management**

Allowing ecological processes to proceed without human interference often is not realistic, and likely to be confined to large areas that either "have not been affected substantially (by human process) or that can be restored if they have been" (Peek 1986: 410). The fact that many, if not most, statutory wilderness areas are not intact, undisturbed ecosystems in any sort of long-term equilibrium, poses specific problems in wilderness wildlife management. A difficulty is that even anthropogenically unaltered ecosystems are dynamic; ecosystems, even unmanaged ones, will change through time (e.g., Brubaker 1988), so that the absence of management is a de-facto decision for a different set of future conditions (Johnson and Agee 1988). The goal cannot be the freezing in time of some "vignette" of ecological development, but rather the restoration of ecological processes where these have been disrupted (Boyce 1991, Botkin and Sobel 1975). An ideal is to allow ecological processes to operate unimpeded by human intervention, but paradoxically, periodic human intervention may be required to achieve that goal (Boyce 1991). Active wildlife management may in fact be needed, if wilderness areas are to retain wilderness values (Peek 1986: 410); but specific management actions that minimize human interference should always be favored.

### ***Predator/Prey Relationships***



Populations of large carnivores (especially wolves and cougars) had been reduced or eliminated in most U.S. areas by the time they received wilderness designation. In many statutory wilderness areas, there has been no substantial influence by large predators on prey populations for many years. Top predators may enhance the maintenance of vegetative diversity and ecosystem integrity (e.g., Peterson 1988), but management often will be required, both for the reintroduction and maintenance of viable populations and for dealing with the inevitable human-wildlife conflicts. Woodland caribou serve as a good example of what problems are faced by wildlife managers in wilderness areas. Predation can be a major factor limiting woodland caribou populations (Bergerud 1974, Bergerud and Elliot 1986, Farnell and McDonald 1987, Gasaway et al. 1983, Seip 1990, 1991). Habitat changes in woodland caribou range which enhance alternate prey species (moose, elk, mule deer, white-tailed deer) or reduce caribou habitat which concentrates the caribou and increases their density may undermine their wolf avoidance strategies and lead to increased predation rates (Seip 1990, 1991). Caribou have been reported to spread out at low densities away from other prey species to avoid higher predation rates (Bergerud et al. 1984, Bergerud and Page 1987, Edmonds and Smith 1991, Seip 1990, 1991). In Alberta, a large proportion of the mountain race of woodland caribou summer in Willmore Wilderness Park and the northern end of Jasper National Park and winter in the boreal foothills (nonwilderness). One of the major concerns for the long-term survival of these herds is that logging activities on winter range will concentrate caribou thereby resulting in higher predation rates by wolves (Edmonds 1988). Wolf control is not currently a publicly supported alternative in Alberta.

### ***Habitat Degradation***

One serious, potential consequence of high abundance of some wildlife populations, especially large herbivores, is their effects on vegetation from browsing, grazing, and trampling. Of significant concern is the potential for loss of rare and endangered plants (Bratton 1979, Warren and Ford 1990) and the disruption or even local extinction of rare fauna, because of direct loss of habitats or seral stages important to wildlife (e.g., Scott and Yahner 1989, Casey and Hein 1983).

Most concern over high populations of white-tailed deer and other herbivores has centered on small, usually Eastern U.S. parks and other areas, especially islands and fragmented areas surrounded by agriculture (e.g., Warren 1991). Deer browsing has reduced plant diversity and threatened less abundant plant species in the Great Smoky

Mountain National Park, site of a relatively large and important eastern wilderness area (Bratton 1979). Viewpoints differ over the extent to which "overgrazing" may be deleterious on larger areas (e.g., GYE; Boyce 1991, Cayot et al. 1979, Chadds and Kay 1991, Coughenour and Singer 1991).

### Hunting



Legal mandates regarding hunting vary for the responsible public land management agency, ranging from often not allowed (NPS lands) to almost always allowed (USFS and BLM lands) (Schoenfeld and Hendee 1978: 73). Hunting "can offer a popular and healthy . . . activity if it is carried out [in a way that] . . . protect[s] wilderness from overuse and ensures wilderness-dependent experiences" (Schoenfeld and Hendee 1978: 74). Further hunting may somewhat replace the role of large extirpated predators. However, hunters are not ecological equivalents of wild predators, employing distinctly different criteria in the selection of animals than do wild predators (Schoenfeld and Hendee 1978: 75). Hunting activity that alters long-term behavior patterns of animals, or significantly skews population age or sex ratios, would be inimical to wilderness goals (Peek 1986: 411).

Hunting is allowed in the majority of the legislated wilderness areas in Canada. There are weapon restrictions in some of these. In contrast, in Alberta, a very strict Wilderness Areas Act not only prohibits hunting in three of its four wilderness areas, but also restricts trapping, fishing and even horse travel. This has had the predictable result of eroding support for the establishment of new wilderness areas in this province (Hummel 1989).

### Translocations

#### Species Restorations

Reintroduction of extirpated species, especially important predators or keystone species, may be critical to restoration of wilderness processes and ecosystem values (e.g., Warren et al. 1990, Mech 1991, Singer 1991). However, "wilderness should not be used solely to benefit endangered species when alternative land classification will offer equal or better protection" nor should translocations impair "significant wilderness values" (IAFWA 1976, cited in Peek 1986: 14).

Restoration of original fauna does restore several wilderness values, but, reestablishment of one faunal component may involve risks or tradeoffs, and may disrupt the existing equilibrium of a system (however artificial or perturbed that system may be). Examples are reintroduction of large predators such as wolves or grizzly bears, which are

controversial from both a human safety standpoint, and their possible impact on populations of visible desirable game species. Human perceptions of a quality wilderness experience may not include real or perceived danger from predator attacks, or reductions in abundance of visible and attractive (and huntable) species such as deer (Peek 1986: 412), even though danger is an integral quality of wilderness implied in the enabling U.S. legislation.

### Maintenance of Viability

Besides restoration of native fauna that have been extirpated, translocations may be needed to maintain the viability of small populations, especially those with large area requirements or having low migration rates. Species for which the available gene pool includes populations separated by hundreds of kilometers, may require periodic translocations from populations, simply to maintain genetic variability. Again, issues of population viability and the need for such maintenance measures are likely to be of more concern on small or isolated wilderness areas, than in large areas that are parts of similar, contiguous habitat.

### Habitat Management

Ordinarily, one would think of habitat management in the context of some deliberate alteration of vegetation structure or composition to favor a particular successional stage or group of associated animals. Habitat manipulation, including prescribed burning, for these purposes may not be compatible with wilderness management guidelines, unless some broader ecosystem objective (e.g., the restoration of a fire-climax community that had been suppressed through previous fire control) is addressed. As an example, an endangered species extant on a southeastern wilderness area (e.g., red-cockaded woodpeckers might depend on fire, but it would not be appropriate to prescribe fire except as part of the restoration of an ecosystem such as the longleaf pine-wiregrass ecosystem, or the shortleaf pine-bluestem ecosystem (Masters et al. 1993).

### Access for "Management" Activities

Many accepted wildlife management activities can be considered unsuitable for use in wilderness areas by the land management agencies or the public. Active management of wildlife and their habitat (i.e., water development, construction of nesting structures, habitat improvement, prescribed fire, predator control, etc.) may not be deemed in keeping with the mandates of the Wilderness Act of 1964 that such areas are "without permanent improvements" and "appear to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable." The BLM manual does not allow

wildlife species (BLMM 8560.34.C.3). However, habitat may be managed for endangered species, and for other species, if management is needed to sustain wilderness values and to correct conditions due to human activities (FSM2323.35.A, BLMM opcit).

Further, the use of motorized transportation, such as airplanes, snow machines, and motor boats, to conduct population monitoring or for management/research activities such as capturing wildlife for marking or transplants, can be deemed in conflict with maintenance of wilderness values. The Wilderness Act of 1964 excludes the use of motorized transportation, in general, but provides for their use "as necessary to meet minimum requirements for administration of the area for the purpose of this Act. . ." However, management jurisdictions have widely varying interpretations of this clause (*Bailey and Woolever 1992*). In Alaskan wilderness areas, the use of airplanes, snowmachines, and motorboats was specifically allowed in the enabling legislation (*Alaska National Interest Lands Conservation Act of 1980*).

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## RECOMMENDATIONS



Clearly, wildlife management in wilderness areas faces many difficult challenges. While solution to these challenges might be complex, some direction can be suggested.

**Manage for ecologically complete areas:** The lack of an ecological perspective in delineating most wilderness areas has been a major cause of many wildlife problems. Where opportunities exist to expand wilderness boundaries to include ecosystem components, such as ecologically complete habitat, additional designations may be appropriate. In most cases, these expansions may not be feasible, so managing surrounding buffer zones to enhance these functions may be a solution. Properly applied ecosystem management should accomplish these goals. This kind of approach will require landscape level evaluations and would also help address concerns about habitat fragmentation.

**Provide larger-sized habitats:** Many wildlife problems in wilderness derive from the relatively small sizes, disjunct distributions and ecologically inappropriate shapes of designated wilderness areas. Hence, tracts of wilderness are frequently too small to accommodate populations of wide-ranging large vertebrates. Or, the distribution and shapes of designated wilderness areas do not include the variety of ecotypes necessary for survival of sensitive species. Public acquisition of key land tracts to enlarge

and consolidate wildlife population refugia may be effective to perpetuate survival of human-sensitive wildlife populations. Where acquisition of public land is not feasible or desirable, a measure of wildlife protection may be achieved on private lands by enlisting the cooperation of local landowners. Economic incentives, including conservation easements and mitigation of regulations to accommodate wildlife - agriculture conflicts have proven successful. Private landowners may be willing to cooperate for the public good. Beyond incentives, the key to enlisting the cooperation of landowners is their perception that they are dealt with honestly and fairly, and that they are involved in the planning of wildlife management strategies.

**Promote natural ranges of habitat diversity:** Within designated wilderness areas, a major problem can be the lack of a natural diversity of successional stages caused by human alterations of disturbance patterns. Adopt an ecosystem management approach to these areas when developing wilderness implementation plans. Agencies could then better justify the use of planned vegetation manipulations, such as controlled burns, to meet ecosystem management goals compatible with the wilderness designations.

**Restore integrity of natural process:** Central to the management of wilderness and its wildlife is the premise that natural processes operate at near-normal levels (levels unaffected by European settlement). Such processes include fire, wind, and ice storms, herbivory, predation, plant and animal diseases, and tree fall in old growth forests. The actions of these processes will foster the continued presence of endemic biota, including wildlife species that have evolved in local wilderness ecosystems. The principal role of management is to ensure the integrity of these processes and their continued function.

**Adopt active-adaptive management:** Wilderness management plans should consider the active-adaptive management approach, as proposed by Johnson and Agee (1988). In this approach: (1) Primary wilderness components are identified. These may be populations, species, biotic communities, natural processes such as animal movements, or synthetic measures of the biota such as community linkages. (2) Wilderness goals are established for these primary components. Goals may be stated as ranges for natural fluctuations. (3) Primary components are monitored to detect deviations from goals. (4) Deviations trigger responses within the minimum-necessary intervention for restoring natural conditions.

**Monitor wilderness biological diversity:** Wilderness areas are often the last regional harbors for some rare and threatened wildlife. Wilderness ecosystems can retain high levels of biotic diversity amid human-dominated land-

scapes that have lost species diversity. Wilderness ecosystems with their biotic diversity serve as scientific controls against which human impacts on biotic communities can be measured. Hence, high priority in wilderness management should be given to fostering wilderness-dependent biodiversity. Wilderness managers should strive to monitor the composition, distribution, and population densities of indigenous plants and animals so that factors threatening their survival are detected early. Negative factors affecting wilderness areas such as acid precipitation, introductions of exotic species, exotic diseases, and livestock impacts often occur on an ecosystem-wide scale. Control of such factors is usually not within the immediate management purview of the wilderness in question, but rather is a political matter of extensive proportions. Ultimately, fostering high quality in North American wilderness resources, including wildlife, is a matter of cooperation among all North American publics and all agencies responsible for natural resource management, continent-wide.

**Coordinate agency management:** A complete review of agency regulations, manuals, and plans is necessary to ensure that all wilderness values are addressed and that the hands-off approach of managing wilderness primarily for recreation is reevaluated. Discrepancies between agencies should be cleared up to simplify management of wilderness complexes managed by several agencies. All agencies should seek to develop cooperative strategies and uniform wildlife management guidelines. Consolidation of authority over wilderness areas may help simplify management. Multiple agency approaches to ecosystem management may also help resolve some potential conflicts.

**Adapt livestock grazing to wilderness goals:** Livestock grazing in wilderness should be critically reviewed to develop a clear picture of the extent of impacts on resources, and to evaluate possibilities for eliminating or reducing livestock from areas where grazing threatens the maintenance of wildlife populations or ecosystems. As grazing management is reviewed for all public lands, it would be ironic if the least control could be implemented for wilderness areas due to the legal mandates of the enabling legislation.

**Control human activities that compromise wilderness values:** In some wilderness areas, management of human uses has already become necessary and additional restrictions are anticipated. Where the level of use interferes with wilderness objectives, particularly with the needs of wildlife species that are sensitive to human activities, restrictions may be needed. Solutions to human management problems in wilderness will continue to depend on innovative local solutions.

**Ungulate population control:** Control of ungulate populations may be necessary on or adjacent to wilderness areas. Such areas may be ecologically and spatially inadequate to support indigenous ungulate population controls including native predators, disease, periodic malnutrition, and other factors. High ungulate densities can severely affect local plant and animal communities, causing local declines in species diversity. An important priority of wildlife management in wilderness should be to foster wildlife population levels that are natural (i.e., have evolved there, as estimated over a long time span). Where feasible, the goal of management should be to control such excessive populations through non-artificial means including predation by native predators, wildlife diseases, and other factors. Where native predators such as the wolf, cougar, or bears have been extirpated, predator restoration should be encouraged, if ecologically and politically feasible. Elsewhere, other controls such as special public hunts (where legal), controlled shooting, trap and transfer, and reproductive controls are appropriate. In all human interventions to adjust wildlife populations, care should be exercised to foster the normal wild behaviors of wildlife. Semi-domestication of wild animals, for whatever reason, will detract from the quality of the wilderness experience. Behavioral modifications of wildlife should be kept to a minimum. Maintaining a high degree of wildness in wildlife will enhance the quality of wilderness.

**Secure funding:** No recommendations will have much effect if management of wilderness areas does not have adequate funding for agency activities or in federal budgeting. The "lands that nobody else wanted" syndrome still influences the prioritization of these areas. Fees for wilderness use may need to be assessed.

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## RESEARCH NEEDS



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Many information needs are apparent from the discussion of wildlife management in wilderness areas. For example, to implement ecosystem management, clear models or understanding of the successional pathways of different biological communities in wilderness areas will be needed. These successional models should incorporate the role of selected disturbance factors, so that management activities, if needed, can be properly planned and executed.

Additional research on the importance of wilderness areas to the maintenance of biodiversity would help document the ecological significance of these areas. While some wilderness areas have been shown to serve as refugia for wildlife, especially some species of large animals, the importance of wilderness areas to other wildlife is poorly documented. Additional information could assist in

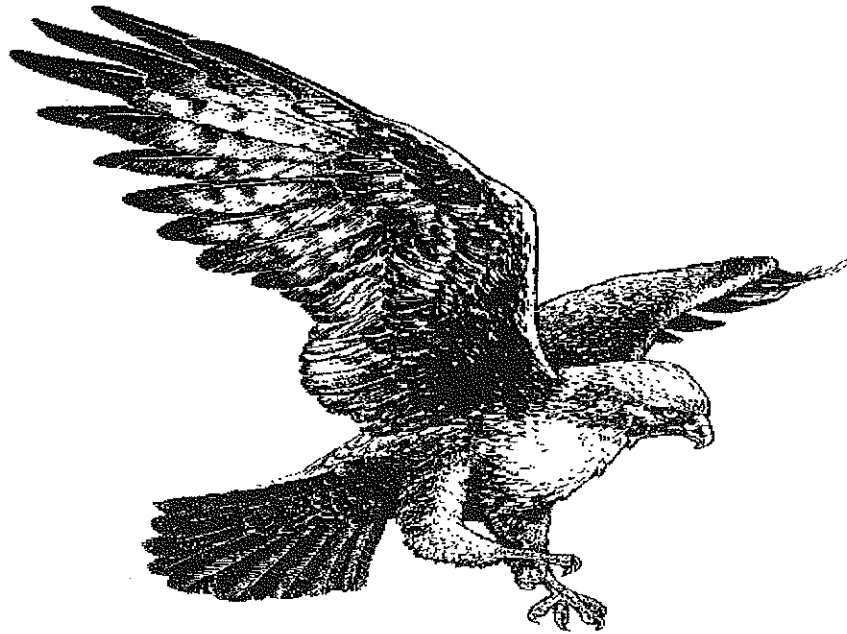
increasing wilderness priority in funding allocations. Research of this type would also help reveal where additional size or complexity of wilderness areas could be of benefit, either through wilderness designations or an ecological focus on the management of surrounding lands.

A potential major problem that needs additional research is the impact of exotic plants and animals on wilderness ecosystems. This research should also address solutions to the problem of exotics.

It has been suggested that wilderness areas have intrinsic value as "natural laboratories" where the relationships among species and habitats can be observed and studied" (Schoenfeld and Hendee 1978, p. 30), and as a "biological standard" for comparison to anthropogenically disturbed areas (Schoenfeld and Hendee 1978: 31), even though significant anthropogenic effects have altered many designated wilderness areas. It should also be clear from the above discussions that decisions about whether and

how to manage wilderness areas for wildlife are hampered by an imperfect understanding of how these systems functioned prior to significant impacts (e.g., Whitlock et al. 1991), and more critically, how best to return disrupted systems to a more pristine state.

Wilderness areas can be important elements of national and international efforts to better understand how relatively intact ecosystems function, and how to better manage lands for conservation. Wilderness areas should be included in a research-management network directed toward (1) baseline monitoring of ecosystem impacts of global anthropogenic factors (e.g., acid rain, global warming), (2) adaptive management (Walters 1986) schemes in which wilderness areas serve as controls to landscapes manipulated under forest, wildlife, and other management, and (3) where consistent with wilderness values, adaptive management of wilderness itself to achieve goals of ecosystem restoration and biological diversity conservation (e.g., Murphy and Noon 1992) while learning more about the systems under management.



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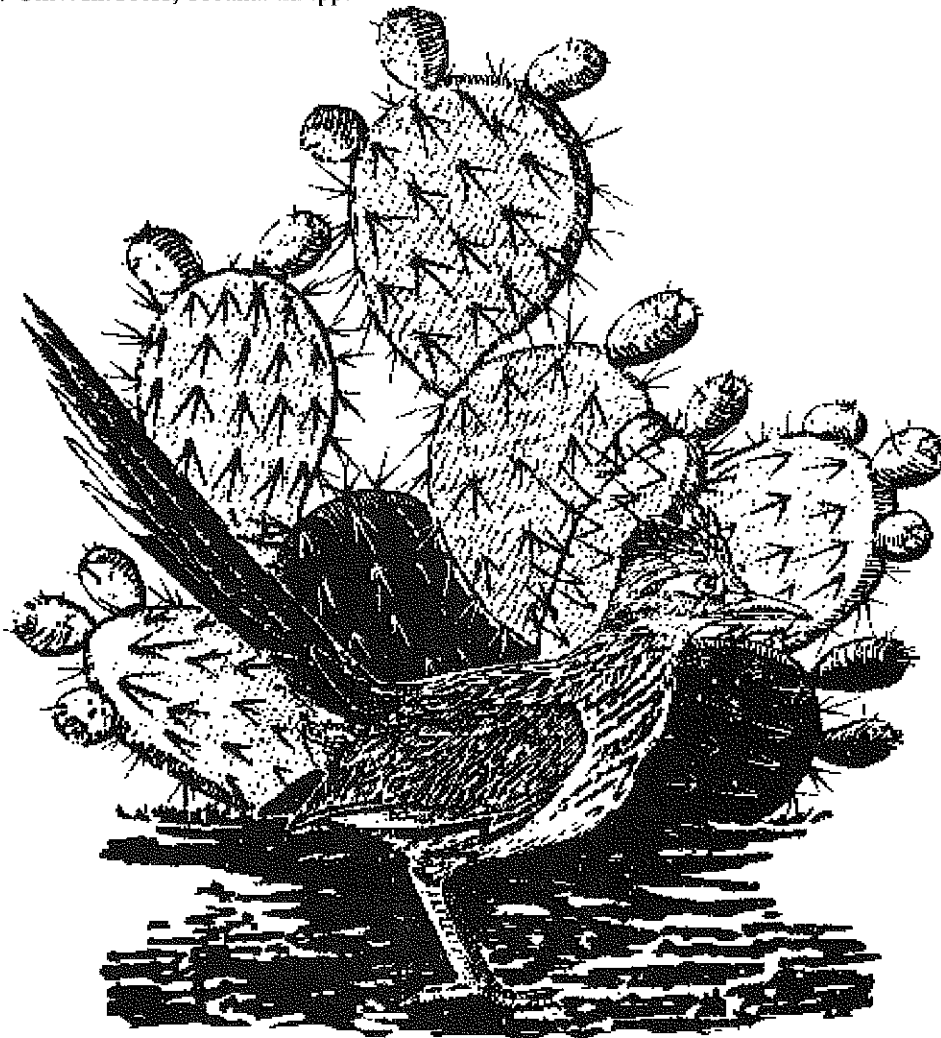
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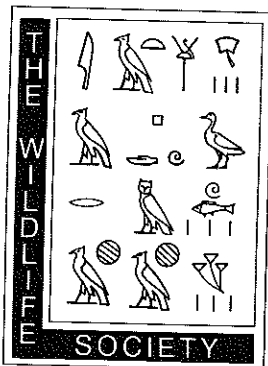
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**APPENDIX--- Common and scientific names of species**

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<u>Common Name</u>	<u>Scientific Name</u>
Loon	<i>Gavies immer</i>
Bison	<i>Bison bison</i>
Grizzly Bear	<i>Ursus horribilis</i>
Northern Spotted Owl	<i>Strix occidentalis caurina</i>
Elk	<i>Cervus elaphus</i>
Bull Trout	<i>Salvelinus confluentus</i>
Bighorn Sheep	<i>Ovis canadensis</i>
Wolves	<i>Canis lupus</i>
Cougar	<i>Felis concolor</i>
Woodland Caribou	<i>Rangifer tarandus</i>
Moose	<i>Alces alces</i>
Mule Deer	<i>Odocoileus hemionus</i>
White-Tailed Deer	<i>Odocoileus virginianus</i>
Lodgepole Pine	<i>Pinus contorta</i>
Longleaf Pine	<i>Pinus palustris</i>
Jack Pine	<i>Pinus banksiana</i>
Short-Leaf Pine	<i>Pinus echinata</i>
Bluestem	<i>Andropogon spp.</i>
Wiregrass	<i>Aristida stricta</i>
Red-Cockaded Woodpecker	<i>Picoides borealis</i>



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The Wildlife Society is the association of wildlife professionals dedicated to excellence in wildlife stewardship through science and education. The goals of The Wildlife Society are to: develop and maintain professional standards for wildlife research and management; enhance knowledge and technical capabilities of wildlife managers; advance professional stewardship of wildlife resources and their habitats; advocate use of sound biological information for wildlife policy and management decisions; and increase public awareness and appreciation of wildlife management. The Wildlife Society, founded in 1937, is a nonprofit organization whose members include research scientists, educators, resource managers, administrators, communications specialists, conservation law enforcement officers, and students from more than 70 countries.