PROCEEDINGS

OF THE 31st ANNUAL MEETING

THE MONTANA CHAPTER

THE WILDLIFE SOCIETY

GREAT FALLS, MONTANA - FEBRUARY 24-26, 1993

FORWARD

The 1993 annual meeting of the Montana Chapter of the Wildlife Society was held 24-26 February at the Sheraton Hotel in Great Falls. This meeting was held in conjunction with the annual meeting of the Montana Chapter of the American Fisheries Society. This was the first time that the two societies had met together in over a decade.

The first day of the conference was devoted to concurrent sessions from both societies consisting of papers and panel discussions. In addition to the papers that follow, a panel discussion titled "The Future of Game Ranching" occurred during the afternoon. Panel members included: Heidi Youmans (Montana Dept. Fish, Wildlife, and Parks), Dr. Don Ferlicka (Montana Dept. of Livestock), Les Graham (Executive Secretary of the Montana Game Breeders Association), and Joe Gutkoski (Montana Wildlife Federation).

The second day included a morning plenary session with Keynote addresses provided by Glen Marx (Natural Resource Aide to Governor Racicot) and Pat Graham (Director Montana Department of Fish, Wildlife, and Parks). Legislative updates were given by Stan Bradshaw (Lobbyist, Trout Unlimited), Jim Richards (Lobbyist, Montana Wildlife Federation), Bob Ream (Legislator, House of Representatives), and Don Bianchi (Legislator, Senate).

In the afternoon a panel discussion entitled "Elk Management in the 90's - Shifty Paradigms?" was held. Panelists included: Mike Hillis (Lolo National Forest), Dave McCleery (Bureau of Land Management), Mike Thompson (Montana Dept. Fish, Wildlife, and Parks), Greg Watson (Plum Creek Timber Co.), and Alan Wood (Montana Dept. of State Lands).

The Wildlife Society Business Meeting was held during the afternoon prior to the joint evening banquet. The Distinguished Service award was presented to L. Jack Lyon and the Bob Watts Communications Award was presented to Craig and Pam Knowles. Kevin Podruzny (MSU) and Denali Henderson (UM) were recipients of the Wynn Freeman Scholarships.

The final day was devoted to papers during the morning with the session closing with an address from Hal Salwasser National President-Elect of The Wildlife Society.

Special thanks are due Harvey Nyberg, Randy Matchett, Marilyn Wood, and Tim Thier for their services as session chair-persons and to Gary Dusek and Les Marcum as panel moderators. These proceedings were compiled and edited by Wayne Kasworm.

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MONTANA CHAPTER, TWS, OFFICERS

YEAR	PRESIDENT	VICE PRESIDENT	SECRETARY-TREASURER
1963-64	Jack Lyon	Tom Mussehl	Les Pengelly
1965-66	Louis Moos	Phillip South	Curtis Halvorson
1966-67	John Harris	Robert Howe/ Jack Schmautz	Tom Mussehl
1967-68	Harold Picton	Gerry Atwell	Bob Hensler
1968-69	Reuel Janson	Duane Pyrah	Duane Whitmer
1969-70	Arnold Foss	Curtis Halvorson	K. Johnson
1970-71	Buck Compton	Roger Bumstead	William Radtkey
1971-72	Bart O'Gara	Charles Eustace	John Firebaugh
1972-73	Roger Bumstead	John Weigand	Robert Ream
1973-74	Dick Mackie	Jim Cole	Gene Allen
	PRESIDENT	**PRESIDENT-ELECT**	**SECRETARY-TREASURER**
1974-75	Jim Cole	Duane Pyrah	Frank Gjersing
1975-76	Duane Pyrah	Bob Martinka	Rick Wallestad
1976-77	Bob Martinka	Dick Knight	Glen Erickson
1977-78	Dick Knight	Ken Coop/ Terry Lonner	Jack Jones
1978-79	Terry Lonner	John Weigand	Jim Cross
1979-80	John Weigand	Bob Hensler	John Cada
1980-81	Bob Hensler	John Ormiston	John Mundinger
1981-82	John Ormiston	Charles Eustace	Jon Swenson
1982-83	Charles Eustace	Jon Malcolm	Mike Hedrick/ Gary Olson
1983-84	Jon Malcolm	Arnold Dood	Gary Olson
1984-85	Arnold Dood	Rich DeSimone	Dave Pac
1985-86	Rich DeSimone	Heidi Youmans	Steve Knapp
1986-87	Heidi Youmans	Alan Christensen	Harvey Nyberg
1987-88	Alan Christensen	Joe Ball	Harvey Nyberg
1988-89	Joe Ball	Mike Aderhold	Ray Mule'
1989-90	Mike Aderhold	Fritz Prellwitz	Ray Mule'
1990-91	Fritz Prellwitz	Keith Aune	Bill Haglan
1991-92	Keith Aune	Gary Dusek	Bill Haglan
1992-93	Gary Dusek	Wayne Kasworm	Gary Hammond
1993-94	Wayne Kasworm	Dennis Flath	Gary Hammond

MONTANA CHAPTER, TWS
AWARD RECIPIENTS

Established 1976

YEAR		
1976	The first chapter award was made for professional achievement and presented to Wynn Freeman prior to establishment of current chapter awards.	
	DISTINGUISHED SERVICE	BIOLOGIST OF THE YEAR
1977-78	Bob Greene	
1978-79	Reuel Janson	
1979-80	Merle Rognrud	
1980-81	Faye Couey	
1981-82	Bob Eng	Tom Mussehl
1982-83	Jim Posewitz	Mike Rath
1983-84	Ken Walcheck	
1984-85		Dale Harms
1985-86		
1986-87	Richard Mackie	
1987-88	Jim Mitchell/ Larry Thompson	Duane Pyrah
1988-89		
1989-90	Jim Phelps/ Joe Egan	Gary Hammond/ Neil Martin
1990-91	Jerry Gallagher	Scott Denson
1991-92	Jack Jones	Mike Thompson
1992-93	Jack Lyon	

COMMUNICATIONS**

1989-90	Gary Dusek
1992-93	Pamela and Craig Knowles

** The award was established in 1990 by the "Bohemian Corners Foundation" and renamed the "Bob Watts Communication Award" by a bylaw change in April 1991 in memory of C.R. "Bob" Watts, a member of the Foundation.

MONTANA CHAPTER, TWS

WYNN FREEMAN SCHOLARSHIP AWARD
Established 1979

YEAR	RECIPIENTS	
1980-81	Karl Grover (MSU)	
1981-82	Tim Andryk (MSU)	
	MSU	UM
1982-83	Jody Canfield	Robin Rae Brown
1983-84	Scott Greer	Rob Bennets
1984-85	John Vore	Sandra Noble
1985-86	Scott Jackson	Susan Reel
1986-87	Katie Albrecht	Mark Hurley
1987-88	Timothy Ferguson	**
1988-89	**	Chris Loggers
1989-90	Shawn Bayless	Nathan Hall
1990-91	Thomas Baumeister	Mike Gibeau
1991-92	Jim Williams	John Hughs
1992-93	Kevin Podruzny	Denali Henderson

** Name of recipient was unavailable at time of printing.

THE EFFECTS OF HUMAN DISTURBANCE MITIGATION ON COMMON LOON PRODUCTIVITY IN NORTHWESTERN MONTANA

LYNN M. KELLY, Montana Loon Society, 6525 Rocky Point Road, Polson, MT 59860

SUMMARY

Productivity and effects of human disturbance on common loons (*Gavia immer*) was studied from 1986-1991 in the Tobacco-Stillwater and Clearwater-Swan drainages in northwestern Montana. Observations determining the amount of time spent off nests and the reasons for leaving nests occurred on weekends between 1 May and 15 June during 2 or 4 hour time periods. Time off the nest was quantified using a stopwatch. The critical disturbance distance (the distance at which an approaching boat caused an incubating loon to leave the nest) was determined using a compass and a range finder with a 914 m capability. At the beginning of each observation period the distance and angle between myself and the incubating bird was recorded. If the loon left the nest, the same two measurements were recorded for the approaching boat. The Law of Cosines was then used to calculate the distance between the approaching boat and the loon nest.

Human related disturbance, which included boats and shoreline activities, accounted for 59% of observed flushes and kept loons off their nests an average of 24 minutes per flush. Twelve (52%) of the 23 boats involved in flushing loons were fishing boats. Canoes, kayaks, and rowboats were also observed disturbing nesting loons. Natural activities taking loons off the nest included territorial activities, nest building, heat stress, and insect harassment. These activities accounted for 40% of the flushes and lasted an average of 8 minutes per flush.

Average flushing distances due to approaching boats for the 4 weeks of incubation were 129, 121, 91, and 64 m respectively. Floating signs were placed 137 m (150 yds) from nest sites and formed a voluntary closure around the area. The number of successful nests, number of chicks, and the number of 2-chick broods were significantly increased after the use of the protective floating signs. The increased number of 2-chick broods is especially significant since this represents the maximum breeding potential of common loons (McIntyre 1975). Yonge (1981) determined that the second egg and chick are expendable. Thus, the voluntary closures are giving the loons the extra time needed to bring the second chick off the nest.

When the lakes involved in voluntary closures were categorized by size, the number of 2-chick broods were significantly increased on small lakes (< 250 ha) after the use of floating signs. Thus, when personnel, time, and money are limited, smaller lakes with a breeding pair will benefit more from this management strategy than larger lakes.

Proper placement of floating signs is important. Three to 6 signs should be placed approximately 150 yards in a semicircle

around the nest site. The number of signs will be determined by the location of the nest site. If the signs are placed too far out, their effectiveness diminishes as people may not see the signs and inadvertently enter the nesting area. Despite excellent compliance, signs which close off too large of an area (those which were placed more than 150 yds from the nest) may be ignored, removed, or vandalized.

Once the voluntary closures are in place, public education about the signs and their purpose will greatly improve public compliance. The most effective way to do this is to have an individual talking to the public at the public access sites as they are putting boats into the water. A spotting scope set up on the boat ramp which enables people to see the nesting loon further enhances public knowledge and compliance with voluntary closures. Newspaper articles, radio, TV, and educational talks given to various sporting groups are important components in the public education efforts.

Signs are left in the water for 1-3 weeks after hatching to allow chicks to become strong enough to leave the protected nursery area. However, signs can be removed immediately if the adults move the chicks out of the voluntary closure soon after hatching. It is important to remove the signs within this period of time because if they are left in place, they will be gradually ignored by the recreating public. This may encourage noncompliance during the next nesting season.

LITERATURE CITED

McIntyre, J. W. 1975. Biology and behavior of the common loon (*Gavia immer*) with reference to its adaptability in a man-altered environment. Univ. of Minnesota. Ph.D Thesis. 230pp.

Yonge, K. S. 1981. The breeding cycle and annual production of the common loon (*Gavia immer*) in the boreal forest region. Univ. of Manitoba, Winnipeg. M.S. Thesis. 131pp.

STATUS, DISTRIBUTION, AND TRENDS OF LYNX POPULATIONS IN THE CONTIGUOUS UNITED STATES

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EDWARD O. GARTON, Department of Fish and Wildlife Resources, College of Forestry, Wildlife and Range, University of Idaho, Moscow, ID 83843

The Canada lynx (*Felis canadensis*) inhabited most of North America including much of the United States historically (Hall and Kelson 1959; Figure 1) but has been eliminated from approximately seventeen states, surviving in a few states that retain tracts of taiga. Current evidence examined in this paper suggests that lynx do not occur in some areas recently suggested as lynx range (e.g. Brittell et al. 1989; Figure 2), based upon the absence of recent documentations from many areas.

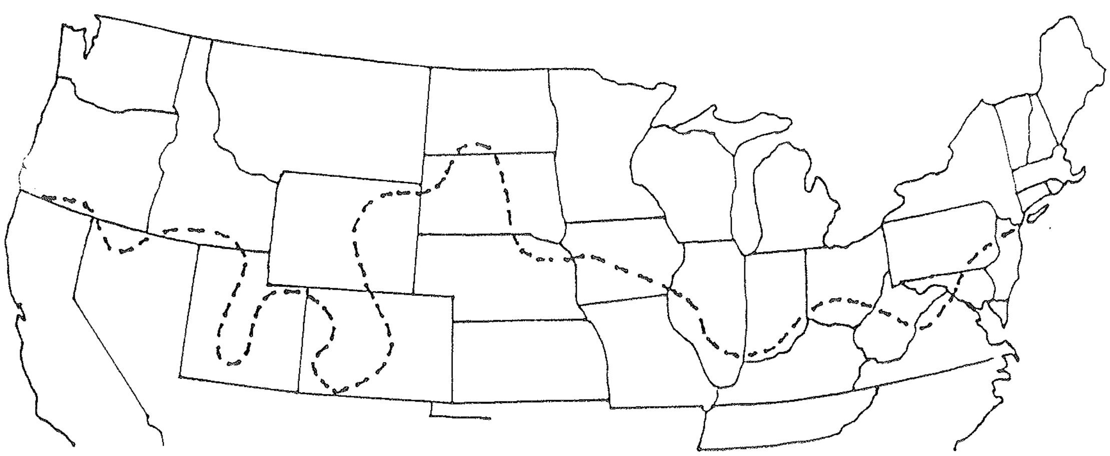

Figure 1. Historical distribution if the Canada Lynx along the southern limit of its North American range (from Hall and Kelson 1959).

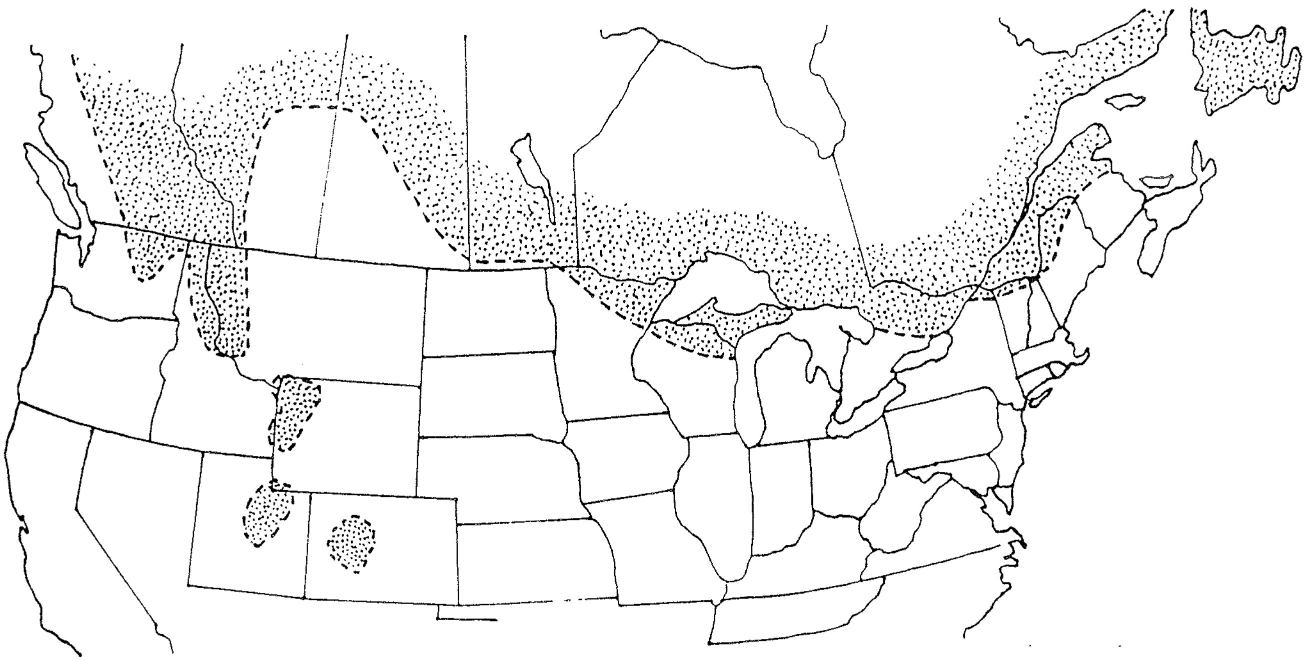

Figure 2. A recent lynx distribution map (from Brittell et al. 1989).

Ecology

Lynx generally occur at relatively low densities with home range sizes ranging from 9 km² to 246 km² (Saunders 1963, Nellis et al. 1972, Berrie 1973, Brand et al. 1976, Koehler et al. 1979, Carbyn and Patriquin 1983, Parker et al. 1983, Stephenson 1984, Brainerd 1985, Bailey et al. 1986, Brittell et al. 1989). They are capable of long-distance dispersal--644 km in one instance (K. Gustafson, SUNY, Syracuse, pers. commun.). Lynx population levels are often closely correlated to those of snowshoe hares (*Lepus americanus*), their principle prey, which undergo regular cycles of increase and decrease (Elton and Nicholson 1942, Dymond 1947, Wing 1953, Keith 1963, Van Zyll de Jong 1966, Brand et al. 1976, Winterhalder 1980). Maxima occur at approximately 9.6 year intervals. In areas containing large expanses of boreal forest, lynx productivity can be surprising. The last three peaks in British Columbia, for example, yielded the following harvests: 12,500 in the trapping season of 1962-63; 8,500 per season during the 1972-73 and 1973-74 seasons; and 6,200 in 1982-83 (Hatler 1988).

In eastern portions of lynx range, with the possible exception of Newfoundland, habitat is not elevation-specific as elevations are more uniformly low. In the Western U.S., however, lynx habitat occurs above latitudinally-correlated elevations such as 2,700 m on the Colorado Plateau (Miller et al. 1981), 1,500 meters in central Washington (Brittell et al. 1989), and somewhat lower in northeast Washington (Brittell et al. 1989) where the climate is more continental. The pronounced topographic dissection of much of the western U.S. causes many lynx habitat areas to be small and isolated from the few large areas (M. Tirhi, USDA Forest Service, Olympia, WA, unpubl. lynx habitat maps; pers. commun.).

Recent Fur Trade History

By the late 1960s, trade in spotted neotropical felid pelts was valued at 30 million dollars annually (Meyers 1973), endangering several jaguar and ocelot populations in South and Central America (Meyers 1973, Smith 1976). Actions taken to correct this problem included Brazil's prohibition on commercial hunting in 1967 and the drafting in 1973 of the Convention on International Trade in Endangered Species of Fauna and Flora (CITES). CITES was implemented in 1975, severely restricting international trade in endangered and threatened species (McMahan 1986). The time lag for implementation of CITES allowed countries with amassed fur stores to liquidate them on the world market. The removal of Appendix I species from the world market caused a shift to small neotropical cats such as geofroy's cat (*Felis geoffroyi*) and the little spotted cat (*Felis tigrina*) and to temperate zone felids including bobcat (*Felis rufus*)and lynx (Funderburk 1986, McMahan 1986). The lynx was listed as an appendix II species, requiring the development of management-based justifications for international trade (Thornback and Jenkins 1982). Market focus on temperate zone felids resulted in pelt price increases. In Montana, lynx pelt values reached a maximum of $477.00 apiece in 1986, a more than twenty-five-fold increase from 1970 when pelts sold for $18.60 (data from MDFWP 1991, Figure 3). During the late 1970s and early 1980s, 10,000-14,000 Montana trappers (roughly 1.5 percent of the state's population) were registered annually, taking up to 69 lynx annually (MDFWP 1991).

The objectives of this study were to obtain and synthesize the most up-to-date information available regarding the historic and present distribution of the lynx, south of Canada, and to document population trends. We also hoped to evaluate the implications of this information for lynx conservation and natural resource management.

METHODS

The occurrence of lynx in a given county is generally not verifiable in any given year because confirmed identifications are rare. Therefore, it is impossible to accurately document trends in lynx distribution in most portions of its U.S. range. However, lynx are susceptible to trapping (Parker et al. 1983, Brittell et. al. 1989) and presence is thus verifiable where intensive trapping coincides with lynx abundance. Other

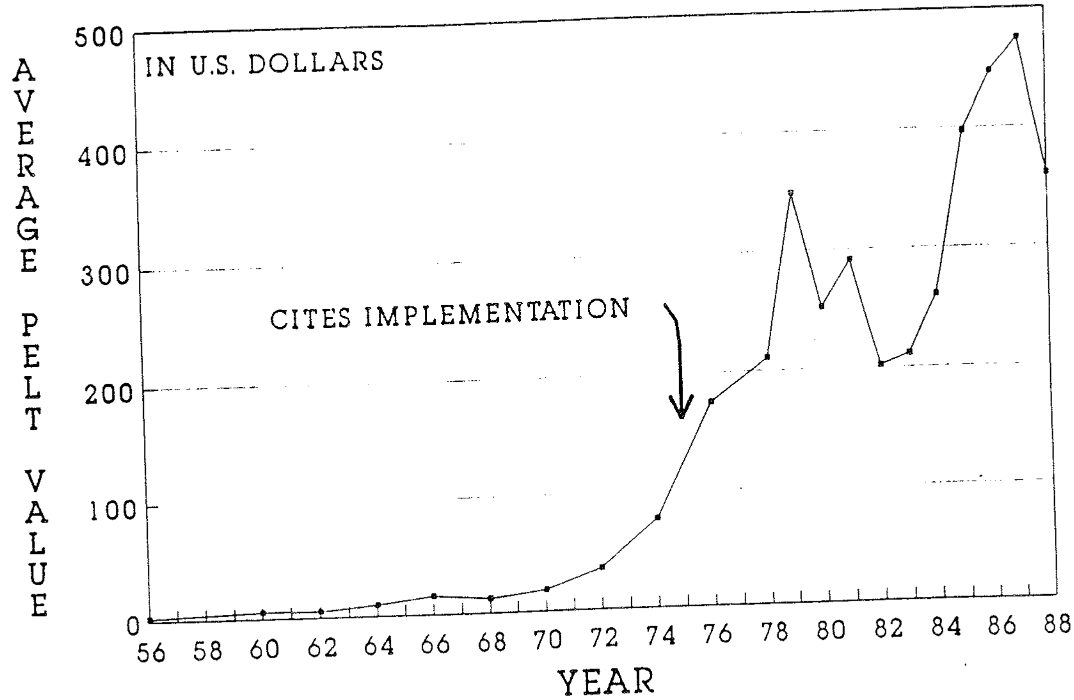

Figure 3. Average lynx pelt market values in Montana (data from MDFWP 1990).

confirmed identifications occur irregularly and contribute to the development of distribution maps.

Sources and Definitions

We contacted fifteen state wildlife agencies to ascertain the level of knowledge and documentation of lynx population parameters in each state. University and non-governmental personnel were also contacted. Documentation provided by these sources, along with other published literature, was reviewed and summarized. Current sightings, track surveys, and harvest records were defined as those occurring after 1979 and were used to estimate current distribution. Current distribution was contrasted with historic distribution derived from records dating as far back as the late nineteenth century. Except where specified, sightings reported as "likely" or "probable" were omitted from this analysis, significantly reducing the data set.

The county was used as the minimum mapping unit based upon the general availability of county-specific data and the general unavailability, unwieldiness, and inaccuracy of finer-resolution data. Occasional sightings that occurred far from optimal lynx habitat areas probably represent irregular dispersal events and were not used to derive range maps.

RESULTS

General Findings

Little information exists on lynx harvests in the U.S. prior to 1965 because trappers and state game agencies often lumped lynx and bobcat together as "lynx cats". This trend continued until 1970 in Colorado and until 1977 in Montana.

Legal lynx harvests have fallen dramatically across the U.S. over the last 15 years (Figure 4). This decline apparently results from decreasing abundance and not from season closures by state game agencies. Harvest quotas over the past several years in Idaho and Montana have not been met (NWF 1991), with the exception of 1991-92 when the limit (2 animals) was trapped in Montana. The Montana harvests occurred close to the Canadian border, which may indicate that lynx dispersing from Canada are being trapped before they are able to establish or replenish more southerly populations. Elsewhere, including Colorado, Idaho, and Wyoming, disjunct populations of undetermined sizes persist. Their tenacity there is associated with relative isolation, inaccessibility, and low human population densities of the areas lynx inhabit.

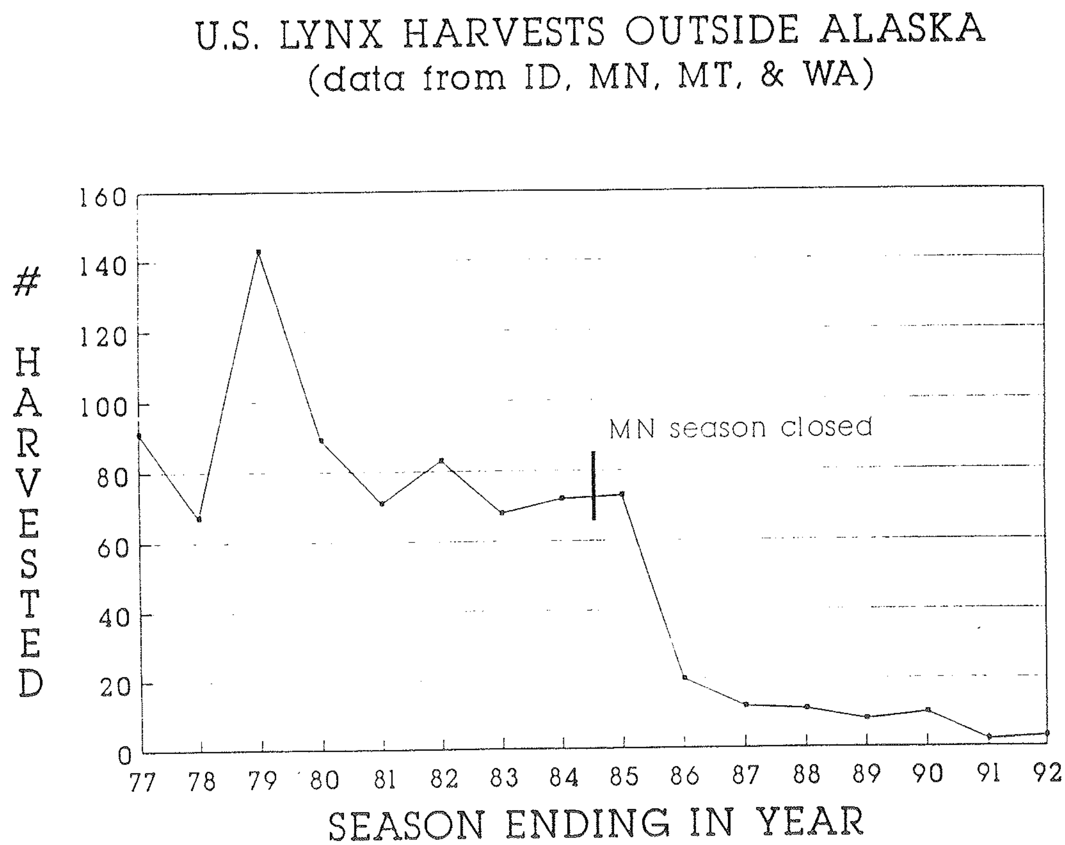

Figure 4. Total legal U.S. lynx harvests over the last 15 years (from Nat. Wildl. Fed. 1991, D.Ware, Washington Dept. Wildlife, Tacoma, pers. comm. 10/91, Dexter 1991).

Lynx are classified as endangered in Colorado, New Hampshire, Vermont, and Wisconsin. They are protected from harvest in ten states, five of which classify them as furbearers with closed seasons. Only Montana and Idaho permit legal harvests (Table 1).

Table 1. Legal status of lynx in the lower 48 States.

State	Current legal status	Comments
Colorado	Endangered	As of 1973
Idaho	Regulated open season "species of special concern"	Population has not been studied or monitored
Maine	Fully protected from harvest	Bounty repealed in 1967
Michigan	Endangered	
Minnesota	Fully protected from harvest	As of 1983-84
Montana	Regulated open season	Population has not been studied or monitored
New Hampshire	Endangered	Season closed in 1965
New York	Fully protected from harvest	Reintroduced
North Dakota	Fully protected from harvest	No recent sightings
Oregon	None	Extirpated; no plans for reintroduction
Utah	Fully protected from harvest	As of 1974
Vermont	Endangered	No recovery program
Washington	Fully protected from harvest	Season closed in 1984
Wisconsin	Endangered	As of early 1970s
Wyoming	Fully protected from harvest	As of 1973

The north-central Washington lynx population, possibly the largest in the lower forty-eight states, was proposed for listing under the Endangered Species Act in June, 1991 (GEA and FLF 1991). That proposal cited ongoing and planned detrimental land use practices and low levels of lynx recruitment as the primary motives for listing. The National Wildlife Federation proposed federal listing for lynx in Idaho, Colorado, Wyoming, and Utah (NWF 1991) documenting declining harvests and lack of monitoring as key issues. The loss or near loss of lynx from Idaho, Montana, Minnesota, New Hampshire, Vermont, Wisconsin, and Utah has made population studies impractical or impossible. Only New York has engaged in a reintroduction program.

Lynx Status by State

Colorado.--Prior to 1970, Colorado lynx pelts were not legally differentiated from those of bobcats. Lynx were first afforded full protection in Colorado in 1973.

In 1978, a fairly comprehensive study of the status of Lynx in Colorado, based upon over 3000 solicitations for information, track surveys, museum and taxidermist specimens, etc., (Miller et al. 1981), was commissioned by the Colorado Division of Wildlife. Its primary purpose was to document historic and current information pertaining to lynx occurrence. The study concluded that lynx distribution is discontinuous and may include parts of Eagle, Lake, Pitkin, and Clear Creek Counties.

Summarizing all information, prior to 1980, lynx were verified from eight Colorado counties (Gunnison, Summit, Montrose, Conejos, Clear Creek, Pitkin, and Eagle) and reported without specimens from an additional ten. For four of the eight verified counties, specimens predated 1926.

In early 1992, T. Andrews and I. Carney surveyed 3,303 km of transect within historic Colorado lynx range for lynx tracks (Andrews 1992). The survey covered parts of Eagle, Pitkin, Lake, and Summit Counties. No tracks found were positively identified as lynx. Sighting information gathered during the same period resulted in seven possible sightings, with none confirmed.

Lynx have been verified in only Clear Creek and Eagle Counties since the end of 1979 (J. Halfpenny, Inst. Arctic & alpine Res., Boulder, pers. commun.; Figure 5).

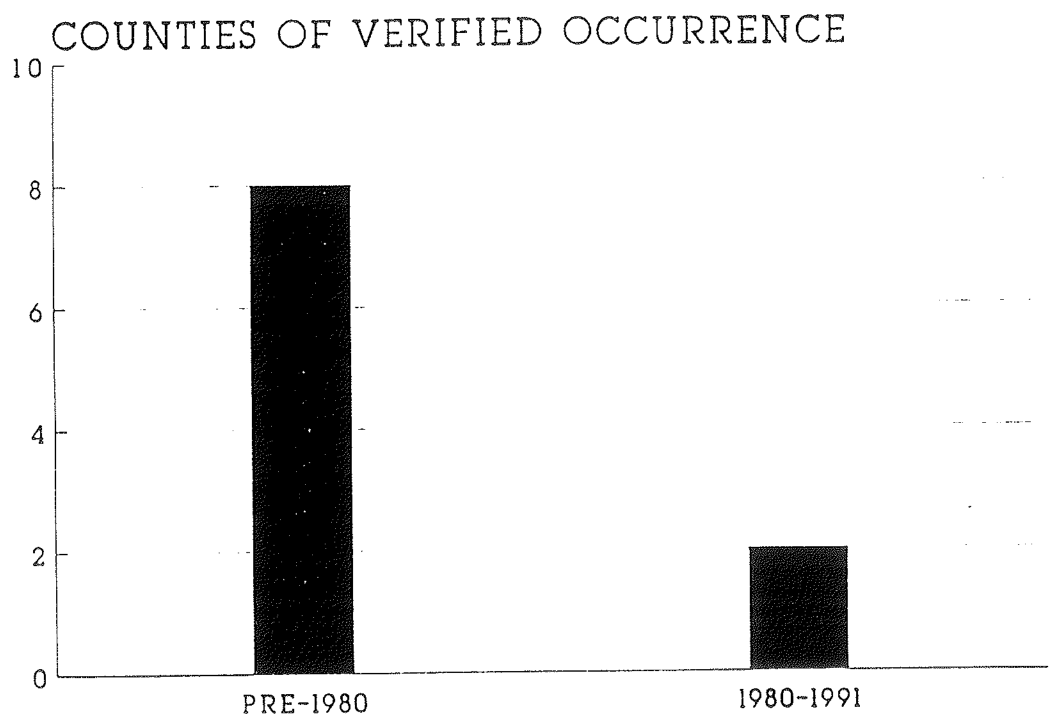

Figure 5. Number of counties in Colorado where lynx occurred historically and "currently".

Idaho.--Prior to the 1977-78 Idaho furbearer season, the lynx was classified as a predator and no harvest regulations were imposed. Rust (1946:317) described historic lynx abundance in northern Idaho by stating that, "twenty-five to thirty are shot or trapped annually by local trappers and hunters in addition to those secured by state and federal predator control agents." The absence of recent sighting information from that part of the state indicates that Rust was correct when he wrote, "Not as prolific as the bobcat, it is possible that in a few more years the lynx will be well on the way to extermination in northern Idaho" (Rust 1946:317).

The Idaho Department of Fish and Game currently classifies lynx as a "species of special concern" and supports a trapping season with an annual harvest of three individuals. That limit has not been reached in recent years. Since the 1985-86 season, 3 lynx have been taken: 1 during the 89-90 season, and 2 during the 91-92 season (one legal, one illegal). The location for the 89-90 harvest was not determined while those of the 91-92 season, both taken in December 1991, were from Idaho and Lemhi counties (G. Will, Idaho Fish & Game, Boise, pers. commun.) which are considered their current state range. During the 1978-79 season, 3 individuals were also taken from Fremont County, raising the possibility that they also persist there.

During the two preceding lows in lynx population cycles, the lowest annual harvest was 4 individuals (NWF 1991) indicating that lynx in Idaho are at their lowest numbers ever. Idaho lynx harvests from 1974-1991 are shown in figure 6.

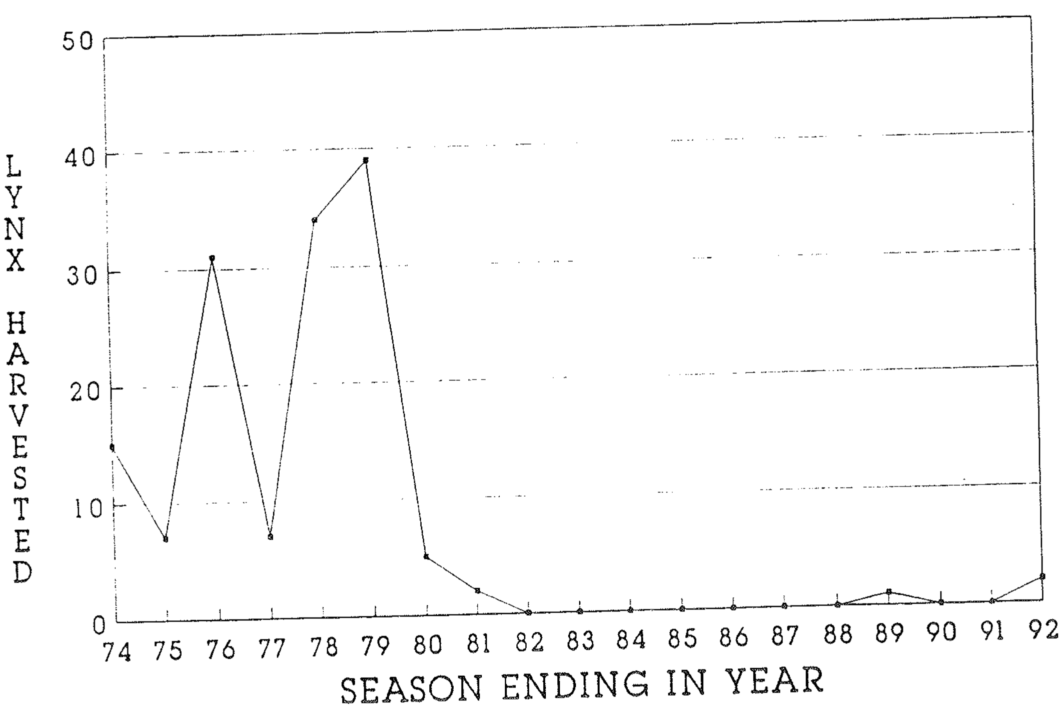

Figure 6. Idaho lynx harvests, 1974-1991 (from NWF 1991).

Maine.--The Maine bounty on lynx was repealed in 1967. The Northeast Lynx Status Report (NHDNR undated) states, "lynx may exist as an occasional breeding animal in a very few remote areas of northern and northwestern Maine." However, the status of lynx in Maine is not really known. Recently lynx have been taken in southern, more populated parts of the state coincidental to bobcat harvests (3 lynx in the last 5 years; K. Elowe, Maine Dept. Inland Fisheries and Wildl., Bangor, pers. commun.). The state of Maine has not conducted any reviews or studies pertaining to the status or distribution of Lynx.

The harvest season on lynx in Maine is now closed.

Michigan.--Historically, lynx occurred in most of the Upper Peninsula and at least twenty-three counties of the Lower Peninsula (Baker 1983). Historic occurrence in most of the Lower Peninsula suggests that a breeding population may have occurred there (regular invasion from Canada to the Michigan's Lower Peninsula would be unlikely), suggesting that the population there was self-sustaining. The lynx is classified as endangered in Michigan.

The most recent record of lynx in Michigan obtained during this investigation was an observation on Isle Royale in 1977 (Peterson 1977). That sighting was preceded by a long period of lynx decline. As early as 1948, the species was suspected to be gone from the state (Burt 1948).

Minnesota.--More lynx have been trapped in Minnesota than any other state except Alaska. From 1930 to 1984, approximately 5,655 were trapped (Schultz 1984), for an average of 105 annually. These records do not reflect total harvest by all methods. Bounty records from 1952-1964, for example, indicate that more bounties were paid for lynx pelts than were legally trapped during that period (Schultz 1984). During the last 5 trapping seasons, from 1979-80 through 1983-84, a total of 109 lynx were harvested from sixteen Minnesota counties. In the final 1983-84 season, only 9 were taken. The 16 counties where lynx were taken after 1979 were Becker, Beltrami, Carlton, Cook, Crow Wing, Itasca, Kittson, Koochiching, Lake, Lake of the Woods, Mahnomen, Marshall, Martin, Morrison, Pine, Roseau, and Saint Louis (Dexter 1991). Martin County was not considered current lynx range because it lies far to the south, adjacent to Iowa, in agricultural grassland. We therefore regarded the other fifteen counties as current Minnesota lynx range.

Historic patterns of lynx population cycling in Minnesota indicated that a population peak would occur in the early 1980s. That failed to occur in spite of record snowshoe hare abundances in the northern counties. This incongruity is thought to result from a loss of breeding lynx stock. In addition, scent post surveys in Ontario and Manitoba during 1990 and 1991 indicated declining lynx populations there (B. Berg, Minn. DNR, Grand Rapids, pers. commun.). Minnesota lynx may now occur only as individuals emigrating from Manitoba or Ontario.

Montana.--Lynx harvests were reported for the 1975-76 season as 250 (MDFWP 1990). However that figure is probably inaccurate since only after the 1976-77 season was a tagging requirement implemented, eliminating confusion with bobcat. It is clear, however, that Montana's lynx harvests have fallen dramatically over the last fifteen years (MDFWP 1990, 1991; NWF 1991).

In 1977, harvests were regulated for the first time with seasons and per-trapper quotas. Since the 1983-84 season, regional and statewide quotas were met just once. This occurred during the 1991-1992 season when two were taken from Lincoln County near the Canadian border (B. Campbell, MDFWP, Kalispell, pers. commun.). During the 1990-91 season, one lynx was trapped and checked in Flathead County (T. Manley, MDFWP, Kalispell, pers. commun.). In June, 1992, a lynx was photographed by an infrared-tripped camera, also in Lincoln County, less than 2 miles from the Canadian border, (W. Kasworm, USFWS, Libby, MT, pers. commun.).

Lynx abundance in Montana is believed to be very low and there is no reason to assume it will recover without the implementation of a recovery program. Roy (1989) concluded that lynx are in serious trouble in Montana and that trapping mortality is the primary factor in preventing lynx recovery there. Figure 7 shows legal Montana lynx harvests from the 1976-77 season through 1992.

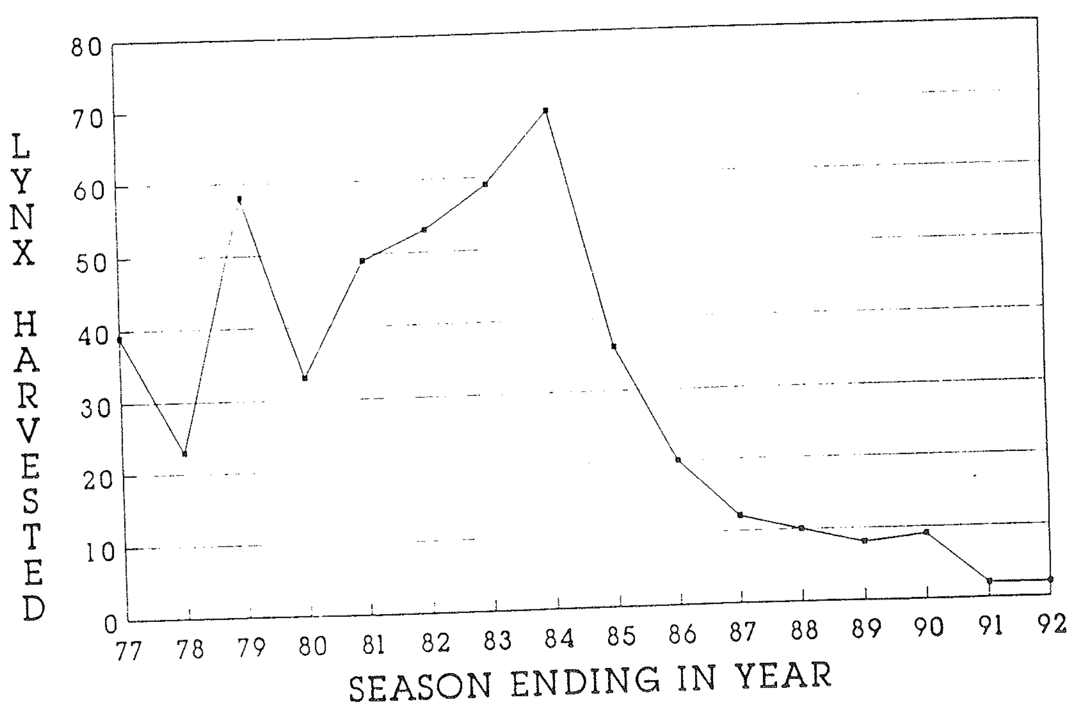

Figure 7. Montana lynx harvests, 1977-1991 (from NWF 1991 and B. Campbell, Mont. Dept. Fish, Wildl. & Parks, pers. commun.).

New Hampshire.--Historically, lynx occurred in New Hampshire with sufficient abundance to permit a limited harvest. Actual harvests evidently exceeded sustainable levels, although other factors such as habitat alteration may have also played a role in lynx decline. New Hampshire was unique in that its harvest records distinguished between bobcat and lynx pelts at least as far back as 1931. From 1931 through 1954, 216 lynx were bountied. The number of Legal harvests after 1954 indicates the rarity of lynx in New Hampshire (Figure 8). Harvest was suspended in 1965.

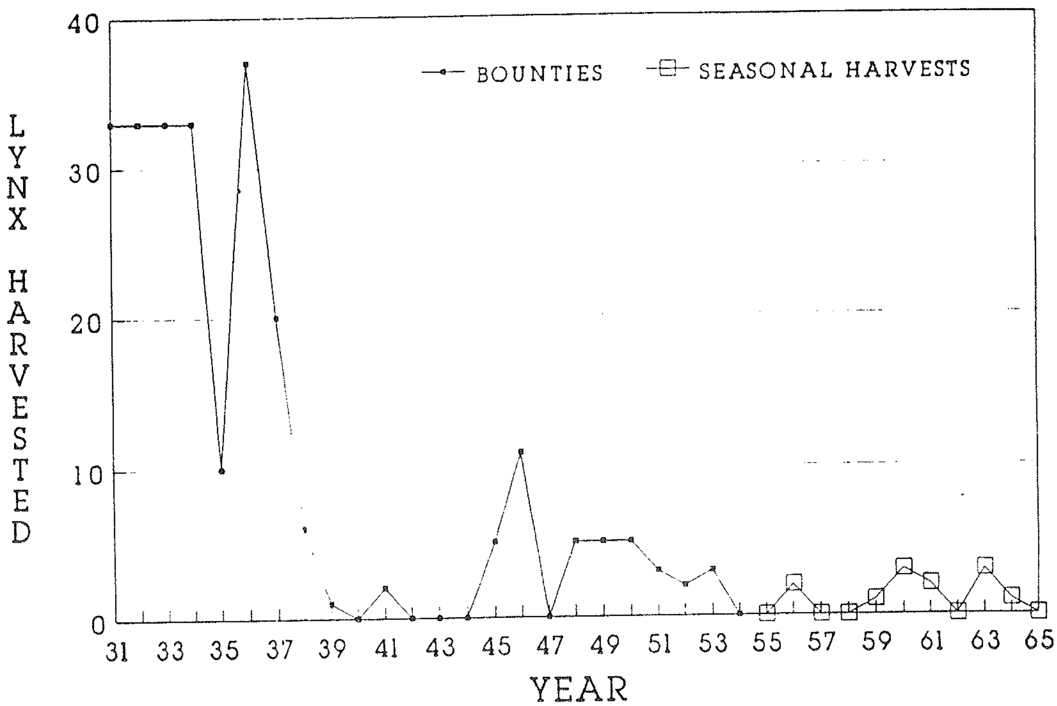

Figure 8. 1931-1955 bounties and 1955-1965 legal harvests for lynx in New Hampshire. Bounty figures (1931-1934) averaged from Silver (1957:300-311); seasonal harvest figures from NHFG (1990).

Before 1954, lynx were harvested from 7 of the state's 10 counties (Cheshire, Carroll, Coos, Grafton, Merrimack, Sullivan, and Hillsboro). No sightings or harvests were listed during the 1970s. In 1983 and 1984 lynx tracks were observed in Coos and Grafton Counties (NHDNR undated); in 1992, a roadkill was reported from Grafton County (J. Litvaitis, White Mts. NF, Laconia, NH pers. commun.). Also in 1992, a sighting originated from Coos County (White Mountains NF records). Litvaitis et al. (1991) surveyed 130 km of transects for tracks in what is considered to be the core of historic lynx range in the White Mountains and failed to verify lynx presence. In 1992, 648 km of trail was surveyed for lynx tracks in historic lynx habitat without positive results (J. Lanier, White Mts. NF, Laconia, NH, pers. commun.). Although reports continue to occur sporadically, a viable population does not occur in New Hampshire.

New York.--Lynx were apparently never historically prominent in New York, but probably inhabited the high peaks region of the Adirondacks and possibly the Catskills. The Adirondack population was the last to be extirpated in the late 1800s (K. Gustafson, SUNY, Syracuse, pers. commun.). Thereafter, wanderers from other areas occurred rarely. The last documented occurrence of a wild lynx in New York was in the Adirondacks in 1951 (Hamilton and Whitaker 1979). The Lynx was unprotected and bountied until 1970 and was declared a game species with a closed season and afforded complete protection in 1976 (NHFG undated).

A reintroduction program was implemented in 1986 to release lynx from Yukon Territory, Canada into the Adirondacks. 83 lynx were released into Essex, Hamilton, and Franklin counties from 1989 through 1991. Some animals dispersed into Vermont, New Hampshire, and New Brunswick. Of those released, 15 were killed by motor vehicles and at least 22 died of other causes (K. Gustafson, SUNY, Syracuse, pers. commun.). The success of this program will be evident in the years to come. No lynx are believed to exist in New York aside from those released.

North Dakota.--In North Dakota, the lynx is now listed as a game animal with a closed season (S. Allen, ND Game and Fish Dept., Bismarck, pers. commun.).

No evidence suggests that a breeding population of lynx occurs in North Dakota. However, North Dakota is within the historic range of dispersers from portions of lynx range in Manitoba (Adams 1963).

Oregon.--While lynx historically occurred in Oregon, perhaps only as dispersing individuals, the species is now considered extirpated there. The last verified lynx sighting was in Benton County in 1957 and there are no plans for lynx recovery (M. Nugent, End. Species Coordinator, Oregon Dept. Fish & Wildl. pers. commun.).

Utah.--In Utah, the lynx is classified as "sensitive" and was fully protected in 1974. Prior to 1972, eight specimens were verified from four counties: Daggett, Summit, Wasatch, and Sanpete. Since 1980, only 1 lynx has been verified in the state. That animal was trapped in Cache County (far northern Utah) on a bobcat permit in December, 1991 (R. Toone, Utah Natural Heritage Program, Utah DNR, pers. commun.). 2 other occurrences, in Uintah and Summit Counties, were listed as "probable" (McKay 1991).

Vermont.--The lynx is classified as endangered and considered a "nearly extirpated species" in Vermont (VANR 1987). In 1928 one was taken in Windham County (Osgood 1938) and in

1937, One was taken in Addison County (Hamilton and Whitaker 1979). The last confirmed occurrence was in 1968 in Franklin County. To date, no recovery plan has been developed (Jim Di Stefano, Vermont Dept. Fish and Wildl., pers. commun.).

Washington.--The only state outside of Alaska for which research has documented a viable population of lynx, along with an estimate of abundance, is Washington. This population is continuous with that of British Columbia and may experience regular immigrations from the north. Approximately 200 lynx are believed to inhabit northcentral and northwestern portions of the state. This figure represents a median around which the population is believed to fluctuate, with a maximum of approximately 300 and a minimum of approximately of 150 (Koehler 1989, Brittell et al. 1989).

Since 1963, lynx have been legally harvested in 8 Washington counties: Chelan, Douglas, Ferry, Okanogan, Pend Oreille, Spokane, Stevens, and Yakima. Since 1979, lynx were taken in all of those except Douglas, Spokane and Yakima. The remaining 5 counties are believed to be the current range of lynx in Washington (Brittell et al. 1989).

In a situation similar to that of Minnesota, Washington failed to experience a lynx population increase during the last cycle peak, which was anticipated in 1982-1983. Harvest figures since 1970 suggest that lynx numbers have been declining steadily (figures obtained from D. Ware, Upland Bird and Furbearers, Washington DNR, Olympia, pers. commun.). The last harvest maximum occurred in 1976 with 37 lynx taken. 10 years later, none was harvested (Figure 9). While a strict permit system was imposed in 1985, the effect of this action on the population cannot be ascertained.

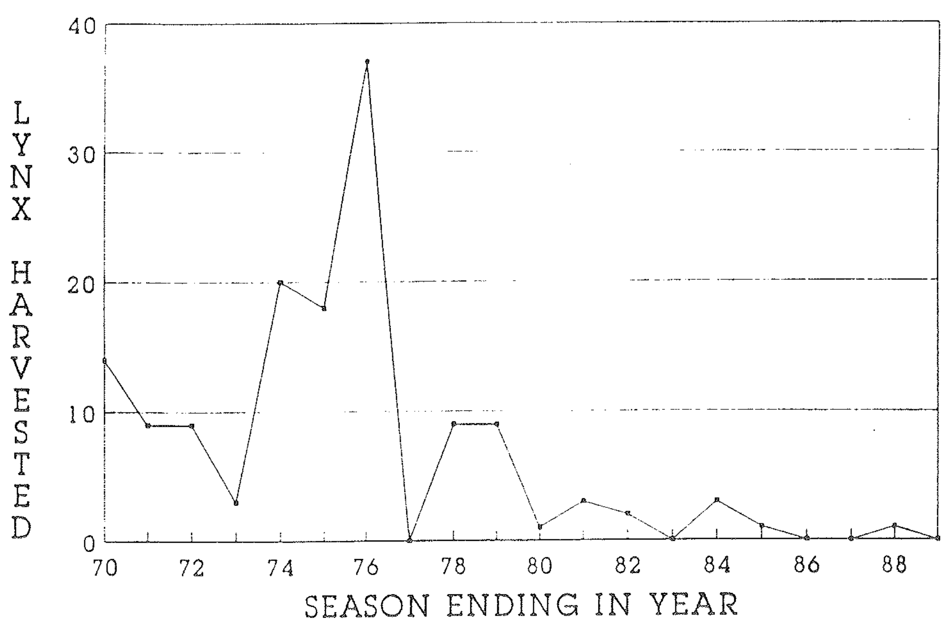

Figure 9. Legal Washington lynx harvests, 1980-1990.

Recognizing the significance of its lynx population, the Okanogan National Forest is developing a management plan that will attempt to integrate timber extraction with lynx conservation (B. Naney and G. Halekas, Okanogan N.F. pers. commun.).

Wisconsin.--Lynx were bountied in Wisconsin from 1865 until 1957 and listed as endangered there in 1972. They were reported in 12 counties from 1976 through 1984 (Thiel 1987). This information was not broken down into pre and post-1980 categories. The counties of occurrence were Douglas, Bayfield, Ashland, Iron, Burnett, Washburn, Sawyer, Price, Oneida, Forest, Marinett, and Shawano. These were represented by 63 individuals. Of those, 56 occurred in 7 northwestern counties. While Wisconsin lies squarely within historic lynx range, a breeding population is not likely to occur there (Thiel 1987, Thiel and Halloway undated). The observed cyclicity of lynx abundance there is thought to have occurred solely as a result of periodic emigrations from Minnesota. This was evidenced by the fact that museum specimens had been taken only during cycle peaks and never at cycle lows (Thiel 1987). The shrinking lynx population of Minnesota raises the possibility that northern Wisconsin could lose its designation as lynx range in the future.

Presently, 1 or 2 lynx sightings are reported each year by bobcat trappers in Douglas and Bayfield counties in northwestern Wisconsin (R. Jurewicz, WDNR, pers. commun.). Those counties are considered current Wisconsin lynx range.

Wyoming.--The lynx was afforded legal protection from harvest in Wyoming in 1973 when it was classified as a "protected animal".

Reeve et al. (1986) solicited information pertaining to lynx distribution, rating responses on a 1-4 probability scale, with 1 defined as certain, 2 as probable, 3 as questionable, and 4 as unlikely. For sightings dated 1980 and later, 62 are listed as probable, while only 1, from Natrona County, is listed as certain. While it is highly unlikely that all identifications listed as probable are incorrect, it would be presumptuous to derive a distribution map upon unconfirmed reports. Therefore we compromised by assuming that current Wyoming lynx distribution consists of those counties in which five or more sightings listed as probable occurred.

Counties of occurrence were deciphered from the maps and UTM coordinates provided in Reeve et al. (1986). Current Wyoming lynx distribution is Fremont, Lincoln, Park, Sublette and Teton Counties. The single confirmed identification from Natrona county, far from other concentrations or earlier range descriptions (e.g. Clark and Stromberg 1987) is not likely to represent a breeding population and was not included in the range map.

The size of the existing Wyoming lynx population may be of the same order of magnitude as that of Washington. Currently there are no monitoring procedures in effect there (A. Langston, Wyoming Game & Fish Dept., pers. commun) and National Forests in

Wyoming maintain no files on lynx (J. Freidlander, USFS, Denver, pers. commun.).

DISCUSSION

The information presented here suggests that downward trends in lynx abundance have occurred through most areas of lynx range in the contiguous U.S. and that lynx distribution is shrinking. Much of the decline has occurred during the last 2 decades. The middle-and-upper elevation forests that comprise lynx habitat are generally more recently-roaded and harvested than low elevation forests (Harris et al. 1982), helping explain why so dramatic a decline in lynx numbers has occurred so recently.

Based upon all of the confirmed lynx locations cited since 1979, including the Adirondack release sites, current lynx range by county is shown in Figure 10. While it is likely that lynx occur outside of the areas shown in Figure 10, the map could prove liberal in the future as habitats are further reduced in quality and areal extent. One should also consider that the map fails to indicate that much of the area within each shaded polygon consists of non-habitat.

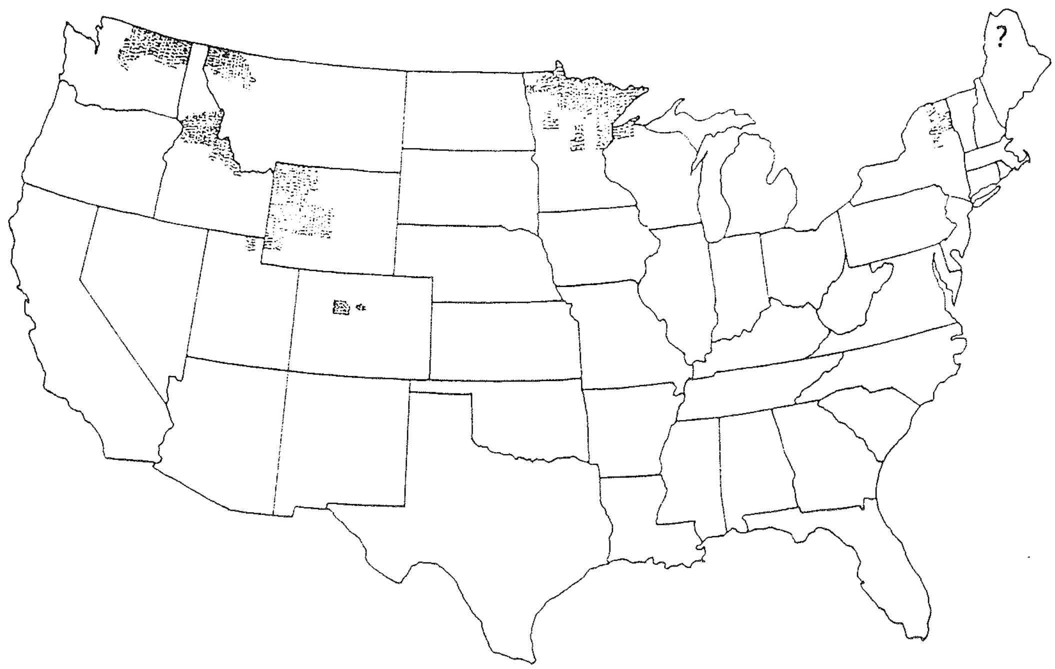

Figure 10. Current U.S. lynx distribution map, by county, for the lower forty-eight states.

Recommendations for restoration of lynx habitat, and of snowshoe hares, their principle prey, are available from the literature (e.g. Koehler et al. 1979, Wolff 1980, Bittner and Rongstad 1982, Parker 1981, Parker et al. 1983, Keith et al. 1984, Bailey et al. 1986, Brittell et al. 1989, Koehler and Brittell 1990). However, habitat may be of secondary importance to trapping pressure and incidental harvest in some areas where lynx have been persecuted and continue to be taken on bobcat or other furbearer tags. Under sustained trapping pressure, lynx harvests have been shown to be completely additive (Brand and Keith 1979, Quinn and Thompson 1987). Consequently, the British Columbia Ministry of the Environment monitors its populations and suspends trapping seasons during cycle lows (V. Bancie, B.C. Ministry of Env., Victoria, B.C., pers. commun. 9/92). Because few animals are trapped during cycle lows, the influence of this action on pelt revenues is small. However, this precautionary measure may be insufficient to ensure sustained harvests there, evidenced by a 50% decline in harvests over the last three cycle peaks (data from Hatler 1988).

In other areas such as northwestern Montana and the Cascade Mountains, intensive logging results in habitat changes of paramount importance. While modified logging prescriptions could provide for snowshoe hare requirements, standard procedures degrade or eliminate denning habitat and create forest openings far larger than lynx are willing to cross (Brittell et al. 1989).

Coarse woody debris, cited as a key habitat component for lynx denning, (Berrie 1973, Guggisberg 1975, Koehler and Hash 1979) has been systematically depleted through timber harvest and management prescriptions. The burning of slash, ostensibly to prepare the seed bed and to reduce fire hazard, is almost universal. For example, more than 200,000 acres are burned annually in Oregon and Washington, for silvicultural purposes (Kauffman 1990). This action reduces structural heterogeneity at and near ground level in managed forests. Other cutting prescriptions such as "seed tree harvests" (intended to leave mature, seed-producing trees on-site) open forests dramatically and are typically followed by slash burning. Functionally, such sites may differ little from clearcuts for fauna that depend upon coarse woody debris.

Some optimism for lynx conservation in timber producing areas lies in the association of lynx and snowshoe hares with early seral and mixed forests in Washington (Brittell et. al. 1989), and with dense, young lodgepole pine stands in Montana (Koehler et. al. 1979). However, associations of lynx dens with old forests of northern and northeast aspects (Koehler 1987, 1989) have obvious implications regarding the lack of this consideration in timber harvesting today, as virtually all forested land available for logging has already been logged at least once.

Lynx apparently do best in areas with high levels of habitat interspersion, using different habitat types for feeding, travel, and denning. While optimum interspersion levels are unknown

(Hatler 1988), geographic information systems could be used to examine this and other questions related to landscape configuration.

The importance of wildfire in maintaining high levels of interspersion at higher elevations should be noted. The correlation between wildfire and higher elevations was determined for the Cascades of Oregon (Burke 1979) and may hold for other mountainous areas. Prehistoric fires would have maintained high levels of interspersion, providing ample post-fire forage for snowshoe hares (Fox 1978), while wildfire suppression, practiced as a rule on public and private timber lands, eliminates the natural post-fire sere. Fire-suppressed areas may exhibit larger patch sizes and lower levels of interspersion.

The success of reintroductions of sensitive, threatened, and endangered species, in particular carnivores whose populations are declining, is much lower than that of ungulates and herbivores. Griffith et. al. (1989) determined a 46% success rate for all sensitive, threatened, and endangered species reintroduction projects surveyed (n = 80) while that of native game species was 86% (n = 118). Theoretical considerations (e.g. Griffith et al. 1989) and cost considerations suggest that lynx reintroduction programs should be considered avenues of last resort so long as viable populations are extant. However, given that adequate habitat, prey, and protection can be provided, reintroductions may be useful in the future.

To date, there has been no unified effort to address the declining trend in lynx populations in the U.S. The lynx is currently a candidate for listing as an endangered species by the U.S. Fish and Wildlife Service. Its legal designation as a federally endangered species throughout its range, south of Canada, would be a reasonable option given that current information suggests that the number of lynx present in this vast area may not exceed several hundred individuals--far fewer than many other species now listed as endangered. Successful recovery will require each state within historic lynx breeding range to begin or to continue an active lynx monitoring or recovery program, to publish habitat guidelines and goals, and to identify existing and potential habitats. The cooperation of various agencies and private groups will be essential, and habitat impacts should be mapped to identify appropriate recovery zones while disruptive land use practices should be modified or curtailed.

SUMMARY

We reviewed the current status of lynx populations and their distributions in the lower forty-eight states. Current breeding distribution probably includes parts of Idaho, Minnesota, Montana, Washington, and Wyoming. Breeding status in Colorado, Maine, New York, Utah, and Wisconsin is undetermined. Lynx are apparently extirpated from Oregon, North Dakota, Michigan, Vermont, and New Hampshire. Summarized data suggest that lynx

are losing areal distribution and numbers. Trends over the last two decades also suggest that some small populations may have disappeared, and that others are likely to disappear in the near future.

Lynx populations are sensitive to habitat disturbance and conversion, and to trapping. The extent to which upper-elevation forests have been logged in recent years correlates with lynx decline, indicating that lynx recovery will require innovative initiatives in habitat management. Optimism for lynx recovery lies in lynx and snowshoe hare habitat relationships and the fact that lynx use a variety of successional and old growth habitats.

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PRESETTLEMENT WILDLIFE AND HABITAT OF MONTANA: AN OVERVIEW

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Under contract with the U.S.D.A. Forest Service, we developed a bibliography of books, papers, and documents with at least some natural history information pertaining to Montana and adjacent lands during the 19th century. Included with this bibliography is an annotation of major expeditions and explorers, tables cross referencing expeditions with drainages traversed, and a roster of early Montana naturalists. Expeditions into Montana began in 1802 and continued throughout the century. Early natural history notes generally were recorded by people with no biological training and tended to be highly qualitative. Later natural history notes generally were recorded by people with biological training and became increasingly more detailed and scientific in nature. Natural history information is available for nearly all regions of Montana, although, certain areas received greater attention than others. Despite the lack of quantitative data, it would be possible to establish regional lists of common mammals and birds, and their relative abundance from sources listed here. We also found relative abundance of timber and grass were consistently recorded even by journalists with no biological training. After reviewing numerous journals and narratives, our impression is that Montana has undergone ecosystem wide reductions in native wildlife. We present journal summaries in support of this statement.

Copies of this report are available from the Regional Office of the U.S. Forest Service in Missoula, Montana.

ECOLOGY OF MOUNTAIN LIONS IN THE SUN RIVER AREA OF NORTHERN MONTANA

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ABSTRACT

Mountain lion (*Felis concolor missoulensis*) habitat use, foraging habits, and home area characteristics were investigated in the Sun River area of northern Montana. Twenty-five mountain lions were monitored in 1991-1992. Mountain lions selected closed-conifer, open-conifer, deciduous tree, and shrubland cover types. Mountain lions avoided grassland and vegetated rock cover types. Mountain lions preferred areas near a stream course (0-200 m). They did not avoid roads or USFS recreational trails. They were found on slopes ranging from gentle (<20%) to steep (>69%). Mountain lions preferred eastern aspects, elevations ranging 1219 m to 1828 m, and were located in both broken and unbroken topography. Mean annual home area size was among the smallest reported in the literature. Mean annual home area size for prairie-front mountain lions was smaller than mountain lions that utilized interior areas. Home area size for prairie-front males was larger than for prairie-front females. Interior male home area size did not differ significantly from interior females. There was considerable overlap in female home areas. Mountain lions used core areas within their individual home areas. Mountain lions primarily killed deer, bighorn sheep, and elk. Bighorn sheep, elk, and mule deer were killed more often during winter (Nov-Apr). White-tailed deer, and smaller mammals were killed more often during summer (May-Oct). Overall, elk contributed more biomass to the diet of mountain lions than deer and bighorn sheep. Specifically, elk bulls, cows, bighorn sheep ewes, and mule deer bucks contributed the most biomass to mountain lion diets. Three instances of cannibalism by mountain lions were documented.

This presentation was a summary of research from M.S. thesis research of the senior author and is available from the Montana State University Library in Bozeman.

THE USE OF G.I.S. SYSTEMS, SPACIAL ANALYSIS, AND LANDSCAPE ECOLOGY TO ASSESS AND MANAGE HABITAT FRAGMENTATION IN BEAR POPULATIONS

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Fragmentation of bear habitat is an ongoing cause of habitat decline worldwide. Causes of habitat fragmentation are directly related to human activities including road building and use, home development, timber harvest, reservoir development, railroads, and human presence. When such human actions are arrayed in a linear fashion, they have the potential to limit the passage of bears through habitat and to decrease the potential for survival of bears that more through or live within such disturbance areas. We have developed methods to overlay human activities using a computer-based G.I.S. database system. This method allows summarizing human activities throughout the linear area in question. By combining these human activity data with information on the impacts of each human activity, we are able to assess the potential significance along a linear zone of human actions in terms of two major criteria of importance to bears: 1) habitat disturbance; and 2) mortality risk. Using these data and data on the existing and potential landscape structure and function of the linear area in question, we can identify potential areas that can act as linkage zones between areas of habitat separated by the linear area of human activities. These linkage zones can be identified on detailed maps and the management within them specified if they are to be maintained a linkages. Such management details can then be implemented by land management agencies to minimize habitat fragmentation before it occurs or to enhance linkages between areas that have already be fragmented.

BREEDING ECOLOGY OF THE HARLEQUIN DUCK (*Histrionicus histrionicus*) IN THE ROCKY MOUNTAINS.

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Harlequin ducks have been known to migrate inland to nest on mountain streams since the first naturalists explored the northern Rocky Mountain Region. Recent studies in Montana, Idaho and Wyoming have found this species to be rare and quite local in distribution and abundance. Arrival dates from the coast vary with elevation but most mated pairs and bachelor males arrive on breeding streams in late March and April. Harlequins typically select low gradient (<2%), second to fourth order streams with high water quality and little human disturbance. Harlequins are closely associated with riffle and run stream habitats with a cobble or boulder substrate. Marked birds demonstrate high site fidelity; females exhibit natal fidelity. Breeding occurs over a four week period; females construct a nest for 2-8 eggs and incubate for 28 days. Nests have been found in hollow snags, cliff sites, in-stream woody debris (jams), and on islands behind woody vegetation. Young are flightless for 56 days, initially using waters with lower velocity and later foraging in faster water. Brood weights at fledging vary, apparently with productivity of natal streams. Pair densities range from 1 pair per km of linear stream to less than 1 pair per 16 km. Nesting success and survival to fledging of known juveniles vary considerably (12-68% and 16-88%, respectively). Primary factors influencing productivity are timing and magnitude of spring runoff. Population estimates for the study area during the breeding season are: Montana: 260 (110 pr.), Idaho: less than 100, Wyoming: less than 100.

NEOTROPICAL MIGRATORY LANDBIRDS OF THE NORTHERN ROCKIES

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About 140 species of landbirds that breed in Region One (consisting mainly of Montana) are neotropical migrants. That is, they breed in North America and their wintering grounds extend into Mexico, Central, and South America.
As a group, neotropical migrants make up roughly 75% of all landbirds that breed in Region One. In recent years the status of some species of neotrops has been in decline. This has been attributed to a number of reasons such as forest fragmentation, nest parasitism, habitat loss on both breeding and wintering grounds, and the effects of pesticides. Declines have been well documented for some Eastern species, where sufficient data has been gathered. A chronic management problem in the West has been the lack of data in general and the paucity of any long term (>20 years) observations, specifically. Efforts are underway to gather data on bird abundance and distribution, reproductive success, habitat relationships, and long term trends. This program will combine the efforts of Federal, State, private, and academic entities.

OVERVIEW OF THE MONTANA SENSITIVE PLANT PROGRAMS

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Montana has over 2400 vascular plant taxa, of which 390 are being tracked as state species of special concern based on their low numbers and perceived or potential imperilment. This recognition does not confer protection, but is the list structure for botanical information in the Biological Conservation Database of the Montana Natural Heritage Program. This centralized information is routinely consulted in private and public environmental assessments and management planning. The state list is continually updated based on survey, monitoring, and taxonomic studies. It is distributed annually in spring and is available from:

Montana Natural Heritage Program
State Library
1515 E. 6th Ave.
P.O. Box 201800
Helena, MT 59620-1800

The 1993 Federal Register Notice of Review (Vol. 58, No. 188 of 30 Sept. 1993) places 23 Montana vascular plant taxa in Category 2 (C2; taxa for which information now in possession of the Service indicates that proposing to list them as endangered or threatened species is possibly appropriate, but for which substantial data on biological vulnerability and threats are not currently known or on file to support the immediate preparation of rules), and one species (*Howellia aquatilis*) proposed as threatened (PT). Note: Comments have been filed on 1993 Federal Register Notice of Review errors, updates, and warranted status changes for Montana. Also, 26 Montana plant taxa have been dropped from further consideration over the years (3C and 3B categories). For copies of the 1993 FR Notice of Review:

U.S. Fish and Wildlife Service
Fish and Wildlife Enhancement
P.O. Box 10023
Helena, MT 59626-0023

Region 1 of the U.S. Forest Service has a sensitive species list and policy; an updated list is pending as of 4 February 1994. Each Forest has a sensitive plants contact person. Regional botany contact is:

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HABITAT EFFECTIVENESS AND ELK VULNERABILITY

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Public interest in the management and protection of North American elk has expanded well beyond purely biological considerations. In Montana, elk hunting is $65 million industry. The state sells 100,000 elk hunting licenses, provides 600,000 recreation days, and has recognized a major growth potential in nonconsumptive uses. Despite a growing pressure on the elk resource, the annual harvest has more than doubled. We probably have twice as many animals today as we had 30 years ago. Here, and elsewhere in the West, managers have demonstrated they can produce elk in many habitats. We are now entering an era in which we have to consider some of the ethical and moral reasons for doing so. The most pressing and immediate management concerns involve several aspects of elk vulnerability during the hunting season.

Thirty years ago, winter mortality was a primary cause of death for big game animals. A major game management concern was reducing animal numbers to prevent damage to winter range forage plants. Winter weather may become important again, but for the last ten years, 90% of elk mortality has been caused by hunting.

In most of the West, management of the elk harvest has involved control of season length and limited permit hunting of cows, while an unrestricted bull harvest has been retained. One widespread result has been a decline in numbers of breeding bulls remaining after the hunting season. Today, many elk herds have distorted population structures that deviate substantially from public expectations and may be biologically unsound. Other western states have reported herds with mature bull:cow ratios of 5:100 on the winter range. There are some herds in which the majority of breeding is accomplished by yearling spike bulls.

Montana has not reached a critical stage yet, but statewide harvest statistics indicate that increases in numbers of animals killed have mostly been cows and spike bulls. Branch-antlered harvest has increased less than 20 percent and the average antler has dropped from 5 to 3 points. There are biological, esthetic, and commercial reasons for having big bulls in an elk herd. Correction of these distortions can only be achieved by reducing the annual harvest of mature bulls.

Reductions in season length, however, are not necessarily seen as a solution. Experience with shorter seasons in Oregon and elsewhere has revealed situations that can only be interpreted as deterioration in hunter behavior and ethics. As the number of hunters increases, the number of legal bulls available declines. When the management response is a shorter hunting season the all too common result is a brief and essentially disgusting spectacle in which elk are unreasonably harassed and the morality of hunting as a sport comes into question. If elk hunting is to continue as a legitimate sporting activity, consideration must be given to controlling the levels of harassment and behavior of the participants.

The highest priorities involve management parameters that will produce greater bull escapement without reducing recreation potential. We need to identify combinations of vegetative and topographic variables that provide security and escapement for hunted elk. We must identify the hunting pressure limits required to overwhelm even optimal habitat characteristics. We can no longer rely on simplistic answers based on hiding cover patch sizes, or hunter densities and season length. Successful elk management is almost certain to require simultaneous examination or modeling of habitats and hunter behavior in those habitats.

It's pretty clear that the reason bull numbers are declining is that bulls get shot. However, there are a lot of corollary causes, one of the most important of which is timber harvest and roads. When this relationship was first recognized it was accepted as a good thing, but as time went on it turned into too much of a good thing. As a result, between 1970 and the mid 80s, there were a number of studies of the relationships between timber harvest, road construction, and elk habitat productivity. Those studies, in turn, produced habitat models that were widely incorporated into forest plans.

In the simplest form, Forest Plan models included a cover/forage curve to predict habitat potential, a road model to estimate reductions in use near open roads, and some guidelines for protecting key areas like moist sites and wallows. These are relatively straightforward concepts, and they are generally well documented. The expected product was a value, Habitat Effectiveness, a measure of the ability of habitats to produce and sustain elk during the summer.

Unfortunately, a lot of things went wrong on the way to application. Even if properly applied, there should have been some question about the recommended opening size of 40 acres, especially when compounded by local recommendation for openings even smaller. On the land, this comes out to be 40-acre measles, and it is bound to grow into 40-acre cover patches that are unquestionably too small. Habitat effectiveness has also been widely misapplied to hunting seasons, winter ranges, and a variety of other situations where it made no sense. And, along the way, some new terms and contrived definitions were invented -- as well as some contrived methods of application. One result was a growing confusion in terminology, to the point that biologists talking about elk and elk habitat encountered difficulties in communicating with each other. Two events grew out of this confusion. The first was a 2-day workshop held at the University of Montana's Lubrecht Experimental Forest in 1990. About 30 biologists participated in a facilitated workshop intended to clarify and standardize some of the elk management terminology. Many different terms were discussed, but the primary accomplishments of the workshop were to clearly identify habitat effectiveness as the ability of habitat to grow and produce elk and establish vulnerability as a measure of habitat ability to protect elk. The results of these discussions were presented at the Western States Elk workshop and have been published as Intermountain Research Station Report GTR-INT-288.

A second event was the Elk Vulnerability Symposium held in Bozeman in 1991. Among other things, this symposium initiated some clarification of the complex situation involving elk and their habitats during the hunting season. Cliff Youmans (1991) presented summary data from the Bitterroot National Forest showing increasing road access and increasing bull harvest until the numbers of bulls available began to decline.

Leptich and Zager (1991) showed us that bull mortality rates in Idaho were directly related to access, and more importantly, that a bull elk in a roaded area has virtually no probability of surviving to age 5. The result, predictably, was a reduction in age structure.

Even so, roads are not the whole answer. Vales et al. (1991) presented hunter density relationships showing that shorter seasons will not protect a limited game resource. Their data indicate that any situation where hunters outnumber legal bulls is certain to produce distorted post season bull/cow ratios.

Habitat quality is also involved. In both roaded and unroaded situations Unsworth & Kuck (1991) showed some of the expected patterns - hunted elk select for heavier timber, north aspects, and steep slopes.

Hillis et al. (1991) proposed a partial solution in protecting unroaded cover patches of at least 250 acres in at least 30 percent of the elk habitat.

Lyon and Canfield (1991) confirmed that patch size becomes an important consideration for elk during the hunting season. In their western Montana study area, elk were pretty much using the habitat as it occurred, until hunting started. Thereafter, selected patches doubled in size.

Additional information is on the way. In the year since the Vulnerability Symposium, Unsworth et al. (in press) have developed a functional predictive model that uses road density, topography, and hunter intensity as input parameters. All of these studies increase our understanding of the concept of Elk vulnerability and make it possible to compare habitat effectiveness and elk vulnerability directly.

HABITAT EFFECTIVENESS: for elk
- focus on habitat loss
- based on behavior of animals
- applies to non-hunting season
- data from pellet groups and radio locations
- primarily cow elk

HABITAT EFFECTIVENESS: to the manager
- access control, open roads and motorized traffic
- cover modification, changes in productive potential
- security - displacement, discomfort, stress, but not death

ELK VULNERABILITY: for elk
- focus on elk mortality
- based on numerical response in population
- applies during the hunting season
- data from animals surviving or dying
- primarily bull elk

ELK VULNERABILITY: to the manager
- access control, any road or trail may be involved
- cover, availability and continuity vs quality
- security affects mortality, timing and rate

The implications of these relationships are hard to ignore. Habitat effectiveness is a measure of the ability of habitats to produce and sustain elk during the summer. Habitat in this context is the land managers' responsibility. And, because 80-90 percent of all elk in the United States spend time on the National Forests, habitat effectiveness has been identified in many Forest plans.

The equivalent responsibility at the state level has been regulation management, specifically, law enforcement and setting population size and structure. In Montana, these goals for every elk herd in the state have been identified in a strategic plan.

Having managed a productive habitat and filled it with elk, federal and state responsibilities begin to merge in vulnerability management. This includes any action designed to improve the chances of a bull elk surviving the hunting season. It is a shared responsibility that cannot be ignored because it cannot be managed by either federal or state action independently. Access control, habitat security, and special regulations all play a part, and they cannot be viewed as actions to be taken independently. It's imperative that game departments and the National Forests recognize all aspects of elk management and work in coordination to satisfy a demonstrated public demand.

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THE REINTRODUCTION OF GRAY WOLVES TO YELLOWSTONE NATIONAL PARK AND CENTRAL IDAHO

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Wolf Eradication- Wolves were once one of the most widely distributed land mammals on earth. In North America, gray wolves (*Canis lupus*) historically occurred in almost every habitat north of what is now Mexico City. However, as European settlers decimated wild ungulate populations and replaced them with livestock, wolves and other large predators that occasionally attacked livestock were persecuted. In addition to the real and perceived conflicts with livestock, old world myths had portrayed wolves as evil and satanic, thus it is not surprising that most people during the settlement era viewed wolves in an extremely negative context. Wolf persecution and eradication were relentless and conducted with almost hysterical zeal. Wolves were not just shot, trapped, and poisoned but burned alive, dragged behind horses, and mutilated. By 1930, government predator eradication programs eliminated wolf populations from the western United States. Similar attitudes resulted in the elimination of wolf populations from the southern portions of the western Canadian provinces by the 1950's. The fact that these events happened within the lives and recent memories of many older western residents strongly affects the social and political climate of wolf recovery efforts today.

Natural Wolf Recovery- In the 1960's, after scientific wildlife research began to dispel many of the negative myths surrounding predators, the first calls for reintroduction of wolves to Yellowstone National Park were made. About the same time, Canadian wildlife management agencies took steps to encourage re-establishment of wolf populations in parts of southern British Columbia and Alberta by eliminating bounties and restricting wolf hunting and trapping. Throughout the 1960's and 1970's lone wolves were occasionally sighted or killed in the northern Rocky Mountains of Montana, Idaho, and Wyoming (Weaver 1978, Ream and Mattson 1982). While Canadian wolf populations continued to expand southward, it was not until 1986 (55 years after eradication) that wolves again produced pups in the western United States (Ream et al. 1989). By 1993 the wolf population in northwestern Montana had increased to about 50 wolves in 5 packs. No wolf packs have been documented in other areas of the western United States, although lone wolves continued to be reported in Wyoming, Idaho, and other areas.

In 1988, the U.S. Fish and Wildlife Service (Service) established a proactive interagency wolf recovery program to assist natural recolonization in Montana (Bangs 1991). The program strongly emphasized public education and information, because controversy over wolves and their management was still largely a issue of symbolism, with strong emotion, rumor, and myth on both "sides" of the wolf recovery issue and illegal killing by the public was the single greatest threat to wolf recovery in Montana. Since 1989, Service biologists have given over 300 presentations to livestock, hunter, environmental, and civic groups that were attended by over 13,000 local residents. In addition, the Service helped generate hundreds of newspaper, television, and magazine articles that provided information about wolves and their recovery to the public. Other Service-led interagency wolf recovery programs were established in Idaho, Wyoming, and Washington and are primarily focused on wolf monitoring and information and education efforts (Fritts et al. 1993).

Since 1980, conflicts with livestock production have been minor, although still extremely controversial (Bangs et al. 1993). A total of 17 cattle and 12 sheep have been killed by wolves, all in Montana. Seventeen wolves were moved or killed by the Service and USDA Animal Damage Control to prevent further livestock losses and build local tolerance of non-depredating wolves (the majority of the wolf population). In 1987, a private group (Defenders of Wildlife) established a successful program that compensates ranchers for livestock killed by wolves (about $10,000 has been paid to date). In 1993, they began a program that pays $5,000 to any landowner who has wolves successfully raise pups on their private property. Effective agency control of problem wolves and the private compensation program has helped reduce local controversy about the presence of wolves.

The Service, other cooperators, and the University of Montana initiated research on wolves and ungulates in and adjacent to Glacier National Park. Wolves in the Glacier Park area generally lived in packs of 8-12 wolves, utilized territories of about 300 mi^2 in valley bottoms, had a single litter of 6 pups in late April, fed primarily on white-tailed deer, and died most often because people killed them. Data indicate that wolves are simply another predator. Of 120 adult female white-tailed deer, elk, and moose monitored with radio telemetry over the past 4 years in that area, 45 have died. Mountain lions killed 14, wolves 10, grizzly bears 7, humans 7, coyotes 3, old age 1, and 3 others died from unknown causes (D. Pletscher, Univ. of Montana, pers. commun.). Those results led to research on mountain lions in 1992. That work suggested that wolves may be a more direct competitor with them than previously believed. Wolves have killed 3 mountain lions and it was not uncommon for wolves to track lions and usurp their ungulate kills (M. Hornocker, Hornocker Wildl. Res. Inst. Inc., pers. commun.). These data suggest the potential impact of wolves on ungulate populations may be lower than previously predicted.

Recovery Plans- In 1974, wolves were legally protected by the federal Endangered Species Act of 1973 (Act) and recovery programs were initiated in the northern Rocky Mountains (Fritts 1991, Fritts et al. 1993). The state of Montana led an interagency recovery team, established by the Service, that developed a recovery plan for the Northern Rocky Mountain Wolf. That 1980 plan recommended a combination of natural recovery and reintroduction be used to recover wolf populations in the area around Yellowstone National Park north to the Canadian border.

A revised recovery plan was approved by the Service in 1987. It identified a recovered wolf population as being at least 10 breeding pairs of wolves, for 3 consecutive years, in each of 3 recovery areas (northwestern Montana, central Idaho and the Yellowstone area). This totals approximately 300 wolves. The plan recommended using the 1982 experimental population section (10j) of the Act to quickly reintroduce wolves to Yellowstone National Park and to conduct liberal management to address local concerns about their potential negative impacts. If 2 wolf packs had not been discovered in central Idaho within 5 years, a similar reintroduction would occur there also.

Wolf Management Committee- In 1990, Congress directed appointment of a Wolf Management Committee, composed of 3 Federal, 3 State and 4 special interest group representatives, to develop a plan for wolf restoration to Yellowstone and central Idaho. That Committee provided a majority, but not unanimous, recommendation to Congress in May 1991. That recommendation included a declaration by Congress directing reintroduction of wolves to Yellowstone National Park, and possibly central Idaho, as a special nonessential experimental population with particularly liberal management by agencies and the public to resolve potential conflicts. Wolves and ungulates under that plan would be intensively managed by the States with Federal funding and thus implementation costs were estimated to be high. Congress took no action on the Committee's recommendation.

Gray Wolf EIS- In November 1991, Congress directed the Service, in consultation with the National Park Service and Forest Service, to prepare an environmental impact statement (EIS), that considered a broad range of alternatives on wolf reintroduction to Yellowstone National Park and central Idaho. In 1992, Congress directed the Service to complete the EIS by January 1994 and stated it expected the preferred alternative to be consistent with existing law.

The Service formed and funded an interagency team to prepare the EIS. In addition to the National Park Service and Forest Service, the states of Wyoming, Idaho, and Montana, USDA Animal Damage Control, and the Wind River Tribes participated. The Gray Wolf EIS program emphasized public participation. In the spring of 1992, nearly 2,500 groups or individuals that had previously expressed an interest in wolves were directly contacted and the EIS program was widely publicized.

In April 1992, a series of 27 "issue scoping" open houses were held in Montana, Wyoming, and Idaho and 7 more in other locations throughout the U.S. The meetings were attended by nearly 1,800 people and thousands of brochures were distributed. Nearly 4,000 people provided their thoughts on issues they felt should be addressed in the EIS. The most commonly mentioned issues involved ecosystem completeness, land use restrictions, livestock losses, humane treatment and respect of wolves, potential impacts to ungulate populations and hunting opportunity, and management strategies and costs. A report describing the public's comments was mailed to 16,000 people in July.

In August 1992, another series of 27 "alternative scoping" open houses and 3 hearings were held in Wyoming, Montana, and Idaho. Three other hearings were held in Seattle, WA, Salt Lake City, UT, and Washington D.C. In addition, a copy of the alternative scoping brochure was inserted into a Sunday edition of the two major newspapers in Montana, Wyoming, and Idaho (total circulation about 250,000). Nearly 2,000 people attended the meetings and nearly 5,000 comments were received about different ways that wolf recovery could be managed. The public comment reflected the strong polarization that has typified management of wolves. A majority (many urban or not living in the potentially affected areas) indicated it wanted immediate reintroduction and full protection of wolves. Many others (primarily rural residents in or near central Idaho or Yellowstone) indicated they did not want wolves to be recovered. A report on the public's ideas and suggestions was mailed to about 30,000 people in November 1992. In April 1993, a Gray Wolf EIS planning update report was published. It discussed the status of the EIS, provided factual information about wolves, and requested the public to report observations of wolves in the northern Rocky Mountains. It was mailed to nearly 40,000 people, residing in all 50 states and over 40 foreign countries that had requested information.

<u>Reintroduction of Wolves designated as Nonessential Experimental Populations</u>- The draft EIS was released to the public on July 1, 1993. The Service proposed to reintroduce gray wolves into both Yellowstone National Park and central Idaho, if 2 naturally occurring wolf packs could not be located in either area before October 1994 (Fig. 1). The reintroduced wolves would be designated as nonessential experimental populations. The experimental rules would allow liberal management of wolves by government agencies and the public to minimize conflicts over public lands, effects on domestic animals and livestock, and impacts on ungulate populations. There would be no land use restrictions for wolves. State and tribal wildlife agencies would be encouraged to lead wolf management outside national parks and national wildlife refuges. Reintroduction would result in wolf population recovery in and around Yellowstone National Park and central Idaho by 2002. Total management costs of the program through recovery (10 breeding pairs in each area for 3 years) and delisting were about $6 million.

In the draft EIS, the Service considered 4 alternatives to the proposed action including "Natural Recovery" (wolf recovery about 2025 and total cost about \$10-\$15 million), "No Wolf" (no recovery and cost about \$100,000), "Wolf Management Committee" (recovery about 2015 and cost of \$100-\$129 million), "Reintroduction of Nonexperimental Wolves" (recovery about 2000 and total cost of \$28 million, including habitat purchases). The impact of each wolf management strategy (except the "No wolf") on livestock, ungulate populations, hunting, land use restrictions, visitor use, and local economies varied primarily in <u>when</u> and <u>where</u> the impacts would occur rather than major differences in the <u>level</u> of impacts.

The Yellowstone area is about 25,000 mi^2 (64,750 km^2) and 76% federal land. This area has over 95,000 ungulates with a hunter harvest of 14,314 ungulates, is grazed by about 412,000 livestock (estimated current annual losses 21,333 head), receives about 14,500,000 recreational visits annually, and has a \$4.2 billion local economy (3.5% due to livestock). The central Idaho area is about 20,700 mi^2 (53,613 km^2) and is nearly all USDA Forest Service land. The central Idaho area has about 241,000 ungulates with a hunter harvest of 33,358 ungulates, is grazed by about 306,525 livestock (estimated current annual losses 21,680 head), receives about 8,000,000 recreational visits annually, and has a \$1.43 billion local economy (5.2% due to livestock).

A recovered wolf population in the Yellowstone area would be anticipated to kill about 19 cattle (1-32) and 68 sheep (17-110) and up to 1,200 ungulates (primarily elk) each year. A recovered wolf population would not affect hunter harvest of male ungulates but may reduce hunter harvests of female elk, deer, and moose for some herds. A recovered wolf population would not affect hunter harvests or populations of bighorn sheep, mountain goats or antelope. A recovered wolf population may reduce populations of elk 5%-30% (30% in some small herds), deer 3%-19%, moose 7%-13%, and bison up to 15%. The presence of wolves would not change uses of public or private land except for restricting potential use of M-44 cyanide devices ("coyote getters") in occupied wolf range. Visitor use would increase (+5% for out of state residents and +10% for local residents), and generate \$7-10 million in additional net economic benefits each year.

A recovered wolf population in the central Idaho area would kill about 10 cattle (1-17) and 57 sheep (32-92) and up to 1,650 ungulates (primarily mule deer) each year. A recovered wolf population would not affect hunter harvest of male elk but may reduce harvest of female elk 10%-15%. A recovered wolf population would not measurably impact hunter harvest of deer, moose, bighorn sheep, or mountain goats. A recovered wolf population would not measurably impact ungulate populations in central Idaho. Wolf presence would not change uses of public or private land (except for restricting use of M-44 devices in occupied wolf range). Visitor use would likely increase (+8% for out of state residents and +2% for local residents), and generate \$5.6-\$8.4 million in additional net economic benefits each year.

Public comment on the draft EIS- Nearly 1,700 copies of the draft EIS and 75,000 copies of the summary draft EIS were distributed in July, August, September, and October of 1993. A copy of the summary draft EIS, a schedule for 16 public hearings (4 each in Montana, Idaho and Wyoming and 4 national) and a request to the public to report observations of wolves in the northern Rocky Mountains was incorporated into a newspaper insert that was distributed in a Sunday edition of the 2 major newspapers in Montana, Wyoming, and Idaho (circulation 270,000). Public comments on the draft EIS were accepted until November 26, 1993. Over 160,000 comments were received and analyzed, a record for public comment on a federal EIS.

Preparing the final EIS A final EIS will be completed in early 1994. Once the EIS is completed it will be forwarded to decision makers in the Service and Department of Interior. They will determine how wolf recovery will proceed. All requests for information or to receive the final EIS should be directed to Ed Bangs, **Gray Wolf EIS, P.O. Box 8017, HELENA, MONTANA 59601 or phone (406)449-5202.** The only prediction that is considered absolutely safe is that extreme controversy will continue to characterize wolves and wolf management for many years to come.

Suggested Reading about Wolves in the West:

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THE EFFECT OF POOL REGULATION ON AQUATIC MACROPHYTES AND WATERFOWL IN MADISON RESERVOIR

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From 1988-1992 we conducted field studies and compiled the recorded and anecdotal history of macrophyte and waterfowl trends in Madison Reservoir since 1932, to establish baseline information on the abundance and distribution of submerged macrophytes in response to water level regulation, and on utilization of the reservoir by various species of waterfowl. From 1932 to 1979, annual Madison Reservoir drawdowns varied in depth and duration and the reservoir was dominated by several *Potamogeton* species. In 1979, an aggressive nuisance species, *Elodea*, began to grow in the reservoir; and by the fall of 1982, *Elodea* had crowded out *Potamogeton* and become the dominant macrophyte species. A six-foot drawdown during the spring of 1983 effectively eliminated *Elodea* from the shallow portions of the reservoir. However, several *Potamogeton* species persisted and rapidly expanded in the reservoir following the 1983 drawdown. By 1988, *Elodea* was again observed growing in small numbers among *Potamogeton* species which dominated the reservoir. By late summer of 1991, *Elodea* was dominant in 76% of all reservoir plots sampled. The severe reduction in macrophyte standing biomass (primarily *Elodea*) after the 1983 drawdown was a probable factor in the decline of various migrant waterfowl using the reservoir from 1984-1991.

WOLVES AND THEIR PREY ALONG THE NORTH FORK OF THE FLATHEAD RIVER

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Gray wolves (*Canis lupus*) have been intensively studied within and near Glacier National Park in northwestern Montana and southeastern British Columbia. The early winter, 1993 population is approximately 35 wolves in 4 packs. Reproduction continues to average 5.5 pups/litter, but the population has remained relatively constant in this area due to dispersal and human-caused mortality. Cause-specific mortality among the primary prey of wolves in this area, white-tailed deer (*Odocoileus virginianus*), elk (*Cervus elaphus*), and moose (*Alces alces*), has been studied by UM graduate students Jon Rachael, Mike Bureau, and Meg Langley, respectively. Radio-collared ungulates have been killed by 6 predators in the past 3 years: mountain lions (*Felis concolor*), black bears (*Ursus americanus*), grizzlies (*U. arctos*), humans, coyotes (*Canis latrans*), and wolves. Annual survivorship for deer, elk, and moose has been 0.73, 0.75, and 0.91, respectively.

USING GIS COMPUTER TECHNOLOGY TO EVALUATE ELK RESPONSE TO ROAD DENSITIES IN NORTHWESTERN MONTANA

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ABSTRACT

Using GIS (Geographic Information System) computer mapping techniques, exact road densities were mapped, then overlaid with over 3900 radio relocations of cow and bull elk in the Lower Clark Fork Study Area (Hunting Districts 123 and 200). This GIS procedure provided availability/use information for 8 classes of road density. The 560 mi^2 study area, defined by the annual home range of radio-collared elk, had 747 miles of digitized roads for an average road density of 1.33 mi/mi^2. When seasonal and permanently closed roads were omitted, open road density decreased to 0.88 mi/mi^2. Male and female elk responded differently to open road densities during most seasons. In all seasons, males avoided road densities >0.5 mi/mi^2. In winter, cows preferred road densities <1.5 mi/mi^2; in spring and summer, they used open road densities of up to 3 mi/mi^2 equal to their availability; during archery and general hunting seasons, cows preferred areas of 0 mi/mi^2 but used habitats with road densities of up to 1.5 mi/mi^2. Evidence suggested that elk were reusing roaded habitats where road closures were established. Implications for travel, project and forest planning are discussed. Displaying elk habitat use patterns with GIS graphics also is discussed.

INTRODUCTION

Numerous studies have demonstrated that elk distribution and hunting season mortality are influenced by roads (Lyon 1979, Canfield 1988, Hillis et al. 1991, Hurley and Sargent 1991, Leptich and Zager 1991, Lyon and Canfield 1991). However, most research on the subject has displayed these relationships in terms of linear "distance" to roads. Although useful, distance measurements are sometimes difficult to implement. Road management of elk habitat on federal lands in Montana often uses the concept of road densities (miles of road per mi^2 of habitat). Current road density targets for elk habitat varies with the Forest. Average road density targets can ignore evaluation of the suitability of security areas and inadequately applied to project level planning.

The Montana Department of Fish, Wildlife, and Parks (DFWP) has been using GIS (Geographical Information System) computer technology to investigate the relationships between road densities and grizzly bears in the Swan Mountains of western Montana (Manley and Mace 1992). Using computer mapping techniques, exact road densities were mapped then overlaid with grizzly bear telemetry locations. Using this information, it was shown which road densities grizzly bears preferred, avoided, or used as expected.

From 1985-1990, DFWP biologists were studying elk movements and habitat use in the Lower Clark Fork Study in HD's 123 and 200. During the study over 3900 radio telemetry locations were made for both bull and cow elk (Henderson et al.). This telemetry data lent itself to similar road density analyses, using the technique developed for grizzly bears.

STUDY AREA

The study area is in southwestern Sanders and northwestern Mineral Counties of western Montana along the Idaho state border. The towns of Saltese, St. Regis, Paradise, Plains and Thompson Falls border the study area. It encompasses 612 square miles (mi^2) of timbered and mountainous terrain in Hunting District (HD) 123 (379 mi^2, 62% of total study area) and HD 200 (233 mi^2, 38%).

The topography is generally steep and elevations vary from 2,400 feet (ft) at the mouth of Prospect Creek to 7,200 ft at the summit of Penrose Peak. The C-C Divide is a major geological formation, running southeast from the Montana-Idaho border to the Clark Fork River near Paradise. The divide is the geographical boundary between DFWP Regions 1 and 2, separates the Thompson Falls/Plains Ranger District from the Superior Ranger District, and is the boundary between Sanders and Mineral Counties.

METHODS

Trapping

Efforts were made to trap and mark elk from all major winter ranges in the study area. Trapping operations were conducted from January to April from 1986 to 1989. Elk trapping and handling procedures, using portable modified Clover traps and a corral trap, were described by Lemke and Henderson (1987) and Thompson et al. (1989). During the study 119 elk (26 males, 93 females) were fitted with radio-collars.

Radio Telemetry

We attempted to relocate radio-tagged elk twice a month from late spring through November and less frequently from December through April. Aerial relocation methods included recording UTM (Universal Transverse Mercator) coordinates, elevation, and general location of radio-collared elk and is described in greater detail by Lemke and Henderson (1987) and Canfield (1988). With financial support from the Lolo National Forest (LNF), more intensive monitoring was conducted daily (weather permitting) immediately prior to and after the beginning of the general hunting seasons.

Road Density and Elk Use Patterns

Over 3,900 elk radio locations (552 for male elk and 3350 for females) were analyzed using standard Geographical Information System (GIS) computer technology to determine elk use patterns relative to road densities. Computer generated maps were overlaid on detailed digitized road maps for the entire study area (Mace 1992). The raster (cell) resolution used for analysis was 30 meter^2. At this resolution, the C-C Divide study area was composed of 1,654,318 cells.

Roads in the study area were assigned to 1 of 4 classes: primary open road, secondary open road, tertiary open road, and seasonal or yearlong closed road. Two road density maps were generated, one with all roads digitized and another with only open roads present. Road densities were classified into 7 levels: 0.0-0.5, 0.5-1.0, 1.0-1.5, 1.5-2.0, 2.0-2.5, 2.5-3.0, and >3.0 miles of road per mi^2.

Elk radio locations were analyzed with respect to the road density levels within which they were positioned. Female and male elk were analyzed separately using 5 seasonal categories with inclusive dates: winter (Dec.1-Feb.29), Spring (Mar.1-May 30), Summer (June 1-Aug.31), Archery Season (Sept. 1-Oct.15), and General Hunting Season (Oct. 15-Nov. 30). Female and male locations, stratified by season, were overlaid on the 2 GIS road density maps. The number of locations occurring in each road density class was determined and constituted "elk use." The amount of each road density class within the study area was determined and constituted "available" road density acreage. Simultaneous Bonferroni confidence limits were used to statistically determine if each road density level was preferred, avoided, or used in proportion to availability (Byers et al. 1984). Confidence limits were constructed at 95%.

RESULTS

The 560 mi^2 study area, defined by elk relocations, contained 747 mi of roads in all classes (Table 1) for an average road density of 1.33 mi of road/mi^2. When seasonal and permanently closed roads were omitted, the open road density decreased to an average of 0.88 mi/mi^2. Evidently, very few tertiary roads remain open. Thirty percent of the total road map and 46% of the open road map were classified as unroaded (0 mi/mi^2) (Table 2). Unroaded habitat occurred in 4 habitat patches of variable size.

Male and female elk responded differently to open road densities during most seasons. Bull elk showed a greater reluctance to use higher road density habitats throughout the year (Table 3). Bulls showed the strongest preference for zero road density habitats during the archery and general hunting seasons. In all seasons, bulls avoided road densities >0.5 mi/mi^2. The seasonal relationship for the use of roadless areas by bulls appears in Figure 1.

Road Class	Number miles in study area
Primary Open	248.02
Secondary Open	243.79
Tertiary Open	1.15
Seasonal/yearlong closed	254.34
Total	747.3

Table 1. Miles of road in the Lower Clark Fork Study Area.

Table 2. Percent of study area occurring in various road density levels.

Road Density (mi/mi^2)	Percent of Study Area	
	All Road Map	Open Road Map
0	33.52	46.36
0-0.5	9.87	48.47
0.5-1.0	10.03	2.42
1.0-1.5	14.72	1.71
1.5-2.0	9.71	0.73
2.0-2.5	7.72	0.22
2.5-3.0	5.26	0.09
>3.0	9.16	0.01

Table 3. The availability and use of road density classes by bull elk in the Lower Clark Fork Study Area. Open road density only.

Road Density (mi/mi^2)	Seasonal Use by Bull Elk				
	Winter	Spring	Summer	Archery	General
0.0	=	=	+	+	+
0.0-0.5	=	=	-	-	-
0.5-1.0	-	-	-	-	-
1.0-1.5	-	-	-	-	-
1.5-2.0	-	=	-	-	-
2.5-3.0	-	-	-	-	-
>3.0	-	-	-	-	-

+ = preferred, = = used as available, - = avoided

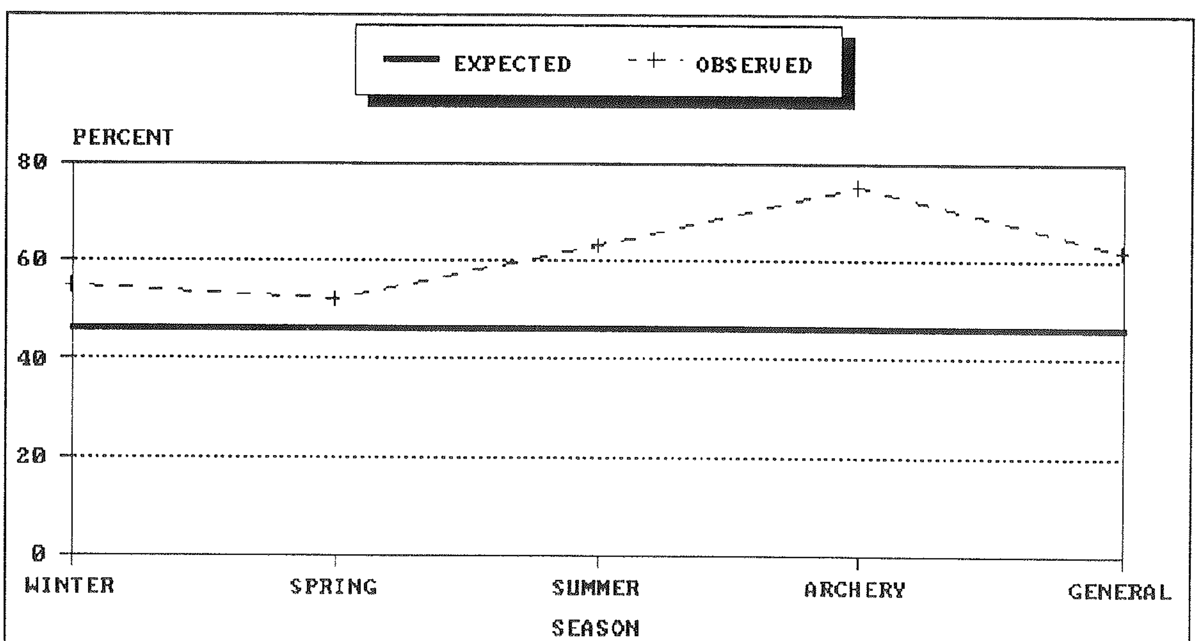

Figure 1. Seasonal preferences of bull elk for habitats with zero road density.

Cow elk were more evenly distributed throughout the study area in a wider variety of road densities than bulls. During the winter cows generally confined their activities to road densities <1.5 mi/mi^2. (Table 4). During spring and summer, habitats having open road densities of up to 3 mi/mi^2 were used greater or equal to availability. Although cow elk preferred to be in areas with zero road density during archery and general hunting seasons, they were present as expected in habitats with road densities of up to 1.5 mi/mi^2. Seasonal use patterns by cows of roadless areas are displayed in Figure 2.

Table 4. The availability and use of road density classes by cow elk in the Lower Clark Fork Study Area. Open road densities only.

Road Density (mi/mi^2)	Seasonal Use by Cow Elk				
	Winter	Spring	Summer	Archery	General
0.0	=	=	+	+	+
0.0-0.5	+	=	+	=	=
0.5-1.0	=	-	=	=	=
1.0-1.5	=	=	-	=	=
1.5-2.0	-	=	=	-	-
2.0-2.5	-	=	=	-	-
2.5-3.0	-	=	=	-	-
>3.0	-	-	-	-	-

+ = preferred, = = used as available, - = avoided

Thirty-four percent of the study area roads were closed on either a seasonal or year-long basis. By looking at elk locations in relation to the total road system, it was possible to determine, if elk were using habitats adjacent to closed roads.

Bull elk preferred to be in zero road density habitats when their locations were overlaid on both the open road map (Table 3) and the all road map (Table 5). By comparing Tables 3 and 5, differences in habitat use occurred in road densities of 0.0-0.5 and 1.0-1.5 mi/mi^2. In Table 3 it is apparent that bull elk

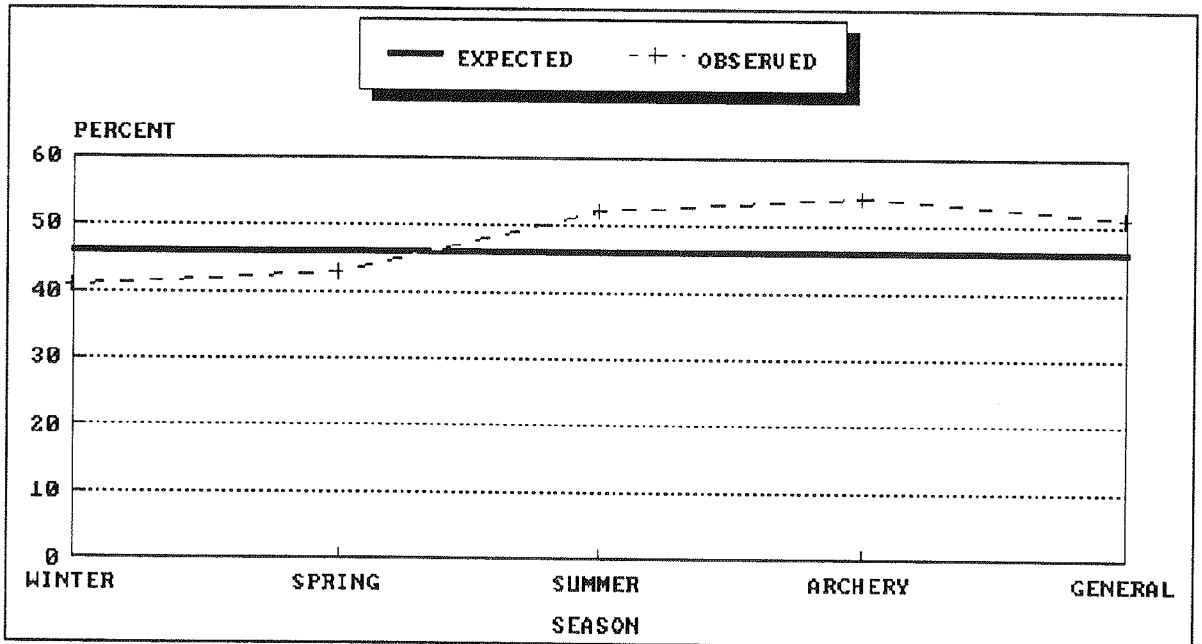

Figure 2. Seasonal preferences of cow elk for habitats with zero road density.

Table 5. The availability and use of road density classes by bull elk in Lower Clark Fork Study Area. All roads included.

Road Density (mi/mi^2)	Seasonal Use by Bull Elk				
	Winter	Spring	Summer	Archery	General
0.0	=	=	+	+	+
0.0-0.5	=	=	=	=	=
0.5-1.0	=	=	=	=	=
1.0-1.5	=	=	=	=	=
1.5-2.0	=	=	=	=	-
2.0-2.5	=	=	-	=	-
2.5-3.0	=	=	=	-	-
>3.0	=	=	-	-	-

+ = preferred, = = used as available, - = avoided

avoided open road habitats throughout the year. However, in Table 5 it clearly shows that bulls were using the moderate road densities even during the hunting seasons. This suggests that bulls were "regaining" lost habitats found behind gated roads.

Cow elk also preferred habitats with zero road density (Table 4). However, no such strong preference was shown by cows, when all roads were considered; nearly all road densities were used as available (Table 6). Like bulls, cow elk were using habitats where roads had been closed.

Table 6. The availability and use of road density classes by cow elk in Lower Clark Fork Study area. All roads included.

Road Density (mi/mi^2)	Seasonal Use by Cow Elk				
	Winter	Spring	Summer	Archery	General
0.0	-	-	=	=	=
0.0-0.5	=	=	=	=	=
0.5-1.0	=	=	=	=	-
1.0-1.5	+	=	=	=	=
1.5-2.0	=	=	=	=	=
2.0-2.5	=	=	=	=	=
2.5-3.0	=	=	=	=	=
>3.0	=	=	=	=	-

+ = preferred
= = used as available
- = avoided

DISCUSSION

The GIS analysis of elk habitat use and road density showed dramatic and statistically significant negative responses of elk to even moderately roaded areas. Both cows and bulls tended to avoid habitats with >0.5 miles of road/mi^2 throughout the year. Bull elk were more selective and actually showed a preference for only roadless habitats. Marcum and Edge (1991) also noted that bull elk respond more strongly than cows to disturbance factors along roads. Road density appears to be a major factor in determining elk habitat use within the study area. The implications of increasing road densities in core elk habitat are serious. Elk, particularly bulls, can effectively "lose" the use of important habitat due to the existence of road densities that are below allowable Forest Service Habitat Effectiveness Index (HEI) standards. Many Forest Plans have HEI standards of 50-70%

for elk habitat. This translates in allowable road densities of 0.7-1.8 mi of road/mi^2, which may not be sufficient to protect elk habitat use, according to our data.

The LNF Forest Plan (1985) established a road density standard of 1.1 mi/mi^2 maximum on highly productive big-game summer range and provided for closing newly built roads in areas of moderate big-game summer range. Our data indicated that these standards would not adequately accommodate elk security needs in many areas, since bull elk showed a strong preference for habitats with less than 0.5 mi/mi^2 during most times of the year.

The study area is heavily forested compared to many other elk habitats in other portions of Montana. It is not clear that elk responses to the same road densities in more "open" habitats would be the same as we found in northwestern Montana.

The analysis did not include topographic and vegetative factors which probably influenced elk habitat use. We, therefore, identified opportunities for further analysis of the interrelationships of elk use, road densities, cover, and topography.

Our data indicated that closing roads may allow elk, to some extent, re-inhabit roaded habitats. The likelihood of significantly expanding road closures is uncertain, given the publics demand for vehicular access to National Forests, thus requiring continued education and interaction with various publics.

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GRIZZLY BEAR USE OF HABITATS MODIFIED BY TIMBER MANAGEMENT

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ABSTRACT

This study employed a sample of 22 radio-collared grizzly bears to document the extent to which grizzly bears used harvested habitats on a seasonal and annual basis and how this use compared to the availability of harvested habitats. Use sites within treated stands were sampled and compared to random sites within the same stand to determine if grizzly bears were selecting unique microsites within stands or if use sites were representative of the stand as a whole. Instrumented grizzly bears significantly avoided using harvested stands within the study area during all seasons. Within composite and seasonal 95% minimum convex polygon home ranges, instrumented grizzly bears used harvested stands in proportion to their availability within their home range polygons. Use of harvested stands did not differ significantly among most of the individual grizzly bears. I found no significant difference in the use of harvested stands between age/sex classes. Instrumented grizzly bears were more likely to use harvested stands in summer than in spring or fall. Clearcuts were used less than other harvest types. Stands harvested 30-40 years ago were more likely to be used than younger or older cuts. Univariate and multivariate analyses of habitat data identified 3 variables that discriminated between use and random sites in 73% of the cases. They were distance to edge, vegetation density between 1.0-1.5 m, and amount of huckleberry present. I concluded that a lack of security cover, human disturbance, and food availability, regulated the amount of use that harvested stands received. Also, stands logged in the study area within the last 10 years are unavailable as grizzly bear habitat and should be recognized as such. Although the amount of available grizzly bear habitat in the study area is likely to increase as harvested stands recover, the study area may be currently over-harvested in terms of providing optimal grizzly bear habitat. I suggest that management agencies conduct ecosystem specific investigations of the effects of logging on grizzly bears. It is neither appropriate nor valid to extrapolate the results of studies in one ecosystem to another.

This presentation was a summary of research from M.S. thesis research and is available from the Montana State University Library in Bozeman.

UPDATE OF MONTANA'S BLACK-FOOTED FERRET REINTRODUCTION PROGRAM

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The black-footed ferret (*Mustela nigripes*), a medium sized mustelid once found throughout the central plains of North America, appeared to be totally dependent on the prairie dog (*Cynomys sp.*) for food and living quarters (Forrest et al. 1985). This secretive, nocturnal mammal was thought to be extinct until 1981 when a small population was discovered in the Meeteetse, Wyoming area. This population thrived until 1985 when it was decimated by canine distemper. The eighteen known survivors were brought into captivity and given the ominous task of recovering their species (Crane 1991).

A national recovery plan for the black-footed ferret called for increasing the captive population to 200 breeding adults by 1991 and reestablishing the surplus offspring in ten separate sites by the year 2010 (USFWS 1988).

In 1991, 49 juvenile ferrets were turned loose on a white-tailed prairie dog (*Cynomys leucurus*) complex in Shirley Basin, Wyoming (Oakleaf et al. 1992). A few of them not only survived their first winter in the wild but at least two litters were produced the following spring (Beers 1992).

An attempt was made to bring the south Phillips County, Montana reintroduction program on line for a 1992 release. However, this was not possible due to a variety of reasons and all the 1992 surplus ferrets (90) were released in Shirley Basin, Wyoming.

MONTANA:

The new target date for releasing ferrets in south Phillips County is fall 1993. The cooperating federal and state agencies are racing against the clock to be ready to go when the ferrets are. There are three separate paper trails that will, hopefully, converge by this fall.

First, the Montana Department of Fish, Wildlife and Parks completed a Reintroduction and Management Plan which was submitted, along with an Environmental Assessment, to the Montana Fish, Wildlife and Parks Commission for their approval. The commissioners voted unanimously to allow the Department to continue to participate in the reintroduction program.

Secondly, the BLM completed the Judith, Valley, Phillips/Resource Management Plan EIS, sent the final out for public comment and are currently responding to a number of protests. Several protests were received that address the prairie dog management section.

The third trail is the US Fish and Wildlife Service's "Proposed Rule", designating this reintroduction nonessential, experimental, that has been swallowed up by the federal review process. The "Final Rule" must be published in the Federal Register before ferrets can be released.

SYLVATIC PLAGUE:

The abundant and thriving black-tailed prairie dog (*Cynomys ludovicianus*) population in south Phillips County was a welcome sight to researchers looking for potential ferret reintroduction sites (Flath 1987). However, this enthusiasm was not shared by the local livestock producers. Negotiations between the Black-footed Ferret Working Group (composed of representative from the various cooperating state and federal agencies) and the landowners resulted in an agreement that prairie dog acres would be maintained at the 1988 levels (the last year these towns were measured).

In 1992, the BLM resurveyed the prairie dog towns in the reintroduction area using the highly sophisticated Global Positioning System (GPS) which uses signals from orbiting satellites to precisely determine the receiver's location. Much to everyone's surprise they recorded a decrease of about 40 percent in the total prairie dog acreage. While some of the loss may have been attributable to the new methodology and some to the normal dynamics of small (5-10 acres) towns, what caught our attention was the sudden and total disappearance of prairie dogs from a number of the towns.

The magnitude of prairie dog losses suggested the presence of the bacterium (*Yersinia pestis*) responsible for sylvatic plague. This disease, which is fatal to rodents, had previously been identified in Garfield County south of the Missouri River but never from Phillips County (CDC pers. comm.). Attempts to confirm the presence of plague by collecting fleas and prairie dog carcasses and long bones were unsuccessful.

Predators, such as coyotes (*Canis latrans*) and red fox (*Vulpes vulpes*), can become infected with sylvatic plague by eating diseased rodents and from their fleas but it is usually not fatal. Antibodies produced after exposure can be detected from blood serum samples.

Fortunately, clearance of the bureaucratic hurdles and acquisition of adequate funding for predator sampling coincided with a good snow cover in mid-January 1993. APHIS Animal Damage Control used a helicopter to collect 53 coyotes from the south Phillips County ferret reintroduction area and 29 coyotes and 3 red fox from the adjacent Fort Belknap Indian Reservation.

A tube of blood was obtained from the thoracic cavity of each animal. The blood was spun down in a centrifuge and the serum sent to the Wyoming Veterinary Laboratory for analysis. Special paper strips (Nobuto strips) were soaked in blood and sent to the Center for Disease Control, Fort Collins, CO. for testing. The carcasses were taken to the Montana Veterinary Laboratory for complete necropsies.

On February 12, word was received from the Wyoming Laboratory that 46 of the coyote samples from south Phillips County tested positive for the presence of plague antibodies. All samples from the Fort Belknap Indian Reservation were negative. CDC confirmed the Wyoming findings. Additionally, eleven coyotes from south Phillips County and three coyotes and one red fox from the reservation tested positive for exposure to tularemia, a disease carried by, and fatal to, rabbits and hares.

DISCUSSION

The appearance of plague in the area should not significantly impact the proposed reintroduction of black-footed ferrets. Proposed release site prairie dog towns will be closely monitored during the summer and contingency plans will be developed in case plague hits the primary release site. Although plague does not directly affect the ferrets, it can severely reduce its main food supply. Ferrets will not be released unless an adequate prey base is available.

The Reintroduction and Management Plan called for maintaining the prairie dog acreage at a set level. Action plans to address the problem of expanding towns sounded good on paper but implementation was shaping up to be a formidable task. The good news is mother nature used sylvatic plague to take care of the problem. The bad news is we now need contingency plans to bring the prairie dog acreage back up to the 1988 levels.

The American West is littered with examples of man's misguided attempts to manipulate natural ecosystems to suit his needs. Therefore, a technological quick fix to build up prairie dog numbers is probably not the best course of action. Rather, they should be allowed to increase and repopulate the area naturally.

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FERRUGINOUS HAWK AND PRAIRIE FALCON REPRODUCTIVE AND BEHAVIORAL RESPONSES TO HUMAN ACTIVITY NEAR THE KEVIN RIM, MONTANA

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ABSTRACT

The reproductive and behavioral responses of nesting ferruginous hawks (*Buteo regalis*) and prairie falcons (*Falco mexicanus*) and the behavioral responses of roadside foraging raptors to human activity and artifacts were studied on a 148 Km^2 study area near Kevin, Montana during the 1991 and 1992 nesting seasons. Thirty-four ferruginous hawk and 24 prairie falcon breeding sites were occupied during the study. Ferruginous hawk and prairie falcon site occupancy was not significantly influenced by the presence of powerlines, roads, or active oil wells. Ferruginous hawks nested primarily on outcrops and cliffs (54%) or elevated ground sites (42%) and were clumped along the Kevin Rim, a prominent sandstone escarpment. Ferruginous hawk nesting density (8.4 km^2/pair) was among the highest reported in the literature, but productivity was relatively low (47% success, 1.1 fledglings /occupied nest). The primary cause of ferruginous hawk pre-dispersal mortality was wet weather, which caused 37% of all losses. The local ferruginous hawk population may not be able to sustain itself at current levels if wet weather patters continue to destroy nests and young. Prairie falcon productivity was also relatively low (71% success, 1.9 fledglings/occupied nest) but appeared sufficient to maintain the population. There was no significant difference between ferruginous hawk of prairie falcon reactions to intrusion in areas with petroleum development. Ferruginous hawks in the Kevin Rim area were quicker to respond to human activity than ferruginous hawks in other studies, which may have been due to past human activity levels or reduced prey availability. Foraging ferruginous hawks avoided humans more than Swainson's hawks (*Buteo swainsoni*), northern harriers (*Circus cyaneus*), or red-tailed hawks (*Buteo jamaicensis*). In spite of this, ferruginous hawks still foraged along secondary roads in oilfields more than expected. Human activity in the area affected only a fraction of the local ferruginous hawk and prairie falcon breeding populations.

This presentation was a summary of research from M.S. thesis research and is available from the Montana State University Library in Bozeman.

HABITAT USE AND BEHAVIOR OF MALE MOUNTAIN SHEEP IN FORAGING ASSOCIATIONS WITH WILD HORSES

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INTRODUCTION

Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*) maximize survival by foraging in secure habitats that afford high visibility and have good interspersion of preferred forage plants with escape cover (Risenhoover and Bailey 1985). Good visibility and precipitous escape cover are structural habitat elements that provide security for mountain sheep from predators (Buechner 1960, Geist 1971, Wishart 1978, Risenhoover and Bailey 1985).

Wild horses (*Equus caballus*) also maximize survival by foraging in secure habitats with good interspersion of preferred forage plants. However, different structural elements of the habitat provide security for mountain sheep and horses; mountain sheep select foraging areas near precipitous escape terrain while horses select foraging areas near open-flat terrain. This is due to basic differences in predator escape tactics for the species; mountain sheep climb to avoid predation and horses run.

Although grasses dominate the diets of both horses and mountain sheep, each species' predator avoidance strategy selects for structurally different habitats. However, when spatial distributions overlap, a competitive situation may occur, with mountain sheep being negatively impacted. Such competition with feral equids has resulted in mountain sheep declines (McMichael 1964, Weaver 1973, Seegmiller and Ohmart 1981).

A growing body of literature supports the hypothesis that horses and other exotics, may in some aspects, facilitate the foraging effectiveness of some native ungulate species, either by habitat modification or increased protection from predators (Berger 1978, Berger 1986, Festa-Bianchet 1991). The purpose of this note is to present unique observations which suggest that male mountain sheep may benefit from close foraging relationships with wild horses. Few data exist on resource competition between mountain sheep and feral horses (Berger 1986), and though not statistically quantifiable, these limited observations support Berger's (1986) hypotheses regarding forage facilitation of native species by exotics.

STUDY AREA AND METHODS

The study was conducted at Bighorn Canyon National Recreation Area (BICA), a 48,679 ha National Park Service unit which centers around a 114 km-long reservoir in southeastern Montana and north-central Wyoming. Mountain sheep recolonized BICA in 1975 due to dispersal of 4 to 6 animals from a nearby transplant. By 1986 the population had increased to over 60 animals (Coates and Schemnitz 1986).

Portions of BICA are federally designated as the Pryor Mountain Wild Horse Range (PMWHR). The 17,402 ha PMWHR supports approximately 120 wild horses and is located 80 km south of Billings, Montana (BLM 1984).

The area is characterized as a desert-shrub woodland (Lichvar et al. 1985) and dominants include a sparse overstory of curlleaf mountain mahogany (*Cercocarpus ledifolius* var. *intercedens*), Utah juniper (*Juniperus osteosperma*), sagebrush (*Artemesia* spp.), greasewood (*Sarcobatus* spp.), with a poorly developed understory of bunch grasses (Lichvar et al. 1985). Annual precipitation averages 15 - 20 cm. Soils present include limestone and sandstone in the precipitous canyonland, and dolomite in the non-precipitous areas (Knight et al. 1987). Elevations vary from a mean-pool level of 1,109 m at the reservoir, to 2,682 m at East Pryor Mountain.

Gray limestone cliffs rise > 250 m vertically from the lakeshore. Cliff faces, ledges, and eroded limestone soils (karst topography) provide abundant escape terrain for mountain sheep. Escape terrain predominated the entire study area, from East Pryor Mountain to the reservoir, and other than an alluvial fan located at the northern extreme of the study area, virtually all habitat was within 300 m of cliffs, ledges, or karst topography.

Three adult ewes (>18 months-old) and a 6 year-old ram were captured and equipped with radio collars manufactured by Telonics (Mesa, Arizona). Systematic radio relocation of these animals provided the opportunity to locate and observe 328 groups of mountain sheep between June 1986 and November 1987.

Group size and age/sex composition were recorded for each observation. Additionally, 3 habitat parameters were analyzed: horse use ("Yes"/"No"), distance to precipitous terrain, and vegetation type. A preference ratio (percent use/percent availability) was used to analyze preference and (or) avoidance of the vegetation types (Risenhoover and Bailey 1985). Because escape terrain was nearly continuous throughout the southern portion of the study area (distance rarely > 300 m), all habitat types were considered as available to mountain sheep. The alluvial fan was also considered as available to mountain sheep, primarily for purposes of investigating differences in habitat selection between male and female cohorts of mountain sheep, and to analyze the influence of distance to escape terrain on foraging behavior.

The foraging behavior of adult mountain sheep was analyzed to determine the effects of habitat security on foraging efficiency (Risenhoover and Bailey 1985). Once a group of mountain sheep was located, a focal animal was selected for analysis of foraging behavior. Recognition of focal animals was aided by identifying marks on pelage or scars. Foraging behavior was observed for 5 consecutive 3 minute periods to determine the amount of time the focal animal devoted to 3 behavioral categories: foraging, social, alert (Risenhoover and Bailey

1985). An animal was engaged in foraging when it actively ingested forage and when it moved about with the group of animals that were actively ingesting forage.

An animal was engaged in social behavior for all intraspecific and interspecific interactions. Social interactions included looking at another animal, moving toward/away from another animal, and mother/young interactions. Alert behavior was recorded if the focal animal stopped foraging to look up in the typical alert posture for mountain sheep (i.e., with ears up and neck outstretched) (Geist 1971), if it looked at a disturbance (e.g. a vehicle on the highway, or a person approaching on foot), or when it ran to avoid a disturbance (e.g. a person approaching on foot). Foraging efficiency was calculated as percent time devoted to foraging behavior during the 15 minute period. Percent time spent in alert or social interactions provided a measure of the relative security of mountain sheep in different habitats.

RESULTS AND DISCUSSION

Four vegetation types (Knight et al 1987) occurred within the observed range of mountain sheep: Utah juniper/mountain mahogany woodland (JU/CE), Utah juniper woodland (JUOS), mountain mahogany woodland (CELE), Douglas fir woodland (PSME). The distribution of JUOS was limited to an alluvial fan at the north end of the study area and narrow fingers interspersed within the JU/CE habitat type. Horse use was always "No" for karst topography and "Yes" for the alluvial fan at the northern extreme of the study area, based on the presence/absence of horse feces observed during field work. Horse use was also observed along fingers of non-precipitous habitat interspersed throughout the JU/CE type. Distribution of PSME was restricted to a deeply incised riparian area present in the core use area occupied by rams.

Overall, 85.7% of the male mountain sheep observations involving mixed age/sex groups occurred in the JU/CE woodland. The JUOS, CELE, and PSME woodlands were used in 13.6, < 1, and < 1% of the observations, respectively (Table 1). The preference ratio for JU/CE is 4.5, indicating that mountain sheep foraging with conspecifics prefer this type (Risenhoover and Bailey 1985). Preference for the JU/CE habitat type was probably due to the interspersion of escape terrain more than differences in visibility between habitat types. Juniper was sparsely distributed throughout both JU/CE and JUOS types. Distinction between types was based on occurrence of curlleaf mountain mahogany rather than on increasing frequency of Utah juniper (Lichvar et al. 1985). Visibility obstruction was low in both JU/CE and JUOS habitat types. Ewes never occupied the PSME type, even though it was located on rocky slopes, because visual obstruction was much higher than in JU/CE or JUOS.

Male mountain sheep were observed foraging with wild horses 22 times on 20 different days and habitat parameters were recorded for 12 observations. Foraging associations usually involved 2 specific male horse/harem groups with bachelor ram groups. Ram group size ranged from 3 to 7 animals, 3 to 10 years of age. Female mountain sheep were never observed in association with wild horses. Horse group size was dynamic, but association usually involved one of 2 specific male horses accompanied by 5 to 8 mares and subadults. Of the 12 observations 83.3% (n=10) occurred in the JUOS vegetative type, and 16.7% (n=2) occurred in the JU/CE type (Table 1). The preference ratio for JUOS is 1.2. The preference ratio for the JUOS type by male mountain sheep foraging with wild horses is noteworthy because habitat utilization patterns for JU/CE and JUOS were reversed when male mountain sheep associated with wild horses (Table 1).

Table 1. Percent habitat utilization by male mountain sheep in foraging associations with conspecifics compared with associations with wild horses. Habitat preference ratios are expressed as + or - and are given in parentheses below each appropriate category.

	Habitat type			
	JU/CE	JUOS	CELE	PSME
Male mountain sheep:				
with conspecifics	85.7	13.6	<1	<1
habitat preference	(+)	(-)		
with wild horses	16.7	83.3	0	0
habitat preference	(-)	(+)		

These limited observations suggest that male mountain sheep foraging with conspecifics may prefer the JU/CE vegetation type, but male mountain sheep foraging with wild horses may prefer the JUOS type. Conversely, male mountain sheep foraging with conspecifics avoided the JUOS type, but male mountain sheep foraging with wild horses avoided the JU/CE type.

Grasses accounted for < 1% of the vegetative cover in the JU/CE type, but approximately 6% of the JUOS type (Knight et al. 1987). Although grasses were present in low composition in both vegetation types, mountain sheep foraging in the JUOS type had a higher availability of grasses.

The average distance to escape terrain was determined for male mountain sheep that foraged with conspecifics and compared to the distance for male mountain sheep that foraged with wild horses (Table 2). Male mountain sheep that foraged with conspecifics remained within an average 47 m (S.D. 69.5 m) from escape terrain, partially because of the ewes reluctance to venture further than 50 m from secure habitat. However, male mountain sheep that foraged with wild horses were an average 217 m (S.D. 310 m) from escape terrain. These data suggest that male mountain sheep in association with wild horses foraged further from escape terrain (in less secure habitat) than with conspecifics.

Table 2. Average distance to escape terrain (meters) of male mountain sheep in association with conspecifics compared to distance when associated with wild horses. Standard deviations shown in parenthesis.

	Distance to escape terrain
Male mountain sheep:	
with conspecifics	47 m (S.D. 69)
with wild horses	217 m (S.D. 310)

The foraging efficiency of mountain sheep with wild horses was 100% for all 12 locations (no alert or social interactions). Male mountain sheep that foraged with wild horses ignored disturbance (e.g. they could be approached readily, and rarely looked up to scan their surroundings even when horses were fighting in their vicinity). Group size ranged from 9 to 16 animals, including rams and horses. Foraging efficiency of male mountain sheep with conspecifics was only 66% (n = 67), and was characterized by high levels of aggressive or social interaction (Table 3). Aggressive interactions were exhibited between rams when 2 or more followed a ewe, and when they established dominance rank in the male cohort. Social interactions between rams occurred when they attended ewes. Aggressive or social interactions were never observed when male mountain sheep foraged with wild horses. This may have been due to size-related dominance in mountain sheep (Geist 1971) and subordinate behavior of male mountain sheep in the presence of the relatively large wild horse (Berger 1986).

Table 3. Average foraging efficiency of male mountain sheep in foraging associations with conspecifics compared with associations with wild horses.

	Percent time devoted to 3 activities while foraging:		
	Foraging	Social	Alert
Male mountain sheep:			
with conspecifics	66%	32%	<1%
with wild horses	100%	0	0

The subordinant/dominant relationship between male mountain sheep and wild horses was suggested both by the sheep's lack of aggressive behaviors while foraging and also by the behavior of male wild horses directed toward male mountain sheep. Male wild horses were observed herding, or driving, male mountain sheep (n=3) in a manner similar to the typical herding posture used when herding females (Feist 1975, Berger 1986). This typical herding posture consisted of running toward a female horse, or in this case a male mountain sheep, with ears flattened against the head, outstretched neck, and head held low to ground. Another indication of the subordinant/dominant relationship between mountain sheep and wild horses was extended penis behaviors that Feist (1975) described as a mechanism to establish dominance in wild horse groups. These extended penis behaviors were directed by a subordinant-male wild horse (without harem) to a 9 year-old male mountain sheep with 3 other rams ages 3 to 7. There were no other horses in the vicinity. By exerting dominance over male mountain sheep or allowing rams to enter their harem, stallions could potentially elevate their own dominance rank and subsequent reproductive success by attracting additional females.

In summary we believe that, contrary to some literature, (McMichael 1964, Weaver 1973, Seegmiller and Ohmart 1981) male mountain sheep and wild horses can have beneficial relationships. Habitat selection by mountain sheep is a complex function of season, age, reproductive status, and sex of animal (Smith 1992). This paper presents analyses which suggest that habitat selection and foraging efficiency, may also be influenced by association with another species during foraging periods. These data support Berger's (1986) hypothesis that feral horses may perhaps serve either as a competitor or as a facilitator, depending on ecological conditions. In this case as a competitor for a patchy supply of grasses, but possibly also as a facilitator by increasing foraging efficiency in insecure habitat. Dominance rank of male horses may have increased as a result of the relationship. Sample sizes were small, but these unique observations suggest that male mountain sheep in association with wild horses foraged further from escape terrain, enabling them to use areas that supported higher composition of grasses than areas used with conspecifics. Male mountain sheep did not exhibit aggressive behaviors while in association with wild horses, and thus had higher foraging efficiency than with conspecifics. To the best of our knowledge, foraging associations of this type have not been previously reported.

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