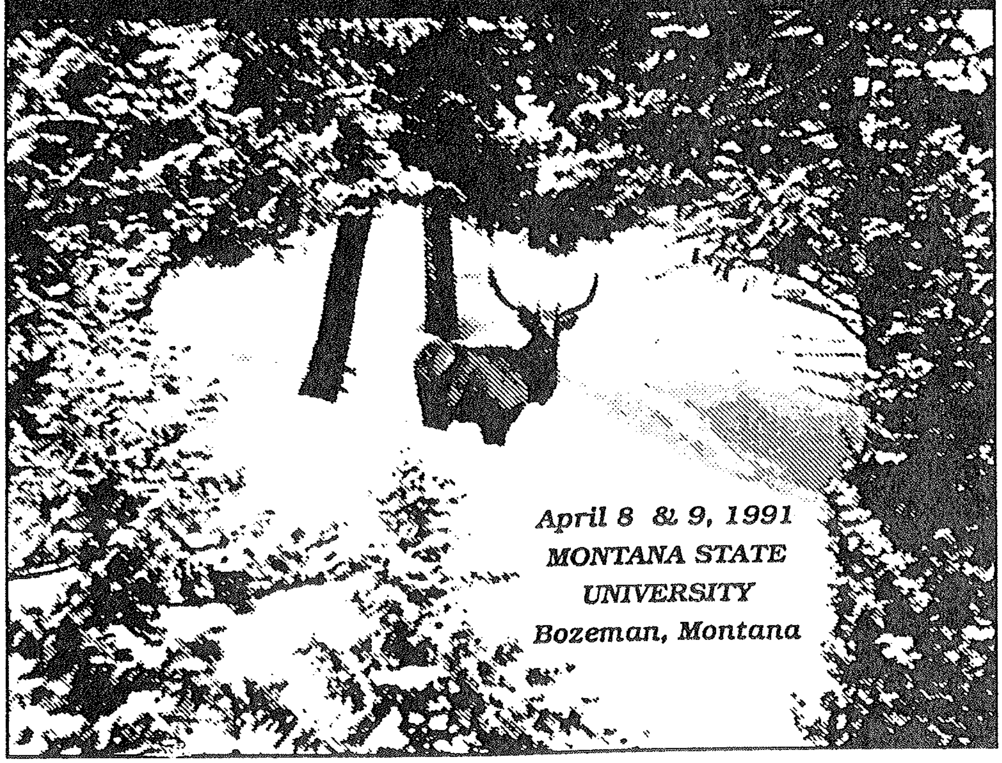
29TH MEETING OF THE MONTANA CHAPTER of the WILDLIFE SOCIETY



April 8 & 9, 1991
MONTANA STATE UNIVERSITY
Bozeman, Montana

MONDAY AGENDA
April 8, 1991

Ballroom B
Chair: Marion Cherry

1:00 Opening Remarks

1:10 **Habitat fragmentation and nest predation: emerging parallels between forest birds and waterfowl.** Joe Ball. Montana Cooperative Wildlife Research Unit, University of Montana, Missoula, MT 59812.

1:40 **Nesting biology of American avocets at two wildlife management areas in north central Montana.** Kristi Dubois. U.S. Fish and Wildlife Service, Helena, MT 59626.

2:00 **Double-crested cormorants and great blue herons: Management for biodiversity.** Marcy Bishop. USF&WS, National Bison Range, Moiese, MT 59824.

2:20 **Release techniques for Columbian sharp-tailed grouse in the Tobacco Valley, Montana.** Lewis Young, David Genter, Bernie Hall, and Marilyn Wood. Kootenai National Forest, Eureka, MT 59717 (LY), The Nature Conservancy, Helena, MT 59624 (DG and BH), Montana Department of Fish, Wildlife and Parks, Kalispell, MT 59901 (MW).

2:40 **Northern pocket gopher use of a black-tailed prairie dog colony following twelve years of no cattle grazing.** Craig J. Knowles and Pamela R. Knowles. Department of Zoology, University of Montana, Missoula, MT and Fauna West Wildlife Consultants, Boulder, MT 59632.

3:00 Break

3:20 **The blackfooted ferret (_Mustela nigripes_) reintroduction program with special reference to south Phillips County, Montana.** Ron Crete and Ron Stoneberg, U.S. Fish and Wildlife Service, Helena, MT 59624 (RC), and Montana Department of Fish, Wildlife and Parks, Hinsdale, MT 59241 (RS).

3:40 **Status of the swift fox in Montana.** Craig J. Knowles and Pamela R. Knowles. FaunaWest Wildlife Consultants, Boulder, MT 59632.

4:00 **Recent status of the bald eagle (_Haliaeetus leucocephalus_) in Montana.** Dennis L. Flath and Robert M. Hazelwood. Montana Department of Fish, Wildlife and Parks, Bozeman, MT 59717 (DF) and U.S. Fish and Wildlife Service, Helena MT 59626 (RMH).

4:20 **Status, distribution, and ecology of the golden eagle in Yellowstone National Park.** Terry McEneaney, Yellowstone National Park, WY 82190.

MONDAY AGENDA
April 8, 1991

Ballroom C
Chair: Dick Hutto

1:00 Opening Remarks

1:10 **An examination of bird distribution in old-growth and rotation-aged ponderosa pin/Douglas-fir stands from a landscape perspective.** Sallie J. Hejl, Jock S. Young, Susan A. Colt, and Ruth E. Woods. USFS, Intermountain Experiment Station, Missoula, MT 59801.

1:40 **On the conservation of neotropical migratory land birds in Montana.** Richard L. Hutto. Division of Biological Sciences, University of Montana, Missoula, MT 59812.

2:00 **Foraging site selection by insectivorous forest birds in western Montana.** Andrew H. Bosma. Division of Biological Sciences, University of Montana, Missoula, MT 59812.

2:20 **Snag use for nest site selection of four primary cavity nesting woodpeckers in the Bridger Mountains, Montana.** James R. Sparks. Biology Department, Montana State University, Bozeman, MT 59715, and Gallatin National Forest, Big Timber, MT 59011.

2:40 **Logging and forest birds: community-level patterns and a critical measure of habitat quality.** Bret W. Tobalske. Division of Biological Sciences, University of Montana, Missoula, MT 59812.

3:00 Break

3:20 **Small mammal density and diversity in Douglas-fir (*Pseudotsuga menziesii*) old-growth forests as related to forest structure.** Patricia Cramer. Biology Department, Montana State University, Bozeman, MT 59717.

3:40 **Red squirrel (*Tamiasciurus hudsonicus*) cache sites and cache pattern in Pattee Canyon, Montana.** Rebecca S. Burton. Division of Biological Sciences, University of Montana, Missoula, MT 59812.

4:00 **Rediscovery of the spotted bat (*Euderma maculatum*), pallid bat (*Antrozous pallidus*) and Townsend's big-eared bat (*Plecotus townsendii*) in south central Montana.** David Worthington. Division of Biological Sciences, University of Montana, Missoula, MT 59812.

4:20 **Results of harlequin duck surveys on the Flathead National Forest, Montana.** John C. Carlson. Montana Natural Heritage Program, Helena, MT 59620 and University of Wyoming, Laramie, WY.

4:30 Poster Session

TUESDAY AGENDA
April 9, 1991

Ballroom B and C

8:00 **Opening remarks**

8:15 **Panel discussion "Are we managing for all wildlife"**
Moderator: Dr. Lee Metzgar

10:00 Break

Chair: Fritz Prellwitz

10:20 **Dynamics of beaver food caches and cache size as a predictor of colony size in Wyoming.** Cynthia Osmundson and Steven Buskirk. U.S. Fish and Wildlife Service, CMR National Wildlife Refuge, Box 110, Lewistown, MT 59457 (CO), Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82071.

10:40 **Mortality rates of the pine marten in southwest Montana.** Craig Fager. Department of Biology, Montana State University, Bozeman, MT 59717.

11:00 **Wolf ecology update.** Dan Pletcher. School of Forestry, University of Montana, Missoula, MT 59812.

11:20 **Mortality and seasonal distribution of white-tailed deer in an area recently recolonized by wolves.** Jon S. Rachael, School of Forestry, University of Montana, Missoula, MT 59812.

11:40 **The significance of disease in wildlife populations.** Mark Johnson DVM. Wildlife Veterinary Consultant, Gardiner, MT. 59030.

12:00 Lunch Break

Chair: Mike Aderhold

1:00 **Survival rates of black bear in northwest Montana.** Wayne F. Kasworm and Timothy J. Thier. U.S. Fish and Wildlife Service, 475 Fish Hatchery Road, Libby, MT 59923.

1:20 **Summary of questionnaire given to spring black bear hunters in northwestern Montana.** Timothy J. Thier. U.S. Fish and Wildlife Service, 475 Fish Hatchery Road, Libby, MT 59923.

1:40 **Grizzly bear population augmentation in the cabinet mountains, northwest Montana.** Wayne F. Kasworm, Timothy J. Thier, and Christopher Servheen. U.S. Fish and Wildlife Service, Libby, MT 59923 (WK and TT), U.S. Fish and Wildlife Service, University of Montana, Missoula MT 59812 (CS).

2:00 **Increasing mountain lion populations and human-lion interactions in Montana** Keith E. Aune. Montana Department of Fish, Wildlife and Parks, Mont. State Univ. Bozeman, MT 59717.

2:20 **Moose-habitat relationships in northwestern Montana and southeastern British Columbia.** Margaret Langley, School of Forestry, University of Montana, Missoula, MT 59812.

2:40 **Some population characteristics of the Yellowstone bison herd.** Helga Ihsle Pac and Kevin Frey. Montana Department of Fish, Wildlife and Parks, Mont. State Univ. Bozeman, MT 59717.

3:00 Break

Chair: Keith Aune

3:20 **Summer habitat use of white-tailed deer in northwestern Montana.** John Morgan. Department of Biology, Montana State University, Bozeman, MT 59717.

3:40 **The Flying D Ranch and its significance to wildlife management in southwest Montana.** Kurt Alt. Montana Department of Fish, Wildlife and Parks, Bozeman, MT 59715.

4:00 **Home range use of historical and present elk populations in south central Montana.** Fred G. VanDyke and John P. Skubinna. Montana Department of Fish, Wildlife and Parks, Red Lodge, MT 59068.

4:20 **Elk plus cows times politics equals ?** Kurt Alt, Fred King, Mark Petroni, and Ron Schott. Montana Department of Fish, Wildlife and Parks, Bozeman, MT 59715 (KA and FK), U. S. Forest Service, Beaverhead National Forest, Ennis, MT 59729.

TUESDAY EVENING

Montana Chapter Business Meeting	**6:00-7:00**	**Gran Tree Ballroom**
Western Barbecue Buffet and Social Hour	**7:00-8:00**	**Gran Tree Atrium**
Awards Presentation	**7:30-8:00**	
Entertainment (Charlie Russell Yarns)	**8:00-9:00**	

HABITAT FRAGMENTATION AND NEST PREDATION: EMERGING PARALLELS BETWEEN FOREST BIRDS AND WATERFOWL

BALL, I. J., Montana Cooperative Wildlife Research Unit, U.S. Fish and Wildlife Service, University of Montana, Missoula, MT 59812

Abstract

Low nest success and faltering populations are a serious threat to neotropical migrant songbirds in the eastern United States and upland nesting ducks in the Prairie Pothole Region. In both cases, excessive nest predation occurs because of habitat fragmentation and supplementation of predator populations by humans. Viable recruitment rates among both groups seem to occur only in the very largest remaining parcels of unfragmented habitat. Protecting or providing "good" habitat in relatively small parcels does not solve, and may exacerbate, the problem. Acknowledging this problem and developing effective and socially acceptable solutions will be difficult, but doing so offers important common ground to those interested in biological diversity, nongame wildlife, and game species.

NESTING BIOLOGY OF AMERICAN AVOCETS AT TWO WILDLIFE MANAGEMENT AREAS IN NORTHCENTRAL MONTANA

Kristi DuBois, U.S. Fish and Wildlife Service, Fish and Wildlife Enhancement, 301 S. Park, Drawer 10023, Helena, MT 59626

Abstract

American Avocet populations were studied at Benton Lake National Wildlife Refuge and Freezout Lake State Wildlife Management Area during the 1990 breeding season, as part of a study to assess the potential impacts of selenium from irrigation drainwater on water bird reproduction. A total of 103 nests were monitored at Benton Lake and 185 nests were monitored at Freezout Lake. Nest success within different avocet colonies varied from 25% to 100%. Overall nest success was 69% at Benton Lake and 64% at Freezout Lake. Mammalian predation and flooding were the primary causes of nest loss. Average clutch size was 3.8 eggs/clutch for both areas. Nesting chronology, egg size, and young size were compared between the two areas. Survival of young to fledging appeared to be good at both areas.

DOUBLE-CRESTED CORMORANTS AND GREAT BLUE HERONS - MANAGEMENT FOR BIODIVERSITY

Marcy Bishop, USFWS, National Bison Range, Moiese, MT 59824

Abstract

Wetland management at Ninepipe and Pablo National Wildlife Refuges has provided for biodiversity and for long term research on a cormorant and heron colony under undisturbed conditions. Management includes protection from outside intrusion, timing of other management duties, restoration and protection of nesting islands and trees, passive predator control and careful banding and study methods. This program has provided for 20 years of data on nesting success, population dynamics, nest stratification, resource partitioning, interactions with other species, behavior and fledging of young as they occur in a natural, undisturbed colony.

RELEASE TECHNIQUES FOR COLUMBIAN SHARP-TAILED GROUSE IN THE TOBACCO VALLEY, MONTANA

Lewis Young, Kootenai National Forest, Eureka, MT 59917
David Genter, Montana Natural Heritage Program, Helena, MT 59620
Bernie Hall, The Nature Conservancy, Helena, MT 59620
Marilyn Wood, Montana Department of Fish, Wildlife, and Parks, Kalispell, MT 59901

Abstract

Since 1987, 61 Columbian sharp-tailed grouse have been transplanted from British Columbia, Canada, to the Tobacco Valley in northwestern Montana to sustain and rejuvenate the last known lek in northwestern Montana. Each year, [illegible] grouse were trapped on leks in Canada using both drop nets and walk-in traps, then transp[illegible] small aircraft or ground transportation as soon as possible. Birds were released on the le[illegible]ence of other grouse using custom made release boxes while sharp-tail vocalizations [illegible] an audio tape player. Releases were made both morning and evening. Observatio[illegible]ded leg bands and in 1990, radio-collars, indicate the transplanted birds join the [illegible] and have good survival rates.

Northern Pocket Gopher Use of a Black-tailed Prairie Dog Colony Following Twelve Years of No Cattle Grazing

Craig J. Knowles and Pamela R. Knowles
Dept. of Zoology, University of Montana, Missoula, MT 59812 (CJK)
FaunaWest Wildlife Consultants, P.O. Box 113, Boulder, MT 59632 (PRK)

Abstract: Northern pocket gophers (Thomomys talpoides) were found to coexist with black-tailed prairie dogs (Cynomys ludovicianus) within a portion of a prairie dog colony excluded from livestock grazing for a period of twelve years. Relative density of fresh pocket gopher mounds inside the exclosure was 60.8/km while relative density outside the exclosure was 4.5/km. Forbs dominated the vegetation in the area used by pocket gophers. Forb and grass production were greater within the exclosure than the adjacent area outside the exclosure.

The black-footed ferret (*Mustela nigripes*) reintroduction program with special reference to south Phillips County, Montana

Ron Crete, USFWS, P.O. Box 10023, Helena, MT 59626

Ron Stoneberg, MDFWP, Box 424, Hinsdale, MT 59241

Abstract: The black-footed ferret (BFF) is one of the rarest and most endangered mammals in North America. It is listed as endangered under Montana and national endangered species laws. All known members of the species are in captivity. An aggressive captive breeding program is reaching the goal of producing individuals in excess of the captive breeding objectives for reintroduction into the wild planned for 1991. National and state interdisciplinary teams are seeking recovery objectives of the BFF Recovery Plan. Surveys to find potential reintroduction sites throughout the historical range of the species identified South Phillips County as a candidate for ferret recovery actions. Planning for BFF recovery in northcentral Montana is dove-tailed with Bureau of Land Management resource planning. An interagency team of biologists works with individuals and groups in this Montana potential recovery area and statewide to understand concerns about black-footed ferret recovery. They will draft a BFF reintroduction and management plan in Spring 1991 aimed to avoid or mitigate impacts to the local economy and desired lifestyles of Montanans while meeting state and national responsibilities for the conservation of the black-footed ferret.

Status of the Swift Fox in Montana

Craig J. Knowles and Pamela R. Knowles
FaunaWest Wildlife Consultants, P.O. Box 113,
Boulder, MT 59632

Abstract: A search was made for historical and recent records of the swift fox (Vulpes velox) in Montana. The first observations of swift foxes in Montana were made by the Lewis and Clark expedition in 1805 along the Marias River and at the Great Falls of the Missouri River. Forty-four specimens were collected prior to 1910. Forty-three of these were collected at Kipp and Blackfoot in upper Teton County and one was collected at Fort Benton. The last historic observations of the swift fox in Montana were made by Bailey and Bailey in 1918 on the plains along the eastern edge of Glacier National Park. The lack of any confirmed records since 1918 prompted Hoffmann et al. in 1969 to declare the swift fox extinct in Montana. However, beginning in 1978, scattered reports of swift foxes in Montana have been documented. Three records have come from southeastern Montana near Miles City, Glendive, and Broadus. Three unconfirmed sightings have been reported near Circle, Forsyth, and Miles City. In addition, swift foxes reintroduced in Alberta and Saskatchewan, Canada have been documented to cross into Montana north of Havre. Two established swift fox populations exist near Montana, and are located near Gillette, Wyoming and in Perkins County in northwestern South Dakota.

RECENT STATUS OF THE BALD EAGLE (Haliaeetus leucocephalus) IN MONTANA

Dennis L. Flath, Montana Department of Fish, Wildlife and Parks, FWP Building, MSU Campus, Bozeman, MT 59717;

and,

Robert M. Hazlewood, US Fish and Wildlife Service, Federal Building and US Courthouse, 301 South Park, PO Box 10023, Helena, MT 59626

Abstract

Changes in the status of Montana's bald eagle nesting population are documented, including factors responsible for population depression and evident recovery. Productivity, rate of population increase and attributes of nesting habitat are described. The nesting population increased from 26 territories producing 29 young in 1980 to 108 territories producing 130 young in 1990. The first North American record of bald eagles producing 4 young in one brood is documented. Management problems and conservation recommendations are presented.

Status, Distribution, and Ecology of the Golden Eagle in Yellowstone National Park

Terry McEneaney, Yellowstone National Park,
P.O. Box 168, Yellowstone Nat. Park, Wyo. 82190

Abstract

The golden eagle (*Aquila chrysaetos*) is one of the most efficient avian predators in the western United States, yet its status in Yellowstone has remained relatively unknown until now. Incidental golden eagle data was collected while censusing for peregrine falcons in Yellowstone from 1986 - 1990. Remote areas of Yellowstone were initially surveyed by helicopter and checked for greater detail using ground reconnaisance. An update on the status, distribution, and ecology of the golden eagle will be discussed along with a historical perspective of golden eagle activity in Yellowstone.

An Examination of Bird Distribution in Old-growth and Rotation-aged Ponderosa Pine/Douglas-fir Stands from a Landscape Perspective

Hejl, Sallie J., Jock S. Young, Susan A. Colt, and Ruth E. Woods, U.S.F.S., Intermountain Research Station, Missoula, Montana

In each of 16 old-growth (200+ years) and 16 rotation-aged (80-120 years) ponderosa pine/Douglas-fir stands in western Montana and adjacent Idaho, birds were counted four times during the 1989 breeding season. Of the 68 species recorded, 14 were found exclusively in old-growth and seven exclusively in rotation-aged stands. For the 26 common species, (1) 8 species were more abundant in old-growth, (2) 7 species were more abundant in rotation age, and (3) 11 were not associated significantly with either habitat. In order to examine landscape-level associations, we analyzed the distribution of the 26 common species in relation to landscape variables calculated from a 2 square-mile area centered on each stand. Landscape variables, especially total amount of old-growth forest and amount of open land, helped to explain the distribution of 14 of the common species.

ON THE CONSERVATION OF NEOTROPICAL MIGRATORY LANDBIRDS IN MONTANA

Richard L. Hutto, Biological Sciences, University of Montana, Missoula, MT 59812

Abstract

I will describe the neotropical migratory landbird conservation initiative developed by federal and state agencies and non-governmental organizations in December 1990. Montana is in an excellent position to accomplish a number of the goals associated with this program, especially with respect to the development of monitoring methods, and the use of existing GIS databases to build habitat suitability models that incorporate landscape-level information. In short, neotropical migrants have the potential to serve as a powerful "management indicator group".

SNAG USE FOR NEST SITE SELECTION OF FOUR PRIMARY CAVITY NESTING WOODPECKERS IN THE BRIDGER MOUNTAINS, MONTANA

Sparks, James, R., Biology Department, Montana State University, Bozeman, Montana 59715 / Big Timber Ranger District, Gallatin National Forest, Big Timber, Montana 59011.

Abstract

During June and July of 1988, 1989, and 1990, 46 active nests of 4 primary cavity nesting woodpeckers were located in Douglas-fir (Pseudotsuga menziesii) forests in the Bridger Mountains of southwestern Montana. 12 Williamson's Sapsucker, 10 Hairy Woodpecker, 9 Three-toed Woodpecker, and 15 Northern Flicker nests were discovered. 31 Douglas-fir, 8 lodgepole pine (Pinus contorta), 4 subalpine fir (Abies Lasiocarpa), 2 limber pine (Pinus Flexilis), and 1 Engelmann spruce (Picea engelmannii) were selected as cavity nesting trees. All trees utilized for nest sites were standing dead trees (snags). To minimize interspecific competition for cavity trees during the breeding season, these 4 woodpecker species appear to select different tree species, select different size (diameter and height) snags, or select snags in different stages of decay for nest sites.

THE STATUS OF THE HARLEQUIN DUCK ON 5 NATIONAL FORESTS OF WESTERN MONTANA

John C. Carlson, Montana Natural Heritage Program, Helena, MT 59620, and University of Wyoming, Laramie, WY 82071

Status surveys for harlequin ducks were conducted on portions of 5 National Forests in Montana during the 1990 breeding season. A total of 91 streams were surveyed on the Lewis & Clark, Flathead, Gallatin, Kootenai, and Lolo National Forests. Stream flow and habitat characteristics were obtained on streams surveyed on the Gallatin, Flathead, Kootenai, and Lolo National Forests. A minimum of 101 individual birds were located on 20 steams and rivers; 25 were males, 25 females, and 51 young of the year. The average brood size was 3.18 young. Harlequin ducks were found predominantly on low gradient, braided type streams with stretches or side channels of slower water. Additional sightings on the Rocky Mountain Division of the Lewis & Clark National Forest revealed an estimated 80 - 122 harlequin ducks, with 13 - 22 broods observed last summer.

DYNAMICS OF BEAVER FOOD CACHES AND CACHE SIZE AS A PREDICTOR OF COLONY SIZE IN WYOMING

CYNTHIA OSMUNDSON, U.S. Fish and Wildlife Service, Charles M. Russell National Wildlife Refuge, Box 110, Lewistown, MT 59457
STEVEN BUSKIRK, Department of Zoology and Physiology, University of Wyoming, Laramie, WY 82071

Abstract: This study investigated the relationship between the size of food caches and the number of beaver in a colony. Two recent studies suggested that cache size may indicate colony size. Results of our study did not support this reported relationship; the correlation between cache size and colony size was not significant (r = 0.16, P = 0.24). Cache construction began in late September and caches grew at a mean rate of 0.45 m^3/week until final freeze-up, typically during the first week of November. Mean final cache area was 61 m^2. Colony size was estimated during night observations with infra-red night vision devices. Mean colony size was estimated to be 5.05. Late fall movements and cache abandonment were identified and studied through the use of implanted radio transmitters. The ability of observers to locate and accurately estimate size of caches from the air was assessed. Aerial observers correctly classified caches by size 47.5% of the time, whereas 11% of known caches were overlooked. Estimated availability of cache material was not significantly correlated with cache size (r = 0.02, P = 0.93).

MORTALITY RATES OF THE PINE MARTEN IN SOUTHWEST MONTANA

Craig Fager, Montana State University
Quinton Kujula, Montana State University

Abstract: Trapping mortality in pine marten was studied during the 1989-1990 and 1990-1991 trapping seasons through mark-recapture methods in the upper Big Hole and West Yellowstone areas of southwest Montana. Trappers caught 40% (2 of 5) of radio collared marten in the upper Big Hole study area during the 1989-1990 season. The marked sample represented 12.5% of the known study area harvest (n=16). This area was abandoned by trappers during the 1990-1991 trapping season. Eight of 23 marked marten were captured by trappers in the West Yellowstone study areas. The marked sample represented 28.6% of known study area harvest (n=28). Harvest sex ratios varied from 2.2M:1F in the upper Big Hole to 1.54M:1F in the West Yellowstone areas. These ratios differed from pre-season live trapping sex ratios (1M:1F, 1M:1.3F) but the difference harvested was not statistically significant. The radio collared marten harvested in the upper Big Hole were trapped approximately 5 linear kilometers from their point of live capture. Radio collared marten harvested in the West Yellowstone area were all captured within 0.5 linear kilometers of their point of live capture during the 1989-1990 season and 0.6-5.4 km during the 1990-1991 season. Variations in harvesting techniques between study areas may explain some of the differences in sex ratios and movements of harvest marten. Trappers in the West Yellowstone area employ a much greater trap density per unit area (approximately 6 sets/km road or trail) than the individual in the upper Big Hole (approximately 1 set/km road or trail).

INTRODUCTION

The Southwest Montana Pine Marten Project is a Montana Department of Fish, Wildlife, and Parks and U.S. Forest Service supported project designed to characterize pine marten habitat and harvest throughout southwest Montana. Recent concerns over an apparent decrease in the harvestable surplus of marten populations were a driving force behind the initiation of the investigation. The project is scheduled to run 3 years. Because marten are easily harvested but are believed to live in extremely specialized habitats, habitat and harvest questions cannot be easily separated; however, for the purposes of this paper, the 2 questions are assumed to be largely independent. This paper combines information gathered by 2 separate investigators during the first 2 field seasons of the Southwest Montana Pine Marten Project.

STUDY AREAS AND METHODS

Three study areas were used to evaluate marten harvest levels. Historical harvest levels, access, and habitat manipulations were all considered in study area selection.

The 32 km^2 Beaver Creek study area lies in hunting district 362, northwest of Quake Lake. Vehicle access is limited to less than 10 km, but 4 trailheads into the Taylor Hilgard Wilderness and adjacent roadless areas provide access to a vast area. Timber harvesting activity has been severely restricted in this area. Historically, 17 to 20 marten have been taken annually from the drainage by a single trapper.

The 68 km^2 West Yellowstone Flats study area lies immediately north of West Yellowstone in hunting district 361. The area is bound by Yellowstone National Park on the eastern edge, Cougar Creek on the north, and Hebgen Lake on the western edge. The flat, open terrain make vehicle access almost unrestricted, particularly with snow machines. Trapper numbers as well as harvest are both highly variable in this area. The known 1989-1990 harvest was 1 marten, but personal averages per trapper in the 7 to 10 range appear to be more normal. This study area was the only one to be directly affected by fire during the summer of 1988.

The 153 km^2 upper Big Hole study area lies northwest of the Big Hole Battlefield, in hunting district 321, and includes the Bender, Schultz, Johnson, and Tie Creek drainages. The area is bound by the Bitterroot National Forest to the northwest and Highway 43 on its southern edge. Road building and timber harvesting activity have been heavy in the last several decades. Several U.S.F.S. trails found in the area are also utilized by trappers. Historically, this area has been regarded as some of southwest Montana's best marten producing habitat. Individual trappers have harvested nearly 50 marten from the study area in some years. During the 1980's, the study area has been trapped intermittently by

at least 3 different individual during different years.

Marten were live-trapped prior to the opening of the December 1 trapping season with single door, wire mesh traps. Through December 1991, most marten were fitted with 148MHZ AVM type P2-B transmitters and eartags. Marten captured in remote, inaccessible areas were fitted with eartags only. Limited live trapping was conducted during the trapping season on the West Yellowstone Flats and upper Big Hole study areas. Because areas live trapped and areas harvested did not completely overlap in all cases, each marked marten was evaluated with regard to harvest vulnerability. Trappers were contacted on an individual basis both before and during the trapping season. These individuals provided valuable information concerning trap density, techniques, and capture locations for both marked and unmarked marten.

Baseline population productivity and density indexes for local populations were developed through 1 km track transects, live trapping-harvest success rates, and home range analysis. Differences in trapping methods other than trap density were not considered as variables.

Results and Discussion

Population indices for the 1989-1990 field season suggest that marten populations in all three study areas were severely depressed. Relative track densities from permanent track transects all fell below 0.6 tracks/km, and were consistent with densities found in an Ontario population suffering from a food shortage (Thompson and Colgan 1987). Harvest data from the trappers utilizing the study areas provided additional evidence of population depression. Success rates in the 1988-1989 season were reduced by 70-90% compared to the 1989-1990 season. (Whitman pers. comm.; Depas pers. comm.). Live trapping success and home ranges would also seem to indicate depressed populations when compared with other studies. Approximately 2.8 times the trapping effort was required to capture marten in our study areas than was required by Hawley and Newby (1957) in another Montana study. Inflated home ranges may be a sign of additional stress on marten populations in Southwest Montana. Home ranges calculated to date run (Table 1) 3 to 10 times as large as home ranges reported for Alaskan marten (male average 6.62 km^2; female average 3.71 km^2) reported by Burskirk (1983).

Table 1. Ninety-five percent, 75%, and core areas[a] for 9 marten, by sex and season, from the upper Big Hole and West Yellowstone study areas.

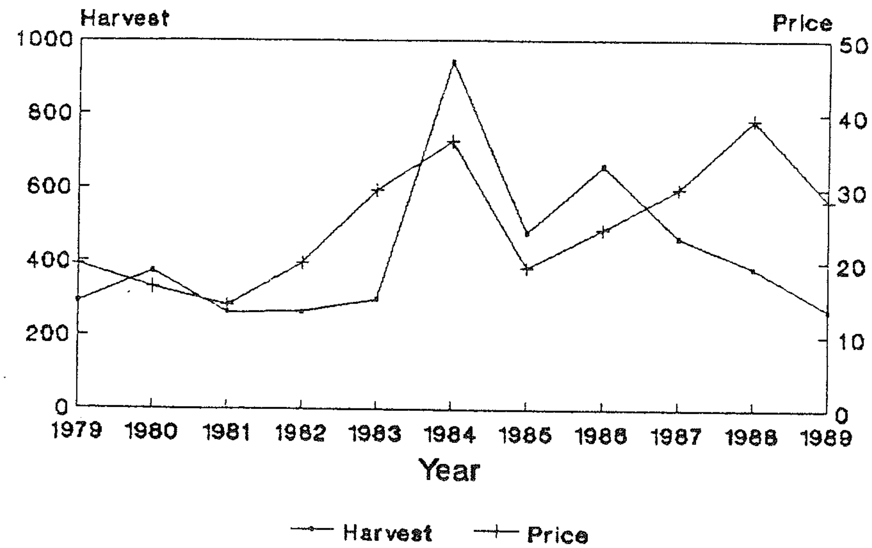
I.D.	Sex	Season	n	Home range in km^2		
				95%	75%	Core
West Yellowstone						
521	M	Winter	28	25.7	9.04	5.6
205	M	Win./Sp.	15	68.0	28.4	13.25
727	F	Winter	8	4.9	3.37	
845	M	Winter	24	29.2	17.7	8.6
845	M	Spring	31	56.6	24.7	17.71
845	M	Win./Sp.	55	67.0	31.36	18.3
Upper Big Hole						
970	F	Winter	29	7.2	3.0	1.8
762	M	Win./Sp.	10	19.1	12.78	3.8
492	M	Winter	18	9.7	5.5	3.5

[a] Core areas reflect approximately 50% utilization.

Figure 1 shows harvest and price trends from the 1979-1980 through 1989-1990 trapping seasons. An average of 428 marten were harvested over the 11 year period. In response to concerns over reduced harvest in some of Region 3's best marten producing habitats, the November through February season was reduced in 1987-1988 to include only the months of December and January. The 1990-1991 harvest (157 marten) appears significantly lower than any of the preceding 11 years. Price data were not available and no marten were bought in 1990-1991 by the principal fur buyer in the Bozeman area. The number of trappers participating annually appears to be declining across the region; however, not enough data are available at this time to draw any conclusions.

Table 2 shows harvest by study area. Harvest rates in 1989-1991 were from 70 to 90% lower than harvests taken on the same areas earlier in the 1980's. Part of this may be because of the 50% reduction in season length. However, given the similar efforts put forth between seasons, it is unlikely that this explains more than a small percentage of the seasonal differences. Losing the month of November has been cited by several trappers we contacted as the primary reason for lower catches during high marten years, after the season length was reduced.

Figure 1. Marten Harvest and Prices
1979-1990



Data from Howard Hash, MDFWP

Table 2. Harvest statistics by study area.

Study area	Harvest	No. Marked In Harvest	% of Harvest	Historic Level
Beaver Creek (H.D. 362)				
1989-1990	6	3 of 11	50%	17-20
1990-1991	16	3-4 of 6	19-25%	
West Yellowstone Flats (H.D. 361)				
1989-1990	1	1 of 1	100%	7-10/Indiv.
1990-1991	6	1 of 6	17%	
Upper Big Hole (H.D. 321)				
1989-1990	16	2 of 5	12.5%	30-50
1990-1991		Abandoned by trapper		

Marked marten constituted between 12.5% and 100% of the known harvest by study area. These values do not represent true harvest percentages because areas live trapped and areas harvested did not overlap 100% in the study areas of the West Yellowstone Flats and the upper Big Hole. However, the values do illustrate that not all marten are likely to be killed by trappers operating in their ranges despite the susceptibility of marten to trapping because all marked marten were at least exposed to trap lines as judged through location of live

capture during November as well as radio locations during the trapping season.

Marten possess a very limited ability to avoid traps in their immediate activity centers. Survivorship of marten that remained resident in the immediate vicinity of the point of live capture was further diminished if local trappers were employing high densities of traps. Marked marten in the Big Hole were harvested 5 km from their point of live capture under a trapping scheme with approximately 1 trap/km. Marten in the West Yellowstone area, under a much higher trap density of at least 6 traps/km, were with 1 exception, caught within 1.5 km of their point of live capture. Radio telemetry has provided largely inconclusive data on marten live trapped in November, but it is clear that a large portion of the Beaver Creek and Big Hole November samples avoided both further live capture and harvest through dispersal after initial live capture. Small sample sizes preclude any meaningful statistical analysis on these samples.

Pre-trapping season sex ratios from all study areas approached 1:1 (Big Hole=1M:1F, West Yellowstone=1M:1.3F). These values are different, but not statistically, from the harvest sex ratios of 2.2M:1F in the Big Hole and 1.54M:1F in the West Yellowstone area.

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WOLF PROJECT UPDATE, NORTH FORK OF THE FLATHEAD RIVER

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Abstract

Gray wolf (*Canis lupus*) populations, movements, and food habits were intensively studied within and near Glacier National Park in northwestern Montana and southeastern British Columbia from 1984 through 1991. Early fall populations increased from approximately 7 in 1984 to 34 in 1990. Illegal poisoning of wolves in British Columbia and dispersal out of the study area reduced the population by 1 April 1991 to approximately 22 animals in 4 packs. Dispersing wolves have moved primarily north. Home ranges of packs in this area have often straddled the international boundary, and excellent cooperation between the agencies involved has occurred. Food habits during winter, determined by backtracking wolves in the snow, have consisted of approximately 70% white-tailed deer (*Odocoileus virginianus*), 20% elk (*Cervus elaphus*), 6% moose (*Alces alces*), and 3% mule deer (*O. hemionus*) over 5 winters. Wolves have not preyed on livestock within the study area.

RED SQUIRREL (Tamiascuirus hudsonicus) CACHE SITES AND CACHE PATTERN IN PATTEE CANYON, MONTANA

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ABSTRACT

The spatial pattern and physical attributes of seed caches used by red squirrels (Tamiasciurus hudsonicus) were the focus of this study conducted in Pattee Canyon, near Missoula, Montana. Within the 320 X 290-m study site there were 103 caches. Each of the squirrels studied used at least 10 caches. There was no evidence of cone theft.

In comparison with unused sites, cache sites were associated with soft soil and were near large ponderosa pine (Pinus ponderosa) trees. Caches had more vegetative cover around the center of the cache than at 3- or 5-m from the center. Unused sites had more total cover than used sites. Caches were not significantly closer to nests or caches than were unused sites and were not significantly associated with tree or log density.

RE-DISCOVERY OF THE SPOTTED BAT (Euderma maculatum), PALLID BAT (Antrozous pallidus), AND TOWNSEND'S BIG-EARED BAT (Plecotus townsendii) IN SOUTH-CENTRAL MONTANA

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Abstract

The spotted bat and pallid bat were known previously in Montana from one individual each captured in 1949 and 1978, respectively. The Townsend's big-eared bat is known to breed in Montana, and was known previously in south-central Montana from winter hibernacula. Two spotted bats, 26 pallid bats, and 11 Townsend's big-eared bats were observed in 1989 and 1990 in the Pryor Mountains. Juveniles and lactating females were observed in all three species, suggesting that the species breed in the region. All three species are listed as species of special concern by the Montana Natural Heritage Program, while the spotted bat and Townsend's big-eared bat are listed under category 2 as candidates for the Endangered Species Act and as sensitive species by the USFS.

LOGGING AND FOREST BIRDS: COMMUNITY-LEVEL PATTERNS AND A CRITICAL MEASURE OF HABITAT QUALITY

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Abstract

I studied the influence of logging upon a community of breeding birds in western larch/Douglas-fir stands on the Coram Experimental Forest, Montana. Ten species, four foraging guilds, and two nesting guilds showed significant differences in abundance among stand conditions during 1989 and 1990. Interactions for abundance between stand conditions and years were evident for two species, one foraging, and one nesting guild. In general, the patterns observed were intuitive. Conifer tree nesters, for example, were least abundant in clearcuts. Ironically, cavity nesters, including Red-naped Sapsuckers, were equally abundant in logged (with some trees and snags reserved) and unlogged habitat. I studied reproductive success among sapsuckers during 1990 to evaluate the suitability of disturbed habitat for this species, and observed higher productivity in logged stands. These data validate current guidelines regarding snag retention within cutting units, and highlight the importance of paper birch and aspen for cavity nesting and other tree-dependent bird species.

SMALL MAMMAL DENSITY AND DIVERSITY IN DOUGLAS FIR (<u>PSEUDOTSUGA MENZISII</u>) OLD GROWTH FORESTS AS RELATED TO FOREST STRUCTURE

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Abstract

Density and diversity of small mammals in old growth forests were studied during the summer months of 1990. Live trapping methods were used on two similar Douglas fir old growth forests in the Hyalite Basin of the Gallatin Range, Montana. The two forest types were similar in aspect, slope, tree composition and age, but differed in complexity of structure, particularly with respect to the amount of downed material contributing to fuel loading. The more complex forest averaged 60.5 tons of downed logs per acre and after 3,600 trap-nights, 317 individual animals were caught there. The more simple forest averaged 6.9 tons of downed logs per acre and produced 192 individual animals after 3,600 trap-nights. Results of this study may indicate that dead and downed logs play a significant factor in numbers of small mammals in old growth forests. These small mammals serve as a prey base for other animals in old growth areas, in particular, the pine marten relies heavily on red-backed voles which constituted a majority of animals caught in this study.

MORTALITY AND SEASONAL DISTRIBUTION OF WHITE-TAILED DEER IN AN AREA RECENTLY RECOLONIZED BY WOLVES

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Abstract: White-tailed deer (*Odocoileus virginianus*) are the most abundant prey item of wolves (*Canis lupus*) that have recently recolonized northwestern Montana, but little is known about mortality or seasonal movements of deer in this area. Since January 1990, I have been investigating cause-specific mortality, seasonal distribution, and fawning-site selection of white-tailed deer in this region. Of 38 female white-tailed deer captured and radio-collared during winter 1989-1990 and 1990-1991, 2 were killed by wolves. A bear (*Ursus americanus*), a coyote (*C. latrans*), and a mountain lion (*Felis concolor*) each killed 1 radio-collared deer, and humans killed 2. Predators killed 3 radio-collared deer during winter and 2 during the fawning period in early June, but killed none during summer or autumn. Although 5 radio-collared deer spent the summer within 1 km of a wolf den in 1990, wolves killed none, possibly because fawns typically comprise a large portion of the diet of wolves during this period. Deer captured on 3 winter ranges in western Glacier National Park migrated in all directions an average of 12 km (n = 21, Range = 0 to 40 km) to summer ranges. Field work will continue through summer 1991.

Although once common throughout the western United States, the gray wolf was extirpated from the Northern Rocky Mountains by widespread public and private control efforts. Reported sightings of wolves were extremely rare in Montana by the 1930's and remained sporadic through the late 1970's (Day 1981). Occasional wolf sightings were probably of dispersing or lone wolves. No documented cases of wolf reproduction in the western U.S. occurred until 1986 when a den was found in Glacier National Park (Ream et al. 1987, 1989). Another den was found in Glacier Park in 1987, and 2 dens were located in British Columbia within 10 km of the international border in 1988. Wolves denned within Glacier National Park again in 1989, but the litter failed. In 1990 wolves denned at 2 sites in Glacier National Park and produced 12 pups. By December 1990, 34 wolves were known to inhabit Glacier National Park and the immediate surrounding areas of the Flathead National Forest and southeastern British Columbia.

The on-going natural recolonization of wolves in northwestern Montana has occurred in an area unlike many other areas where wolf studies have been conducted. Because this area has been without a breeding population of wolves for more than 50 years, ungulate populations in the relative security of Glacier National Park have probably reached an equilibrium with their habitat and other predators. Additionally, prey diversity in this system is higher than in most other systems studied. Most studies of wolf-prey interactions elsewhere have been conducted in areas with only 1 or 2 primary prey species (e.g. Murie 1944,

Mech 1966, Messier and Crete 1985, Ballard et al. 1987). White-tailed deer, mule deer (*O. hemionus*), elk (*Cervus elaphus*), and moose (*Alces alces*), are relatively abundant and provide a potential prey base for wolves in northwestern Montana. Low numbers of mountain goats (*Oreamnos americanus*) and bighorn sheep (*Ovis canadensis*) are present at higher elevations.

Wolf recolonization is highly controversial. Researchers studying public attitudes toward wolves have documented a public concern for native ungulate populations (e.g. Kellert 1985, McNaught 1987, Bath 1987, Bath and Buchanan 1989, Tucker and Pletscher 1989). To answer questions from the public and to justify management actions, resource managers need reliable information on impacts of wolf predation on ungulate populations.

In the North Fork drainage of the Flathead river in northwestern Montana, nearly half (45%) of the prey killed by wolves were white-tailed deer (Boyd et al. in prep.). Although white-tailed deer are the top management priority of the Montana Department of Fish, Wildlife and Parks in northwestern Montana, cause-specific mortality rates and seasonal movement patterns of deer in this area were unknown.

Results of a predator-prey study in an area being recolonized by wolves may yield valuable information with applications to other areas where wolves may recolonize or be reintroduced. My research objectives were to:

1) Evaluate cause-specific mortality of white-tailed deer within the area recolonized by wolves;

2) Document seasonal distribution of white-tailed deer, including identification of key areas of seasonal use;

3) Initiate an index to monitor deer abundance over time; and,

4) Estimate population sex- and age- structure.

Funding for this study was provided by the U.S. Fish and Wildlife Service. I gratefully acknowledge the contributions of the Montana Cooperative Wildlife Research Unit, Montana Department of Fish, Wildlife and Parks, and Glacier National Park.

STUDY AREA

This study was conducted in the valley of the North Fork of the Flathead river in northwestern Montana and southeastern British Columbia. The study area extended from Anaconda creek in Glacier National Park northward to 30 km beyond the Canadian border.

The North Fork valley bottom varies from 4-10 km in width and rises from 1024 m elevation in the south to 1375 m in the northern part of the study area. Peaks of the Whitefish range form the western border of the valley, and the Livingston range defines the eastern border.

Land east of the North Fork of the Flathead river lies in Glacier National Park. West of the river, land is a mosaic of

Flathead National Forest and private property. North of the international border, land on both sides of the river is primarily under British Columbia provincial ownership.

Mean temperature ranges from -9 C in January to 16 C in July (Singer 1979). Snow normally covers the study area from mid-November through mid-April.

Dense lodgepole pine (Pinus contorta) forests dominate most of the North Fork valley, but sub-alpine fir (Abies lasiocarpa), spruce (Picea spp.), western larch (Larix occidentalis), and Douglas-fir (Psuedotsuga menziesii) communities exist throughout the valley. Abundant meadows and riparian areas are dispersed within the study area. Detailed descriptions of vegetation communities in this area have been provided by Habeck (1970), Jenkins (1985), and Krahmer (1989).

METHODS

Trapping

I selected 3 white-tailed deer wintering areas in Glacier National Park for trapping: Kintla Lake, Bowman Road, and the Sullivan Meadow area. These 3 winter ranges provided a northern, central, and southern sample of deer within the area inhabited by wolves. Deer were trapped from the Kintla Lake, Sullivan Meadow, and Bowman Road winter ranges from 21 January through 31 March 1990, and from 26 November 1990 to 26 February 1991.

Deer were trapped with modified elk-sized Clover traps (described by Thompson et al. 1989) or standard Clover traps (Clover 1956). All traps were baited with alfalfa hay (certified to be free of noxious weeds). Female white-tailed deer were manually restrained and instrumented with a radio transmitter (MOD-500, Telonics, Inc., Mesa, Ariz.) with a mortality sensor (4-hr delay). When does >1 yr old were captured, I extracted a canine tooth (I_4) for use in age-determination. Deer were released following tooth extraction. Male white-tailed deer and all mule deer were released without being handled.

Mortality

I tried to monitor activity signals of all radio-collared deer at least once daily. When a radio signal indicated that a deer had not moved in >4 hrs, I carefully approached the animal on the ground and performed a post-mortem examination to determine cause of death (O'Gara 1978, Wobeser and Spraker 1980). When predation had occurred, I recorded kill and chase information, and when possible, attempted to establish the pre-mortality condition of the animal via analysis of femur marrow, kidney fat index, and description of other vital organs (Thorne et al. 1982). If near-total consumption of the carcass made it impossible to ascertain if the deer was killed or was scavenged soon after death, I attributed cause of death to what I considered the most likely scenario and labeled the death a "probable" predation. Seasonal and yearly cause-specific mortality rates will be computed with program MICROMORT (version

1.3, Heisey 1987) and methods of Heisey and Fuller (1985) upon completion of field work.

Seasonal Distribution

To identify key areas of seasonal use and document movement patterns, I attempted to locate all deer weekly by triangulating at least 3 strong radio bearings. I plotted radio bearings on USGS (1:24,000) or Energy, Mines and Resources Canada (1:50,000) topographic maps, and selected a location either at the center of the smallest triangle defined by 3 or more signal azimuths, or at the intersection of 2 such triangles. I divided locations into 6 categories of precision (<1 ha, 1-3 ha, 3-6 ha, 6-12 ha, 12-25 ha, or >25 ha) based on size of the triangle, or "error polygon." Variable topography and lack of an extensive road network within the study area frequently inhibited my ability to get close-range, line-of-sight signal fixes. Consequently, precise triangulations were often difficult to obtain. Only locations with error polygons of <25 ha were used in calculation of seasonal ranges. If I could not locate a deer from the ground, I located it from a Cessna 180 airplane when possible.

I computed minimum convex polygon and 95% harmonic mean (25 grid cell) range for winter and summer ranges of each radio-collared deer (McPAAL ver. 1.2, Stuwe and Blohowiak nd.). To estimate migration distances, I calculated the straight-line distance between the approximate center of each deer's winter and summer range.

Index of Population Abundance

I initiated an intensive pellet-group sampling scheme to monitor trend of the white-tailed deer population over time. Methods were based on non-permanent 1.8 m-radius plots and variability estimates of Tucker (Thesis in prep). Pellet group sampling began in April concurrent with disappearance of snow cover. In 1990 I counted pellet groups in 80 plots on 7.5 pairs of transects (n = 600 plots) in areas with lower density of deer (Fig. 3), and 40 plots in 20 0.25 km^2 blocks (n = 800 plots) in areas with high density of deer (Kintla Lake/Starvation Ridge area, Bowman Road/Akokala area, and Sullivan Meadow). Based on variance estimates obtained from 1990 data, I will revise this sampling scheme to enable future researchers to detect a 20% change in white-tailed deer population numbers (Confidence Limit = 0.90).

Population Sex- and Age- structure

During spring green-up, large numbers of white-tailed deer gather in fields along the North Fork Road to take advantage of the new grass shoots. One hour before sunset, from mid-April to mid-May, 1990 and 1991, I drove from 1.6 km south of Coal Creek (mile marker 24) to Polebridge (mile marker 32) and searched for deer. All deer were counted and observed with 10x binoculars. If possible, deer were classified as adult (>1 yr-old) males or females, or fawns (<1 yr-old). Upon completion of the field

work, age-structure estimated from roadside counts will be compared to age-distribution of does killed by hunters in November and December of the previous year.

RESULTS AND DISCUSSION

From January through March 1990, 50 white-tailed deer and 11 mule deer were captured. Twenty-three white-tailed deer females were fitted with radio collars. During winter 1990-1991, 54 white-tailed deer were captured and 15 females were radio-collared. In March 1990 1 radio transmitter apparently ceased functioning.

Mortalities

Between February 1990 and March 1991, 7 radio-collared deer were killed. Wolves and humans each killed 2 radio-collared deer, and a bear, mountain lion, and coyote each killed 1 (Table 1). Wolves killed a 2.5 yr-old female on 13 March 1990, and probably killed a 10 yr-old female on 4 June 1990. Because the carcass of the second deer was heavily scavenged by black bears, I was unable to determine if wolves had actually killed the deer or only scavenged the carcass. Bears probably killed an old (11-13 yrs) radio-collared deer on 13 June 1991. Lack of remains prevented positive determination of whether the deer was killed by bears or scavenged soon after death. Humans were responsible for the death of a deer on 26 June 1990, and another during hunting season on 5 November 1990. A mountain lion killed a deer on 31 January 1991, and coyotes killed a fawn (approx. 8 months old) on 13 February 1991.

Predators killed 3 radio-collared deer during winter and 2 during the fawning period in June, but killed none during summer or autumn (Table 1). Both deer killed during the June fawning period were very old (Table 1). Because older deer may be in weakened physical state after a long winter and the increased physical demands of pregnancy, they are likely to very vulnerable to predation during the fawning period. Lack of predation on adults during summer and autumn months suggests that predators may be relying on an abundance of fawns during this period (Van Ballenberghe et al. 1975, Fritts and Mech 1981, Nelson and Mech 1986).

Seasonal Distribution

Radio-collared white-tailed deer wintered in 3 areas within the range inhabited by wolves in western Glacier National Park: the Kintla Lake area, the Polebridge/Bowman Lake area, and the Sullivan Meadow area. Females migrated from winter ranges during May and travelled an average of 12.0 km (n = 21, SD = 11.6) to summer ranges (Table 2). One deer migrated 40 km from winter range to summer range, but 4 deer did not migrate from wintering areas and lived in the same area year-round (Table 2). Deer began migrating from summer ranges as early as 26 August and arrived on winter ranges as early as 16 October. All deer

migrated from their summer ranges by mid-December. Of the 13 deer that migrated from summer ranges to winter ranges in 1990, 6 used intermediate "transitional" ranges for > 2 months, probably because of the lack of snow prior to late November.

Seasonal distribution of white-tailed deer in this area does not appear to be influenced by the presence of wolves. During summer, 5 radio-collared deer spent the summer within 1 km of an active wolf den in Sullivan Meadow. Wolves were in the meadow area continually from mid-April through December 1990, but the deer seemed unaffected by the presence of wolves and remained in the area.

Population Index

In April and May 1990, 1,667 deer pellet groups were counted in 1,400 1.8m-radius non-permanent plots ($\bar{x}$ = 1.2 groups/plot, SD = 2.0). This pellet sampling index will be revised and continued in spring 1991.

Sex- and Age- Composition

I counted 1173 white-tailed deer in 11 evenings during April and May 1990 ($\bar{x}$ = 106.6 deer/evening, SD = 29.2). I categorized 102 deer as adult males (15%), 429 as adult females (62%), and 155 as fawns (23%); 487 deer could not be classified. Roadside surveys will continue in Spring 1991.

CONCLUSION

Results presented in this paper are from the first year of a 2-year study. I feel strongly that it is premature to attempt to make specific conclusions based on these preliminary data. Consequently, I have refrained from making specific conclusions and have provided only a minimal and general discussion of results. Field work for this study will continue through the end of August 1991. After this time I will offer a more detailed discussion and attempt to make reliable conclusions.

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Table 1. Cause-specific mortality of radio-collared female white-tailed deer in the North Fork drainage of the Flathead River, February 1990 - March 1991.

Cause	Predator	Date	Age of Deer (yrs)
Predation	Wolves	03/13/90	2.5
Probable Predation	Wolves	06/04/90	10.0
Probable Predation	Bear	06/13/90	11-13
Accident[1]	Humans	06/26/90	8.0
Hunting	Human	11/05/90	6.5
Predation	Mountain Lion	01/31/91	5.5
Predation	Coyote	02/13/91	0.75

1 Killed by accident during translocation attempt in Glacier National Park.

Table 2. Seasonal distribution and migration distances of white-tailed deer radio-collared in Glacier National Park (GNP) in winter 1990.

ID#	Winter Range in GNP	Summer Range	Migration Dist. (km)
101	Kintla Lake	Kintla Lake	0
102	Kintla Lake	Colts Cr., Pvt[1]	11
103	Kintla Lake	Couldrey, Cr., BC	21
105	Kintla Lake	Kintla Lake	0
106	Kintla Lake	Ford Cr., GNP	5
107	Kintla Lake	Harvey Cr., BC	40
108	Kintla Lake	8 km S. Polebridge, Pvt	27
109	Kintla Lake	Couldrey Cr., BC	21
110	Polebridge	Polebridge, Pvt	1
111	Sullivan Meadow	Dutch Creek, GNP	8
112	Sullivan Meadow	Big Prairie, GNP	16
113	Sullivan Meadow	Mid. Quartz Lake, GNP	14
114	Sullivan Meadow	Sullivan Meadow	0
115	Sullivan Meadow	Sullivan Meadow	0
116	Sullivan Meadow	Sullivan Meadow	2
117	Sullivan Meadow	Mud Lake, GNP	7
118	Sullivan Meadow	Hay Creek, FNF[2]	23
119	Sullivan Meadow	Logging Cr., GNP	3
120	Sullivan Meadow	Hidden Meadow, GNP	7
121	Sullivan Meadow	Tepee Lake, FNF	31
123	Sullivan Meadow	Anaconda Creek, GNP	16

1 Pvt = Private property
2 FNF = Flathead National Forest

The Significant of Disease in Wildlife Populations

This talk is oriented toward wildlife biologists organizing and conducting population ecology studies. It is for those of you who have asked the question,"Do I need to add disease investigations to my population study in order to be complete?". The answer is not always "yes". Hopefully this presentation will increase your familiarity with diseases in wildlife populations and help you begin to answer this question.

The word "disease" is very general. It is defined as any condition that impairs the normal structure or function of an individual or population. Disease can include infectious agents, parasites, nutritional problems, environmental toxins, cancers and physical damage - anything that causes "dis-ease".

Disease ecology is one of the many bridges connecting wildlife ecology and veterinary science. Disease ecology looks at how diseases influence, and are influenced by , the dynamics of animal populations. It relates individual physiology and disease to population health and condition. I like to consider disease ecology as being more of a population issue in which the research biologist and manager can contribute greatly utilizing veterinary skills and perspectives for data collection.

Infectious diseases are very dynamic in wildlife populations. We often perceive them as being in some quiescent, stagnant form, but they are ever changing. One example is prevalence (number of animals infected) of a disease, which can fluctuate over the years[1]. Infectious diseases also exert continuous pressure on populations. We generally view them negatively, but they often play a very positive role in population regulation and adaption[2].

Their impact is very complex, being influenced by factors such as weather, predators and intra- and interspecific competition. Weather and other environmental factors can affect the abundance of disease organisms. Predators selecting for compromised prey can serve as regulators of disease populations. Competition and nutrition can contribute stress factors increasing the population's susceptibility to disease.

There is constant interaction between hosts and infectious agents. Hosts are continuously applying pressure on the disease agent in an effort to fight off infection. This pressure, in turn, influences the infecting organism to change in order to be more effective or less evident to the host. Such a "tug-of-war" produces diseases that are continuously evolving (sometimes into new diseases) and populations with changing disease resistance[4].

Some diseases, such as the footworm (Wehrdikmansin cervipedis) and abdominal worm (Setaria yehi) of elk, have evolved with the host into an almost symbiotic relationship resulting in little damage to either parasite or host. Such diseases, obviously, may not be cost-effective for a field biologist to include into ecological studies.

From a practical perspective, the above relationships between disease agents, host and environment suggests that there are no easy answers and that data may not always provide conclusive results. It also supports the need for disease investigations so we can clarify these complex relationships.

There are a variety of roles that diseases play in wildlife populations. The following are some brief examples of these roles.

Diseases can directly limit populations by being life threatening.

Canine parvovirus and feline panleukopenia can easily cause death to individuals

previously unexposed (and therefore unprotected). Losses from these diseases commonly occur in young animals near the time of weaning when it is difficult to identify the occurrence of mortalities in free-ranging wildlife and even more difficult identifying the cause of mortalities.

Rabies has decimated entire wolf packs in coastal Alaska[5], but does not appear to play a similar role in interior Alaska or in Minnesota wolf populations. The reason for this difference is unknown.

Bluetongue occurs in livestock and wildlife over much of the United States. In the Rocky Mountain region, this disease is often neglected in wildlife studies. Yet in 1976, bluetongue killed a minimum of 1400 antelope and deer in eastern Wyoming[6] emphasizing the importance of this disease in wild ruminants.

Diseases can directly limit populations by causing reproductive failure. Brucella abortus in bison and elk of the Yellowstone ecosystem is a notable example of this role. The major symptoms of brucellosis in cows are abortions, premature births and birth of non-viable calves[6]. Without disease investigations, these losses due to reproductive failure as well as those causing mortality of young could easily be overlooked or mistaken for predation, starvation or other factors.

Diseases can indirectly limit populations.

As stated above,disease agents continually exert pressure. Their presence is one more additional stress that can be as significant as many environmental factors we frequently consider in our wildlife populations. Dr. Terry Spraker describes the scenario of a dog swimming in a pond. Place a small weight on his back and he will continue to swim strong and high in the water. But with each additional weight, he will be slower and lower in the water. Finally, there will be a single weight that keeps the dog from reaching the other shore. It is not the final weight which was most significant for the dog's loss, but an accumulation of weights, just as our wildlife populations have an accumulation of stresses placed upon them including diseases.

Winter ticks are a good example of an additional stress to wildlife. They can be a serious parasite for moose and elk causing anemia due to blood loss and hypothermia due to hair loss.

Diseases can support one species in competing against other species.

Dramatic examples of this role are the arterial worm (Elaeophora schneideri) and the meningeal worm (Parelaphostrongylus tenuis). The mule deer benefits from having E. schneideri as a parasite. This parasite reaches maturity within carotid arteries of the mule deer, produces microfilariae in the bloodstream which are picked up by horseflies and transmitted to other ungulates. This parasite is fatal to many abnormal hosts such as elk and moose resulting in blockage of arteries supplying the head, blindness, loss of body parts and death. In areas of Arizona and New Mexico where mule deer, horseflies and the arterial worm are abundant, elk populations are limited[7].

The meningeal worm benefits it normal host, white-tailed deer, and is devastating for many other ruminants including elk, moose and mule deer. It exists primarily in the eastern United States. Adult parasites reside in the membranes (meninges) covering the brain, produce eggs that hatch into larvae. These larvae enter the bloodstream, travel to the lungs,

are coughed up and swallowed, and exit with the feces. The larvae then develop within land snails into infective stages which are picked up by grazing individuals. In abnormal hosts, these larvae migrate to the brain also, but wander throughout the tissue of the brain and spinal cord causing life-threatening damage[7].

The meningeal worm prevents successful elk reintroductions into the eastern United States. It is also a strong example of why we must be careful transporting wildlife (and their diseases), in this case, from eastern to western parts of the country.

<u>Wildlife diseases can be indicators for the biologist.</u>

Lungworm/pneumonia complex in bighorn sheep is usually an indicator of stress within the population. With outbreaks occurring, other stress factors are often identified, such as human activity, hunting, and high population density. Researchers have developed methods to monitor a stress hormone, cortisol, within sheep populations and can identify stressed populations before disease outbreaks occur. Once identified, wildlife managers can modify factors to reduce stress and prevent all age die-offs (T. Spraker, pers. comm.).

Some diseases are more prevalent in domestic animals than in wildlife. The presence of these diseases in wildlife populations can suggest that the population is utilizing habitat shared with domestic animals - information often valuable to the biologist. Prevalence of various diseases within the wildlife population can be compared to known prevalence rates in local livestock. Once identified, modes of transmission and disease influences for both wildlife and domestic animals should be considered.

These are just a few of the roles of disease in wildlife populations.

As we decide whether or not to incorporate disease investigations into a population study, it is worth asking, "Why has there been so little done in disease ecology?". Aldo Leopold stated almost 60 years ago, "The role of disease in wildlife conservation has probably been radically underestimated." This is still true today.

Traditionally, there has been a separation between wildlife biology and veterinary science. Wildlife biology has worked with populations collecting data on factors outside of the individual. Veterinary science has focused on the individual and its internal activity. Fortunately, these two fields are interacting more all the time.

Blood collecting, necropsies, and other data collection skills for disease investigations are not routinely taught as part of university wildlife programs. Transport and handling of samples and interpretation of results can be equally obscure without proper consultation and training.

Once data is collected, there is not a great deal that the manager feels he can do with it. Eradication of disease in free-ranging populations appears impossible with our current technology. We don't even have a clear understanding of how to reduce the prevalence of most diseases. But disease studies do contribute to eventual eradication of some diseases and increase our understanding of population dynamics.

With limited finances and manpower the researcher and manager must also consider the cost/benefit of every investigation. Disease studies can be very costly, or at times, very inexpensive. Logistically, sample collections are easily incorporated into animal handling programs for most field conditions.

Moral obligations and ethical values should also be considered. As we capture and handle wildlife, we have a responsibility to gather as much information as possible, within reason. If diseases appear to play a significant role, scientific investigation of population

dynamics would be incomplete without including disease aspects. Also with the many wildlife diseases affecting human health and livestock, it is the field biologist who can play a significant role in understanding and eradicating these diseases.

Lastly, and most significantly, diseases are often neglected in wildlife studies because there is so little known about the disease ecology of most diseases. Often the questions are not even developed, let alone acquiring answers. Again it is the field biologist working with veterinary perspectives that can provide insight and answers.

There are a variety of resources for the researcher and manager for assistance in developing and conducting disease investigations. These include:

- Biologists with strong backgrounds in wildlife diseases
- State diagnostic laboratories and wildlife research labs
- Members of the Wildlife Disease Association that are publishing papers on the species you are studying
- Wildlife veterinarians that combine veterinary science with population perspectives and a practical understanding of field conditions.

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BLACK BEAR SURVIVAL RATES IN NORTHWEST MONTANA

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Abstract: Survival estimates were calculated for black bears (*Ursus americanus*) >= 4 years old for the period 1983-1990 in northwest Montana. Data was examined from several studies on black bears in 3 Hunting Districts (HD 100, HD 104, and HD 121) using 3 different approaches. In the first approach a computer model (MICROMORT; Heisey and Fuller 1985) was used to calculate survival for radio collared bears only (N = 45). In the second approach, life tables were calculated for all black bears >= 4 years old that had been captured, tagged, and released (N = 189). In the third approach, life tables were calculated for all bears >= 4 years old that had been killed and reported by hunters (N = 617). Capture information and radio monitoring indicated that the age of first successful reproduction was 6 years old or greater, mean litter size was 1.7 cubs, and the mean interval between litters was 3.5 years. Based on this information, a minimum sustainable annual survival rate of 0.89 was estimated. Composite annual survival rates for radio collared bears ranged from 0.49-0.77 for males and 0.68-0.89 for females. Annual survival rates calculated from life tables for captured bears ranged from 0.70-0.81 for males and 0.72-0.84 for females. Annual survival rates calculated from life tables for bears killed by hunters ranged from 0.69-0.75 for males and 0.73-0.74 for females. All analyses indicated survival rates lower than the minimum sustainable rate of 0.89. Management strategies related to mortality (e.g. hunting season timing, hunting season length, hunter access, and enforcement) were discussed.

INTRODUCTION

Black bear hunting in northwest Montana has shown a dramatic increase in popularity since the early 1970's. In 1971, Region 1 of the Montana Department of Fish, Wildlife, and Parks (MDFWP) recorded about 19,000 black bear hunter days and approximately 650 bears killed. By 1979, hunter days had increased to 55,000 with almost 1,000 bears harvested. With this increase in harvest and hunting pressure, MDFWP biologists became concerned about trends in overall bear numbers. Interviews with hunters and residents indicated a general decline in bear sightings and nuisance bear complaints.

An average of 62% of the annual harvest from 1978-1980 occurred during the spring hunting season, with most during May. Black bears are vulnerable to hunting in spring because snow cover forces animals searching for food into limited areas of early green-up. Females (particularly females with cubs) tend to emerge from dens later in the spring than males (Hugie 1982, Beecham 1980, Waddel and Brown 1984). In an effort to reduce the overall harvest and afford greater protection to reproductively active females, MDFWP biologists shortened the spring season in districts 100, 101, 103, and 104 to only 2 weeks in late April beginning in 1981. After 3 years of curtailed harvest, black bear populations appeared to increase. In response, the spring season

was lengthened to 4 weeks in 1984 (15 May ending date). This paper seeks to compare and evaluate mortality rates under this hunting regime using data from hunting districts 100, 104, and 121.

STUDY AREA

Habitat use and population characteristics of black and grizzly bears were studied from 1983 to 1990 in the Cabinet Mountains and the Yaak River drainage of northwest Montana (48° N, 116° W). The study area encompassed approximately 7,800 km^2 and is bisected by the Kootenai River, with the Cabinet Mountains to the south and the Yaak River area to the north (Figure 1). Approximately 90% of the study area was on public land administered by the Kootenai and Panhandle National Forests. The Cabinet Mountains Wilderness Area encompassed 381 km^2 of the study area at higher elevations of the Cabinet Mountains.

Elevations on the study area ranged from 664 m along the Kootenai River to 2,664 m at Snowshoe Peak. Weather is dominated by a Pacific maritime climate characterized by short, warm summers and heavy, wet winter snowfalls. South and west slopes at lower elevations supported stands of ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*). Grand fir (*Abies grandis*), western red cedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*) dominated the lower elevation moist sites. Mixed stands of subalpine fir (*Abies lasiocarpa*), spruce (*Picea engelmannii*), and mountain hemlock (*Tsuga mertensiana*) were predominant above 1,500 m. Lodgepole pine (*Pinus contorta*) dominated large areas at mid- and upper elevations, especially north of the Kootenai River. Mixed stands of coniferous and deciduous trees were interspersed with riparian shrubfields and wet meadows along the major rivers. Huckleberry (*Vaccinium* spp.), an important food for black and grizzly bears, was a common component in the understory. The occurrence of huckleberry and other berry-producing shrubs were largely a result of wildfires that occurred between 1910 and 1929, and also from timber harvesting. Effective fire suppression since then has virtually eliminated wildfire as a natural force in creating and maintaining berry-producing shrubfields.

The southern portion of the study area was characterized by high, precipitous peaks with steep slopes. The northern portion was characterized by mountains that were lower in elevation, had gentler slopes, and were forest-covered. Contemporary resource use includes mineral exploration and extraction, timber harvesting, and recreation.

METHODS

Capture and Marking

Bears were captured with leg-hold snares following the techniques described by Johnson and Pelton (1980). The snares are manufactured by Aldrich Snare Co. (Clallam Bay, WA) and consist of 0.25 inch wound steel aircraft cable. All bears were immobilized with a drug mixture of Ketaset (ketamine hydrochloride) and Rompun (xylazine hydrochloride). Drugs were administered intramuscularly with either a syringe mounted on a pole or a Palmer Cap-Chur gun. Immobilized bears were measured, weighed, tattooed, and a first premolar tooth extracted for age determination (Stoneberg and Jonkel 1966).

Fig

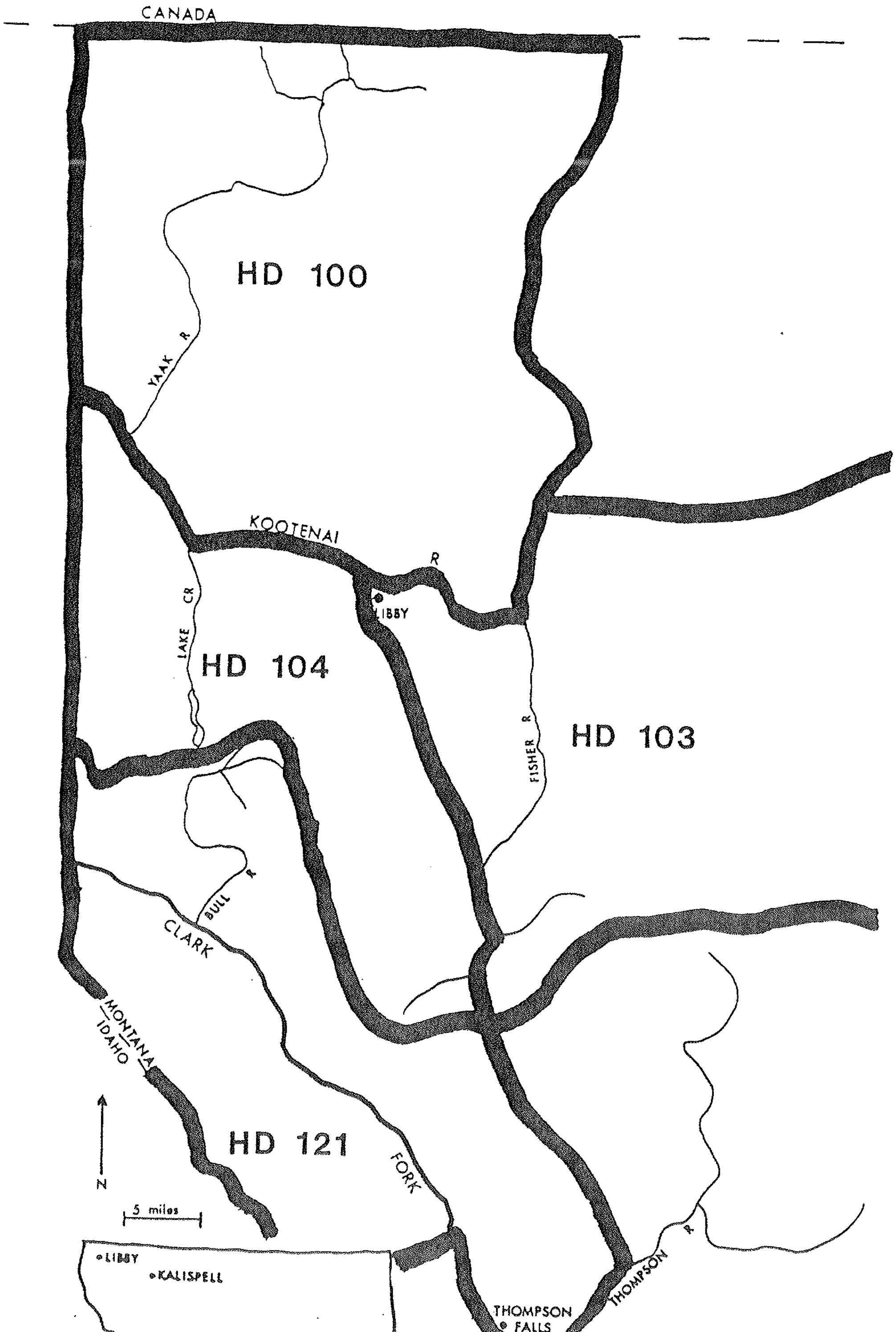

Fig. 1. Map of study area in northwest Montana.

Each bear was marked with an individually numbered ear tag in each ear. Attached to each ear tag was a 4 X 13 cm streamer of armatite. The color of the streamers varied by species and the year in which the animal was captured. Only adult black bears (>= 4.0 years old) were fitted with radio collars. Motion-sensitive collars manufactured by Telonics (Mesa, Arizona) were used on most bears. To prevent permanent attachment, a canvas spacer was placed in the collars that was designed to separate in 2-3 years, (Hellgren et al. 1988).

Trapping efforts were conducted during the spring (prior to mid-July) from 1983-1987 and 1989-1990. Fall trapping efforts (early September to mid-October) were conducted in 1984, 1986, 1987, 1989, and 1990. Trap sites were usually located within 200 m of a road to allow vehicle access. Many trap sites were behind closed roads. One or two 2-person crews checked the snares daily. Bait consisted primarily of road-killed deer, with lesser amounts of beaver carcasses, elk, moose, and meat scraps from processing plants.

Radio Monitoring

Weekly aerial radio locations were obtained (weather permitting) on instrumented black bears each week during the 7-8 month period in which they were active. In addition, efforts were made to obtain as many ground locations as possible, usually by triangulating from a vehicle. Bear activity was assessed each time a location was obtained. Collars that were inactive for unusual periods of time were approached from the ground and a determination was made of the bear's fate. All specific locations were plotted on USGS topographic maps (1:24,000) and recorded by Universal Transverse Mercator Coordinates (UTM's). Distance from radio locations to the nearest open road and trail were measured on maps to 30 m accuracy. Closed roads (closed to motorized vehicles) were considered trails in the analysis.

Survival Estimation

The MICROMORT computer software package was used to calculate survival and cause-specific mortality rates from the radio telemetry information (Heisey and Fuller 1985). This method required the assumptions that marked individuals were representative of the population and that individuals within sex and age classes had independent and equal probabilities of survival. Only radio-collared bears were used in determining survival rates.

Mortality dates were established from hunter harvest information and estimates of dates based on radio telemetry, collar retrieval, and mortality site inspection. Radio failure or suspected mortality dates were estimated by using the date of the last radio location when the animal was known to be alive. Survival rates included suspected mortalities from radio-collared bears that disappeared with less than 2.5 years of elapsed time on their transmitters.

Seasons were defined on the basis of spring and fall hunting season dates. These periods were (1) spring, 15 April to 31 May, (47 days) (2) summer, 1 June to 31 August, (92 days); (3) autumn, 1 September to 30 November, (91 days); (4) winter, 1 December to 14 April (135 days).

Life table analysis (Downing 1980) was applied to samples of captured and hunter harvested black bears. Means were calculated from sex and age specific survival rates of bears >= 4 years-old. Hunter harvest information from the mandatory black bear tooth return program was obtained from MDFWP records. It

was estimated that this sample represents about 70% of all harvested black bears and has been in effect since 1985 (Brown et al. 1987). Hunting district 103 was divided into 2 districts (103 and 104) in 1989. Harvest information referenced as district 104 includes all of district 103.

RESULTS

Reproduction

Black bear capture and radio monitoring data were examined to determine reproductive parameters for females in the study area. Ninety-eight captures of female black bears from 1983-1990 were analyzed to determine first age of reproduction. Incidence of estrous, lactation, cub presence, and nipple length were used in the analysis (Table 1). Lactation or cub presence was noted in only 1 of 27 bears aged 3-5 years-old. The 4 year-old bear that did show signs of lactation was radio collared and was never seen subsequently with cubs. Signs of estrous were noted in 15% (n = 27) of the black bears aged 3-5 years-old. Five of eight 6 year-olds showed signs of estrous, were lactating, or had cubs present at capture. Fifty-six percent (n = 55) of the captured black bears >= 7 years-old were in a similar reproductive state. Radio monitoring information indicated that no female bears first captured as 4 or 5 year-olds (n = 4) produced cubs prior to the age of 6. Female black bears in our study area may come into estrous as early as 3 years-old, but few successfully produce cubs before the age of 6 years-old. Mean age of first reproduction may be > 6 years-old.

Table 1. Reproductive state of female black bears captured in northwest Montana, 1983-1990.

Age Class	n	Estrous	Lactation or Cubs	Nipple Length >= 12 mm (n[1])
Cub-2.0	8	0	0	0 (5)
3.0	10	1	0	0 (7)
4.0	9	2	1	0 (6)
5.0	8	1	0	0 (6)
6.0	8	2	3	4 (5)
7.0	11	3	2	7 (9)
8.0	11	2	2	9 (10)
9.0	8	2	3	6 (7)
10.0-24.0	25	12	5	23 (23)

[1]Sample size for nipple length measurement.

We have postulated that nipple length is greater for bears that have produced cubs than for bears that have not produced cubs (Kasworm and Manley 1988). Nipple length measurements have been recorded on female bears captured since 1984 (n = 78). None of the 24 captured black bears <= 5 years-old had nipple lengths >= 12 mm. Ninety-one percent of captured bears >= 6 years-old (n = 54) had nipple lengths >= 12 mm. While this information does not

demonstrate a cause and effect relationship, it would seem unlikely that the dramatic correlation of increased nipple length and first reproduction could be completely coincidental. We believe this information supports our contention that little successful reproduction occurs on our study area before females reach 6 years of age.

Radio monitoring of 22 female black bears >= 6 years-old provided estimates of cub production and reproductive interval (Table 2). Fifty-nine female black bear-years of information was obtained from 1983-1990. Seventeen litters of cubs were known to have been produced during the study period. Two of those litters were known to have been lost because of the death of the mother before counts of cubs could be obtained. Fifteen known litters produced 25 cubs for a mean litter size of 1.7. Mean bear-years per litter was 3.5. Production of 25 cubs and the deduction of 2 bear-years from the total to account for the 2 known lost litters produced a calculated reproductive rate of 0.44. Assuming each of the 2 lost litters produced 2 cubs, the calculated reproductive rate would have been 0.49.

Table 2. Cub production of radio-collared female black bears >= 6 years-old in northwest Montana, 1984-1990.

	1984	1985	1986	1987	1988	1989	1990	Total
No. Cubs:	1	3	7	4	8	1	1	25
No. Litters:	1	1	7[1]	2	4	1	1	17[1]
No. Females Monitored:	5	12	18	12	8	2	2	59

[1]Includes 2 litters which were lost before counts of cubs were obtained.

Maximum Sustainable Mortality

A population model which estimates maximum sustainable mortality was developed by Bunnell and Tait (1980). This model assumed that the mortality rate is constant for all age-classes and that cubs die only if the mother dies. The mortality rate was balanced against the natality rate needed to produce a nondeclining population. Using an average litter size of 1.7, an interbirth interval of 3.5 years, and a first age of reproduction of 6 produces a maximum sustainable mortality rate of 11% from all causes. Survival rates less than 0.89 would cause this population to decline.

Survival of Radio Collared Black Bears

Forty-five black bears aged 4 to 21 years-old were radio collared in 3 study areas of northwest Montana during 1983-1990 (Appendix Table 1). Nineteen of these individuals were males that carried functional collars for 97-1,524 days. Twenty-six of the individuals were females that carried functional collars for 67-1,781 days. Eighteen instances of known mortality and 4 instances of suspected mortality were recorded over the 8 years of study. No mortality was detected in the sample during winter. Eight of 9 male deaths occurred during spring and 1 male died during summer. No male mortality was detected during autumn. Female mortality was distributed through 3 seasons

with 7 deaths occurring in spring and 3 each during both summer and autumn.

Seasonal and annual survival estimates were calculated by sex for each hunting district within the study area (Table 3). No mortality was observed during winter. Interval survival rates for males were not different among districts (Z tests, $P > 0.05$). Male survival rates were lowest during spring in all districts. Spring survival of females in district 104 was less than for females in district 121 ($P < 0.05$). All other interval comparisons of females among districts were not different ($P > 0.05$). Survival rates of females were lowest during spring in districts 100 and 104. Summer and autumn rates were equally low in district 121.

Table 3. Seasonal and annual survival rates of radio-collared black bears in northwest Montana, 1983-1990.

			Season[1]			
Sex District	*n*	Radio Days	Spring (Deaths, 95% CI)	Summer (Deaths, 95% CI)	Autumn (Deaths, 95% CI)	Annual (Deaths, 95% CI)
Male						
100	9	5,546	0.75 (4, 0.56-0.99)	1.00 (0)	1.00 (0)	0.75 (4, 0.56-0.99)
104	8	4,708	0.77 (3, 0.57-1.00)	1.00 (0)	1.00 (0)	0.77 (3, 0.57-1.00)
121	2	1,070	0.69 (1, 0.33-1.00)	0.71 (1, 0.36-1.00)	1.00 (0)	0.49 (2, 0.18-1.00)
Total	19	11,324	0.75 (8, 0.61-0.91)	0.97 (1, 0.91-1.00)	1.00 (0)	0.73 (9, 0.59-0.90)
Female						
100	9	4,634	0.82 (2, 0.62-1.00)	1.00 (0)	0.88 (2, 0.74-1.00)	0.72 (4, 0.52-1.00)
104	12	8,038	0.75 (5, 0.58-0.96)	0.91 (2, 0.80-1.00)	1.00 (0)	0.68 (7, 0.52-0.91)
121	5	5,969	1.00 (0)	0.94 (1, 0.83-1.00)	0.94 (1, 0.84-1.00)	0.89 (2, 0.75-1.00)
Total	26	18,641	0.84 (7, 0.74-0.96)	0.94 (3, 0.88-1.00)	0.95 (3, 0.89-1.00)	0.75 (13,0.64-0.88)

[1]No mortality was observed during winter.

Annual survival rates of males were not different ($P = 0.516$) between districts 100 and 104 (0.75 and 0.77, respectively). Male annual survival rates in district 121 (0.49) were different ($P < 0.001$) from districts 100 and 104. Similar relationships were observed among female black bears. Female annual survival rates were not different ($P = 0.114$) between districts 100 and 104 (0.72 and 0.68, respectively). Annual survival rates of females in district 121 (0.89) were different ($P < 0.001$) from districts 100 and 104. Pooled annual survival rates for males and females were 0.73 and 0.75, respectively.

Cause of Mortality

Nine male and 13 female mortalities occurred over the course of this study (Table 4). Twelve were reported hunter kills (8 male and 4 female), 2 were illegal kills (both females with cubs and outside of legal season), 1 was a natural mortality (female), 3 were of unknown origin (all female), and 4 were suspect mortalities based on the loss of the radio signal (1 male and 3

female). Forty-five percent of total mortality was unreported. Composite male and female annual mortality from all districts was 0.27 and 0.25 respectively. Hunting was the largest single source of mortality for males and females at 0.25 and 0.09 respectively. All other individual mortality sources were <= 0.06 each. Some of the mortality classified as unknown or suspect may have been related to hunting (e.g. wounding loss or failure to report kill).

Table 4. Pooled mortality rates by source for radio-collared black bears from hunting districts 100, 104, and 121 in northwest Montana, 1983-1990.

Mortality Source	Sex	Season[1] Spring (Deaths, 95% CI)	Summer (Deaths, 95% CI)	Autumn (Deaths, 95% CI)	Annual (Deaths, 95% CI)
Hunting	Male	0.25 (8, 0.10-0.40)	0.00 (0)	0.00 (0)	0.25 (8, 0.10-0.40)
	Female	0.09 (4, 0.01-0.17)	0.00 (0)	0.00 (0)	0.09 (4, 0.01-0.17)
Illegal	Male	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
	Female	0.05 (2, 0.00-0.11)	0.00 (0)	0.00 (0)	0.05 (2, 0.00-0.11)
Natural	Male	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
	Female	0.00 (0)	0.02 (1, 0.00-0.06)	0.00 (0)	0.02 (1, 0.00-0.05)
Unknown	Male	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)
	Female	0.00 (0)	0.00 (0)	0.05 (3, 0.00-0.11)	0.05 (3, 0.00-0.09)
Suspect	Male	0.00 (0)	0.03 (1, 0.00-0.09)	0.00 (0)	0.03 (1, 0.00-0.09)
	Female	0.02 (1, 0.00-0.07)	0.04 (2, 0.00-0.09)	0.00 (0)	0.06 (3, 0.00-0.12)
TOTAL	Male	0.25 (8, 0.09-0.39)	0.03 (1, 0.00-0.09)	0.00 (0)	0.27 (9, 0.10-0.41)
	Female	0.16 (7, 0.04-0.26)	0.06 (3, 0.00-0.12)	0.05 (3, 0.00-0.11)	0.25 (13,0.12-0.36)

[1]No mortality was observed during winter.

Relations of Human Access to Mortality

Road and trail influences on black bears in hunting districts 104 and 121 were described by Kasworm and Manley (1990). This analysis involved distances from radio locations to the nearest open road or trail (trails include closed roads). This data set was further analyzed to determine the relations between mortality and black bear use of habitat near roads or trails. Only aerial locations were analyzed.

Mean distance to the nearest open road from 518 radio locations of bears killed during this study (x = 1,576 m) was less (t-test, $P < 0.001$) than the mean distance for 701 locations of bears still alive at the end of the study (x = 1,959 m). Mean distance to the nearest trail from locations of bears killed during the study (x = 590 m) was less (t-test, $P = 0.043$) than the mean distance for bears still alive at the end of the study (x = 655 m).

Life Table Analysis of the Capture Sample

Trapping activities resulted in the capture of 189 black bears >= 4.0 years old in the 3 hunting districts during 1983-1990. Comparisons of male and female capture sample age distributions by hunting district showed no differences among years (Kruskal-Wallis, $P > 0.177$). Yearly capture samples were pooled to form 6 samples of males and females from the 3 districts. Life table analysis was performed on each sample to estimate mean adult survival rates (Appendix Table 2). Mean survival rates for males >= 4.0 years old varied from 0.70-0.81 and mean survival rates for females varied from 0.72-0.84.

Life Table Analysis of the Hunter Harvest

A mandatory tooth return program for successful Montana black bear hunters has been in effect since 1985. Hunter harvest from the 3 hunting districts was 617 black bears >= 4.0 years old from 1985-1989. Comparisons of male and female harvest sample age distributions by hunting district showed no differences among years (Kruskal-Wallis, $P > 0.082$). Yearly harvest samples were pooled to form 6 samples of males and females from the 3 districts. Similar life table techniques as employed on the capture sample were applied to the harvest samples to estimate a mean adult survival rate for males and females >= 4.0 years-old (Appendix Table 3). Mean survival rates for males >= 4.0 years old varied from 0.69-0.75 and survival rates for females varied from 0.73-0.74.

DISCUSSION

We calculated a natality rate of 0.49 and an age of first reproduction of 6 years-old for our study area. These values are similar to the natality rate of 0.57 and 6 years-old as a first age of reproduction for the Whitefish Range in northwest Montana (Jonkel and Cowan 1971). Studies in northern Idaho have indicated natality rates of 0.46 and a first age of reproduction at 5 years-old (Beecham 1980 in Stringham 1990). However, these values contrast sharply from central and eastern U.S. black bear populations which have reported natality rates of 1.04-1.45 and mean age of first reproduction of 3.6-6.3 years-old (Rogers 1987, Alt 1982 in Stringham 1990).

When reproductive rates of black bears and grizzly bears (*Ursus arctos horribilis*) are compared, the values are similar or lower for black bears. A study of grizzly bears on the Montana Rocky Mountain East Front (Aune and Kasworm 1989) indicated a natality rate of 0.85 and a mean age of first reproduction of 7 years-old. McLellan (1988) reported a natality rate of 0.86 and a mean age of first reproduction of 6 years-old for grizzly bears in the North Fork of the Flathead drainage in northwest Montana and southeast British Columbia. Considerable attention is currently given to reducing the mortality of grizzly bears, because of their low reproductive parameters. Similar concerns should be expressed for black bears if current population levels are to be maintained or increased.

The evidence presented indicates survival rates lower than the minimum sustainable, given the reproductive parameters of the population. At least one potential bias in our data involves the proximity of radio collared bears to roads. Black bears that used habitat closer to roads appear to have a higher

mortality rate than bears that used less densely roaded habitat. Since the majority of trapping occurred within 200 m of roads (both open and closed roads), it is possible that bears captured were more prone to being killed. A large proportion of the marked bears killed were harvested during the spring hunting season, even though the total kill was evenly divided between the spring and fall hunting seasons in recent years.

Another potential bias in our data involves the segment of the population sampled by radio telemetry. Only bears >= 4 years-old were collared and survival rates determined by telemetry represent only that age group. Lower survival of subadult than adult black bears has been reported (Bunnell and Tait 1985). However, given the magnitude of mortality in the 3 data sets, the low reproductive rates of the population, and the degree of access currently available, we believe that a more conservative approach is warranted in northwest Montana black bear management.

MANAGEMENT IMPLICATIONS

Management of the black bear in Montana has evolved from early status as a nuisance to that of a highly valued game animal. Hunting seasons in northwest Montana have also evolved from a year round season to the current 4 week spring season and the 12 week autumn season. Comparatively, deer and elk seasons are held only in the autumn for 5 weeks. It is illegal for hunters to take cubs or female bears with young and the use of bait or dogs in hunting black bears is prohibited.

Hunter harvest of black bears and associated unreported mortality appears to be the largest source of mortality. Several means of reducing hunter kill are available. Reducing the season length during either the spring or autumn or a combination of reductions could be applied.

Many resident and nonresident hunters in Montana receive a black bear tag as part of a combination license. Some of these hunters may not directly seek to kill a black bear, but harvest them incidental to other big game hunting. Reducing incidental take by selling tags only to hunters who are interested in black bear hunting may reduce harvest. Incidental take could be eliminated by closing the black bear season before the opening of general big game season.

Mortality quotas have been applied to black bear hunting in south central Montana. These quotas involve total mortality and female mortality. When one of these quotas is reached, the season closes on 48 hour notice. Hunting only by permit is another option to reduce harvest by allowing only a specific number of individuals the opportunity to hunt.

The illegal kill of black bears documented by this study occurred exclusively in females; however, some of the unknown or suspect mortality in both sexes may have also been illegal kills. Illegal kills in this study represented not only the loss of the adult female, but also the loss of their newborn cubs. Under Montana law, it is currently legal to carry a loaded weapon in a vehicle while hunting. Shooting from a public highway is prohibited, but U.S. Forest Service roads are not considered public highways. Changes in these laws and an intensive hunter information and education program could reduce the mortality of females with cubs, young bears, and wounding losses often associated with quick shots. Increased law enforcement activity through additional personnel, patrols, undercover operations, rewards for information, and vigorous prosecution could decrease illegal take through deterrent effects.

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Appendix Table 1. Capture information, monitoring periods, and fate of radio collared black bears in northwest Montana, 1983-1990.

Tag Number	Sex	Capture Age	District	Capture Date	Days Monitored	Date of Last Relocation	Fate
84-85	F	4	104	6 May 83	728	3 May 85	Suspect Mortality
88-89	M	5	104	11 May 83	1,524	13 Jul 87	Radio Failure
90-91	M	12	104	13 May 83	702[1]	14 Apr 85	Radio Failure
263-264	M	10	104	23 May 83	342	29 Apr 84	Hunter Kill
366-367	M	10	121	29 May 83	716	14 May 85	Hunter Kill
686-687	F	15	121	26 May 84	871	13 Oct 86	Mortality (Unknown Cause)
701-702	F	21	121	28 May 84	1,136	7 Jul 87	Natural Mortality
726-727	F	6	121	29 May 84	1,781	14 Apr 89	Alive
736-737	F	7	121	18 Jun 84	1,031	14 Apr 87	Radio Failure
763-764	M	16	104	24 Jun 84	320	9 May 86	Hunter Kill
799-800	F	9	104	28 Jun 84	656[1]	14 Apr 86	Radio Failure
779-780	F	11	121	11 Oct 84	1,150	14 Apr 89	Alive
630-631	M	16	104	10 May 85	97	14 Aug 85	Lost Collar
757-758	F	13	104	16 May 85	463	21 Aug 86	Suspect Mortality
11-11	F	8	104	16 May 85	421	10 Jul 87	Suspect Mortality
13-13	F	10	104	24 May 85	362	20 May 86	Illegal Kill (with cubs)
7-7	F	7	104	6 Jun 85	689	25 Apr 87	Hunter Kill
265-266	M	12	104	7 Jun 85	701	8 May 87	Hunter Kill
5-5	F	7	104	15 Jun 85	1,034	14 Apr 85	Radio Failure
10-10	F	14	104	22 Jun 85	343	30 May 86	Illegal Kill (lactating)
26-26	F	11	104	12 Jul 85	308	15 May 86	Hunter Kill
102-102	M	8	100	4 May 86	1,144	21 Jun 89	Lost Collar
103-103	M	7	100	10 May 86	367	11 May 87	Hunter Kill
104-104	M	8	100	12 May 86	357	3 May 87	Hunter Kill
31-31	M	11	104	12 May 86	427	12 Jul 87	Lost Collar
105-105	F	5	100	22 May 86	1,058	14 Apr 89	Radio Failure
110-110	F	15	100	30 May 86	141	17 Oct 86	Mortality (Unknown cause)
111-111	M	9	100	5 Jun 86	342	12 May 87	Hunter Kill
112-112	M	7	100	13 Jun 86	389	6 Jul 87	Lost Collar
37-37	M	11	121	15 Jun 86	354	3 Jun 87	Suspect Mortality
255-256	F	9	104	3 Jul 86	1,016	14 Apr 89	Alive
42-42	F	9	104	9 Jul 86	1,010	14 Apr 89	Alive
41-41	F	10	104	11 Jul 86	1,008	14 Apr 89	Alive
120-120	F	8	100	30 Aug 86	1,160	2 Nov 89	Mortality (Unknown cause)
123-123	F	7	100	12 Sep 86	240	9 May 87	Hunter Kill
130-130	M	4	100	26 May 87	1,284	30 Nov 90	Alive
132-132	M	6	100	9 Jun 87	703	13 May 89	Hunter Kill
133-133	F	7	100	13 Jun 87	1,266	30 Nov 90	Alive
114-135	M	6	100	1 Jul 87	409	13 Aug 88	Lost Collar
748-749	M	6	104	28 Aug 87	595[1]	14 Apr 89	Alive
186-186	F	8	100	30 Sep 89	427	30 Nov 90	Alive
191-191	F	4	100	12 Oct 89	202	1 May 90	Hunter Kill
117-198	M	9	100	30 May 90	185	30 Nov 90	Alive
219-219	F	15	100	19 Sep 90	73	30 Nov 90	Alive
220-220	F	5	100	25 Sep 90	67	30 Nov 90	Alive

[1]Collar used previously on another animal.

Appendix Table 2. Age and sex specific life tables for captured male and female black bears in hunting districts 100, 104, and 121, 1983-1990.

Males

	Hunting District 100				Hunting District 103				Hunting District 121			
Age	Number Caught	Initial Cohort	Lx	Survival Rate	Number Caught	Initial Cohort	Lx	Survival Rate	Number Caught	Initial Cohort	Lx	Survival Rate
4	6	39	1.000	0.846	11	54	1.000	0.796	3	27	1.000	0.889
5	4	33	0.846	0.879	5	43	0.796	0.884	3	24	0.889	0.875
6	5	29	0.744	0.828	8	38	0.704	0.789	5	21	0.778	0.762
7	4	24	0.615	0.833	7	30	0.556	0.767	5	16	0.593	0.688
8	4	20	0.513	0.800	3	23	0.426	0.870	2	11	0.407	0.818
9	2	16	0.410	0.875	7	20	0.370	0.650	2	9	0.333	0.778
10	3	14	0.359	0.786	2	13	0.241	0.846	3	7	0.259	0.571
11	3	11	0.282	0.727	3	11	0.204	0.727	0	4	0.148	1.000
12	0	8	0.205	1.000	4	8	0.148	0.500	0	4	0.148	1.000
13	2	8	0.205	0.750	1	4	0.074	0.750	0	4	0.148	1.000
14	4	6	0.154	0.333	0	3	0.056	1.000	0	4	0.148	1.000
15	1	2	0.051	0.500	1	3	0.056	0.667	1	4	0.148	0.750
16	0	1	0.026	1.000	1	2	0.037	0.500	1	3	0.111	0.667
17	0	1	0.026	1.000	1	1	0.019	0.000	0	2	0.074	1.000
18	1	1	0.026	0.000					0	2	0.074	1.000
19									1	2	0.074	0.500
20									0	1	0.037	1.000
21									0	1	0.037	1.000
22									1	1	0.037	0.000
Mean Survival Rate				0.744				0.696				0.805

Females

	Hunting District 100				Hunting District 103				Hunting District 121			
Age	Number Caught	Initial Cohort	Lx	Survival Rate	Number Caught	Initial Cohort	Lx	Survival Rate	Number Caught	Initial Cohort	Lx	Survival Rate
4	2	21	1.000	0.905	4	36	1.000	0.889	1	12	1.000	0.917
5	2	19	0.905	0.895	5	32	0.889	0.844	0	11	0.917	1.000
6	1	17	0.810	0.941	3	27	0.750	0.889	3	11	0.917	0.727
7	4	16	0.762	0.750	5	24	0.667	0.792	1	8	0.667	0.875
8	6	12	0.571	0.500	3	19	0.528	0.842	0	7	0.583	1.000
9	2	6	0.286	0.667	3	16	0.444	0.813	1	7	0.583	0.857
10	1	4	0.190	0.750	2	13	0.361	0.846	0	6	0.500	1.000
11	1	3	0.143	0.667	3	11	0.306	0.727	1	6	0.500	0.833
12	0	2	0.095	1.000	4	8	0.222	0.500	2	5	0.417	0.600
13	0	2	0.095	1.000	0	4	0.111	1.000	0	3	0.250	1.000
14	0	2	0.095	1.000	3	4	0.111	0.250	0	3	0.250	1.000
15	2	2	0.095	0.000	0	1	0.028	1.000	2	3	0.250	0.333
16					1	1	0.028	0.000	0	1	0.083	1.000
17									0	1	0.083	1.000
18									0	1	0.083	1.000
19									0	1	0.083	1.000
20									0	1	0.083	1.000
21									1	1	0.083	0.000
Mean Survival Rate				0.756				0.722				0.841

Appendix Table 3. Age and sex specific life tables for hunter harvested male and female black bears in hunting districts 100, 104, and 121, 1985-1989.

Males

	Hunting District 100				Hunting District 103				Hunting District 121			
Age	Number Caught	Initial Cohort	Lx	Survival Rate	Number Caught	Initial Cohort	Lx	Survival Rate	Number Caught	Initial Cohort	Lx	Survival Rate
4	28	113	1.000	0.752	21	117	1.000	0.821	39	144	1.000	0.729
5	20	85	0.752	0.765	14	96	0.821	0.854	14	105	0.729	0.867
6	11	65	0.575	0.831	13	82	0.701	0.841	22	91	0.632	0.758
7	10	54	0.478	0.815	9	69	0.590	0.870	12	69	0.479	0.826
8	7	44	0.389	0.841	11	60	0.513	0.817	10	57	0.396	0.825
9	7	37	0.327	0.811	11	49	0.419	0.776	8	47	0.326	0.830
10	7	30	0.265	0.767	4	38	0.325	0.895	8	39	0.271	0.795
11	11	23	0.204	0.522	7	34	0.291	0.794	8	31	0.215	0.742
12	2	12	0.106	0.833	2	27	0.231	0.926	7	23	0.160	0.696
13	1	10	0.088	0.900	6	25	0.214	0.760	1	16	0.111	0.938
14	2	9	0.080	0.778	9	19	0.162	0.526	2	15	0.104	0.867
15	4	7	0.062	0.429	2	10	0.085	0.800	4	13	0.090	0.692
16	2	3	0.027	0.333	2	8	0.068	0.750	1	9	0.063	0.889
17	0	1	0.009	1.000	1	6	0.051	0.833	1	8	0.056	0.875
18	1	1	0.009	0.000	1	5	0.043	0.800	0	7	0.049	1.000
19					1	4	0.034	0.750	2	7	0.049	0.714
20					1	3	0.026	0.667	2	5	0.035	0.600
21					1	2	0.017	0.500	1	3	0.021	0.667
22					1	1	0.009	0.000	0	2	0.014	1.000
23									1	2	0.014	0.500
24									1	1	0.007	0.000
Mean Survival Rate				0.692				0.736				0.753

Females

	Hunting District 100				Hunting District 103				Hunting District 121			
Age	Number Caught	Initial Cohort	Lx	Survival Rate	Number Caught	Initial Cohort	Lx	Survival Rate	Number Caught	Initial Cohort	Lx	Survival Rate
4	16	68	1.000	0.765	13	76	1.000	0.829	9	99	1.000	0.909
5	10	52	0.765	0.808	8	63	0.829	0.873	12	90	0.909	0.867
6	4	42	0.618	0.905	7	55	0.724	0.873	4	78	0.788	0.949
7	11	38	0.559	0.711	8	48	0.632	0.833	9	74	0.747	0.878
8	5	27	0.397	0.815	8	40	0.526	0.800	7	65	0.657	0.892
9	4	22	0.324	0.818	8	32	0.421	0.750	13	58	0.586	0.776
10	5	18	0.265	0.722	4	24	0.316	0.833	10	45	0.455	0.778
11	1	13	0.191	0.923	5	20	0.263	0.750	7	35	0.354	0.800
12	3	12	0.176	0.750	1	15	0.197	0.933	9	28	0.283	0.679
13	1	9	0.132	0.889	4	14	0.184	0.714	5	19	0.192	0.737
14	1	8	0.118	0.875	1	10	0.132	0.900	4	14	0.141	0.714
15	3	7	0.103	0.571	3	9	0.118	0.667	3	10	0.101	0.700
16	2	4	0.059	0.500	3	6	0.079	0.500	1	7	0.071	0.857
17	0	2	0.029	1.000	2	3	0.039	0.333	2	6	0.061	0.667
18	0	2	0.029	1.000	0	1	0.013	1.000	2	4	0.040	0.500
19	1	2	0.029	0.500	0	1	0.013	1.000	0	2	0.020	1.000
20	1	1	0.015	0.000	1	1	0.013	0.000	1	2	0.020	0.500
21								1.000	1	1	0.010	0.000
Mean Survival Rate				0.738				0.741				0.733

SUMMARY OF QUESTIONNAIRE GIVEN TO SPRING BLACK BEAR HUNTERS IN NORTHWESTERN MONTANA

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Abstract: In 1986 and 1987, questionnaires were distributed to as many of the spring black bear (*Ursus americanus)* hunters in Hunting District 100 (HD 100) as possible, with a special effort made to contact all successful hunters. A total of 125 questionnaires were returned, 61 of them from successful hunters. Completed questionnaires were obtained from 78% of all successful spring hunters in HD 100, as recorded by the Montana Department of Fish, Wildlife, and Park's (MDFWP) mandatory tooth return program for successful hunters. All hunters were asked a variety of questions that related to hunter techniques, number and types of bears observed, and the amount of hunter effort. Successful hunters were asked to complete an additional section with questions that pertained to the time of day the bear was killed, the distance the bear was killed from an open road, and the type of habitat in which the bear was killed. The mean number of bears observed was 4.2 for successful hunters and 2.5 for unsuccessful hunters. Thirty-four percent of the respondents claimed they declined shooting at a legal bear, with "small size" the most common reason given. Twenty-four hunters stated they shot at a minimum of 29 bears that were not killed, of which at least 2 were wounded. "Driving roads" was the most common hunting technique given, with walking closed roads second. Only 6 of the 61 bears reported killed were shot before noon. Fifty-two percent of the successful hunters reported they killed their bear within 300 m of an open road. Sixty-six percent of the bears killed were first observed from an open road. Clearcuts and/or roads were stated as the habitat where at least 70% of the bears were killed.

In 1986 and 1987, data was collected on black bears in HD 100 of extreme northwestern Montana in partial fulfillment of the requirements for an M.S. degree in Environmental Studies (Thier 1990). That study addressed the population characteristics of black bears in the area and examined the impacts of hunting, primarily during the spring hunting season. The spring hunting season in HD 100 typically extends from 15 April to 15 May. During the study 28 individual black bears were captured, marked and released, 13 with radio transmitting collars. The movements of instrumented bears and the mortality of both marked and unmarked bears was carefully monitored.

In an effort to better understand hunter technique, effort, and success, questionnaires were distributed to as many of the spring black bear hunters in HD 100 as possible, with a special effort made to contact successful hunters. Although information from Montana's annually conducted telephone survey was helpful, it failed to address many important points. The objectives in conducting this survey was to gather information that might complement the other research being conducted, and to gather baseline data that would be useful in future management.

STUDY AREA

The study area (HD 100) is a 3,613 km2 area in extreme northwestern Montana. It is bordered by the Kootenai River on the south and east, the U.S./Canada border to the north, and the Montana/Idaho border on the west. The Yaak River drains approximately 70% of the area.

Topography on the study area is varied, with rugged, glaciated peaks present in the Northwest Peak Scenic Area. Rounded peaks and ridges cover most of the remaining area, a result of continental glaciation. Coniferous forests predominate, with cutting units the primary source of diversity. Elevations range from 664 m along the Kootenai River to 2348 m atop Northwest Peak. Climate is dominated by Pacific Maritime weather patterns that are responsible for the 50-150 cm of annual precipitation.

Vegetation is diverse, with an overstory of western hemlock (*Tsuga heterophylla*) and western red cedar (*Thuja plicata*) the indicated climax species on the majority of the study area (Pfister et al. 1977). Ponderosa pine (*Pinus ponderosae*) and Douglas-fir (*Psuedotsuga menzeisii*) are common on lower elevations and on south and western slopes. Subalpine fir (*Abies lasiocarpa*) and spruce (*Picea* spp.) predominate in the upper elevations and cirque basins. Large stands of lodgepole pine (*Pinus contorta*) and western larch (*Larix occidentalis*) occur at mid and upper elevations over much of the study area, largely the result of extensive wildfires in the past.

Timber harvesting is the primary economic use of the area, and a well-developed road system provides reasonable access to the majority of the area. Human populations are centered in the cities of Libby, Troy, and Eureka. The Kootenai National Forest administers approximately 95% of the study area, with the remaining in corporate and private ownership.

METHODS

A questionnaire was developed and distributed to as many of the spring black bear hunters of HD 100 as possible. The questionnaire consisted of 2 parts; Part I was to be completed by all hunters who received the questionnaire, and Part II was to be completed by successful hunters. Hunters were approached in camps and occasionally stopped along roads. Included with each questionnaire was a self-addressed, stamped envelope and directions for its completion. Each member of a group was given the questionnaire with a realization that some data would be duplicated. Names and addresses of all successful spring hunters in HD 100 were obtained from MDFWP and a questionnaire was mailed to them. Successful hunters who did not respond to the first questionnaire were sent a second with a personal note urging them to complete it.

All hunters were asked a variety of questions in Part I that related to hunting techniques, the number and types of bears observed, and the amount of hunter effort. Successful hunters in Part II were asked questions that pertained to the time of day the bear was killed, the distance the bear was killed from an open road, and the type of habitat in which the bear was killed.

RESULTS

One hundred twenty-five of the 1986 and 1987 spring black bear hunters in HD 100 responded to the questionnaire. Sixty-one (49%) of the respondents had killed a bear and 64 (51%) had not. Thirty-four of the 44 recorded successful spring hunters (77%) for 1986 responded to the questionnaire, as did 23 of the 29 (79%) recorded successful hunters for 1987. In both 1986 and 1987, 2 hunters returned the questionnaire indicating that they had killed bears that were not on MDFWP records. These 4 returns are included in the analysis. Fifty-five of the 125 respondents (44%) were from Montana, and 70 were nonresident hunters. Of the 70 nonresident hunters who responded, 46 (66%) were from Utah. Of the 61 successful spring hunters who responded to the questionnaire, 21 (34%) were from Montana, 25 (41%) were from Utah, and 15 (25%) were from other states (Table 1). Successful hunters from Montana were less likely to respond to the questionnaire than were people from all other states ($P < 0.005$, Chi-square = 7.78, 3 d.f.).

Table 1. State residence of respondents to the questionnaire.

	Successful		Unsuccessful		
	1986	1987	1986	1987	Total
Montana	12 (33)[a]	9 (36)	14 (48)	20 (57)	55 (44)
Utah	19 (53)	6 (24)	9 (31)	12 (34)	46 (37)
Other	5 (14)	10 (40)	6 (21)	3 (9)	24 (19)
Total	36(100)	25(100)	29(100)	35(100)	125(100)

[a]Percentage in ().

Questionnaires were distributed to as many hunters as possible. Because most hunters hunted in groups, a duplication of some or most sightings was expected. For example, among the 1986 successful hunters, 6 hunters from 2 groups reported seeing 69 bears, or 59% of all bears observed by the 25 respondents in that category. The actual number of individual bears observed by those 6 hunters was probably less than 30.

The 125 hunters who responded to the questionnaire reported seeing a total of 421 black bears. The mean number of bears observed/hunter was 4.2 for successful hunters and 2.5 for unsuccessful hunters. The average group size for hunters was 3.2 hunters/group. The average number of days spent hunting in HD 100 was 5.1 days/hunter. The proportion of bears observed that were black vs. brown was 72% black, 26% brown, and 2% unreported. Twenty-eight of the 421 bears reported (7%) were females accompanied by cubs, of which there were 49 total. No effort was made to differentiate a cub less than 6 months old from a yearling. The sightings include all young bears still with their mothers. Several bears referred to as cubs, but not

accompanied by a mother, were excluded from the cub category. Discussions with hunters indicated that they sometimes referred to any small bear as a cub, even 2-year olds. The mean litter size observed by hunters was 1.75 cubs/litter. The most cubs observed per litter was 2 (Table 2).

Hunters were asked to state whether or not they willingly passed killing a legal bear, the number of bears passed, and the reason for not killing the bear. Forty-two hunters (34% of all respondents) claimed they declined to shoot at 81 legal bears. "Small size" was the most common reason given, with 64 bears passed for that reason. Thirteen bears were passed because their coat color was black, 1 because it was brown, 1 because the coat was rubbed, and 2 for unknown reasons.

Table 2. Summary of bears observed by hunters ("S.H." = Successful Hunters and "U.H." = Unsuccessful Hunters).

	1986		1987		
	S.H.	U.H.	S.H.	U.H.	Combined
No. of respondents	36	29	25	35	125
No. of bears observed	142	90	116	73	421
No. of females (w/ cubs)	7	7	10	4	28
No. of cubs observed	12	12	17	8	49
% of non-cub bears adult females with cubs	5%	9%	10%	6%	8%
Mean litter size observed	1.71	1.71	1.70	2.00	1.75
No. black (colored) bears	106	60	90	49	305 (72%)
No. brown (colored) bears	36	23	24	23	106 (26%)
No. unknown color	0	7	2	1	10 (2%)

Hunters were asked to state whether or not they shot at any bears, the number of bears shot at, and whether or not they wounded any bears. Excluded were the bears killed by successful hunters. Twenty-four hunters stated they shot at a minimum of 29 bears, of which 2 were known to have been wounded. Four of the hunters stated they shot at a bear but didn't say how many. One hunter was inadvertently sent 2 questionnaires for 1986; on 1 questionnaire he indicated he wounded a bear and on the other he did not (Table 3).

Hunters were asked to state their primary method of hunting, and 7 different options were given. Although it was stated to mark only 1 or 2 of the 7 options listed, most hunters checked 3 or 4. In total, the 125

Table 3. Summary of hunter effort and success ("S.H." = Successful Hunter and "U.H." = Unsuccessful Hunter).

	1986		1987		
	S.H.	U.H.	S.H.	U.H.	Combined
Total respondents	36	29	25	35	125
Percent of all successful spring hunters responding	77%	--	79%	--	78%
Mean no. hunters/group	3.4	3.8	2.9	2.8	3.2
Mean no. days hunting in HD 100	5.5	5.4	4.4	5.3	5.2
Mean no. bears obs./hunter	3.9	3.1	4.6	2.1	3.4
No. hunters who passed shooting legal bear	14(39)[a]	12(41)	8(32)	8(17)	42(34)
Total bears passed	22	17	27	15	81
Too small	16	13	23	12	64
Black color	5	2	4	2	11
Brown color	1	0	0	0	1
Rubbed hide	0	0	0	1	1
No. hunters shooting at bears	5(14)	8(28)	5(20)	6(17)	24(19)
No. bears shot at	5	11	7	6	29
No. bears wounded	2	0	0	0	2

[a]Percent in ().

respondents checked 351 hunting techniques. Driving roads was the most common technique listed, and walking closed roads was second. Bicycling closed roads was the least common hunting technique employed. Most hunting activity was closely associated with roads, either open or closed (Table 4).

Table 4. Primary methods of hunting ("S.H." = Successful Hunters and "U.H." = Unsuccessful Hunters).

	1986		1987		
	S.H.	U.H.	S.H.	U.H.	Combined
Walk closed roads	28(25)	24(27)	19(36)	25(28)	96(27)
Bicycle closed roads	3 (3)	2 (2)	1 (2)	2 (2)	8 (2)
Slowly walk likely areas	12(11)	10(11)	5 (9)	8 (9)	35(10)
Drive roads	30(27)	25(28)	15(28)	29(32)	99(28)
Glass from roads	19(17)	20(22)	9(17)	25(28)	73(21)
Glass from backcountry	17(15)	7 (8)	2 (4)	8 (9)	34(10)
Other	1 (1)	2 (2)	2 (4)	1 (1)	6 (2)
Total	110(99)	90(100)	53(100)	98(99)	351(100)

[a]Percent in (); may not equal 100 due to rounding error.

Successful hunters were asked to complete an additional section that asked questions specific to the bear they killed. One of the questions asked was the time of day their bear was killed. Assuming that 0900 separates early morning from late morning and 1700 separates early afternoon from late afternoon, at least 30 of the 61 bears killed (49%) were shot in the late afternoon. An additional 9 hunters did not give a specific time and only stated "Afternoon." Only 6 of the 61 bears killed (10%) were shot before noon (Table 5).

Table 5. Time when bears were killed by successful hunters (n = 61).

	1986	1987	Combined
Early Morning	0	2	2 (3)[a]
Late Morning	1	1	2 (3)
Early Afternoon	8	7	15 (25)
Late Afternoon	18	12	30 (49)
"Morning"	2	0	2 (3)
"Afternoon"	6	3	9 (15)
Unknown	1	0	1 (2)
Total	36	25	61(100)

[a]Percent in ().

Hunters were also asked to state the distance from an open road (in yards or miles) their bear was killed. Converted to metric, 24 of 61 successful hunters (39%) stated that they killed their bear within 100 m of an open road, and 52% reported they killed their bear within 300 m of an open road. Six hunters stated that they killed their bear within 10 m of an open road. Two hunters stated that their bears were shot immediately on an open road. Only 8 bears (13%) were killed more than 1 km from an open road. When asked if they first observed the bear they shot from an open road, 40 (66%) of the 61 successful hunters stated that they had (Table 6).

Hunters were also asked to state the type of habitat that best described where their bear was killed (Table 7). Eight different

Table 6. Distance from an open road bears were killed (n = 61).

	1986	1987	Combined
0-100 m	16(44)[a]	8(32)	24(39)
100-300 m	3 (8)	5(20)	8(13)
300-500 m	7(19)	6(24)	13(21)
500 m-1 km	4(11)	1 (4)	5 (8)
>1 km	3 (8)	5(20)	8(13)
Unknown	3 (8)	0	3 (5)
Total	36(98)	25(100)	61(99)

[a]Percent in (); may not equal 100 due to rounding error.

Table 7. Habitat that best described where bears were killed in HD 100 (n = 61).

Type of Habitat	1986	1987	TOTAL
Grassy opening on slope	5	1	6
Avalanche chute	1	0	1
Cutting unit (clearcut)	7	5	12
Cutting unit (select cut)	1	2	3
Near road	4	7	11
Open timber	1	1	2
Wet meadow	1	1	2
Dry meadow	1	0	1
Other	2	3	5
Didn't respond	1	0	1
Near road & wet meadow	3	0	3
Near road & grassy opening	3	0	3
Near road & clearcut	4	3	7
Near road & open timber	1	0	1
Clearcut & grassy opening	1	0	1
Clearcut & wet meadow	0	2	2
	36	25	61

options were provided. Again, more than 1 option was sometimes marked. Clearcuts and/or roads were stated as the habitat where at least 43 of the 61 bears (70%) were killed.

A space was available on the questionnaire for hunters to express whatever comments they desired. These comments were summarized and the people offering similar comments were tabulated (Table 8).

Table 8. Summary of comments by hunters from 125 questionnaires returned. (The number of similar comments is in parenthesis.)

- Would like information on the bear they killed (2)
- Would like information on study (4)
- Liked the area's roads (1)
- Enjoyed the hunt (2)
- Too many non-resident hunters (11)
- Covered 1,500 miles and only saw 3 bears (1)
- Would like more road closures (3)
- Would like the spring season either shortened or discontinued (4)
- Would like a longer spring season (3)
- Party member saw grizzlies or sign (3)
- Believed more bears in HD 100 than in Flathead (1)
- Saw fewer bears and/or sign than in past (5)
- Maps of road closures and area should be better available (2)
- Saw localized bear sign (2)
- Saw considerable bear sign (3)
- Should keep bicycles off closed roads (1)
- The bear they shot had been wounded previously (2)
- Knew of several hunters who wounded and lost bears (1)
- Had a problem with area guides (2)
- Observed road closure violations (1)
- Missed bear because of loose scope (1)

DISCUSSION

The survey I conducted of black bear hunters appears original in nature. With the exception of the phone surveys conducted by MDFWP, in which hunters are asked if they killed a bear and the number of days hunted, I could find no similar study reported.

The specific reason for the high proportion of Utah hunters in HD 100 is not clear. Several local residents claimed it was due to the publicity the area received in popular hunting magazines. Others said it could be traced to a single individual who lived in the Libby area, moved to Utah, and then returned in the spring with friends to hunt. Whatever the reason, hunters from Utah comprised a significant portion of the spring black bear hunters.

Questionnaires were distributed to as many of the black bear hunters in HD 100 as possible, with a clear understanding that there would be a duplication of some data because hunters tended to hunt in groups. This should be kept in mind when considering data such as the total numbers of bears observed, total number of legal bears passed by hunters, and total numbers of females and cubs observed. However, the duplication of sightings should not have influenced the proportion of brown vs. black bears observed, the proportion of females with cubs observed, and mean litter sizes. The average number of bears observed by successful hunters was biased in that a special effort was made to contact many of these hunters, knowing that they

had seen at least 1 bear (the bear they shot).

The interpretation of some of the results require an interpretation of human nature, specifically that of hunters. The fact that 42 of the hunters sampled declined shots at 81 legal bears can probably be viewed as a maximum. That only 2 bears were wounded is undoubtedly a minimum. The number of bears killed in the spring of 1987 that had been wounded previously (5 of 29), indicates that many bears are being shot at.

Roads were obviously an important part of the hunting experience for many of the hunters, with driving roads the most common hunting technique employed. The reason this method is so successful is probably related to the fact that most roadsides are seeded to grass and clover to prevent soil erosion. These plants are also important spring foods for bears in northwestern Montana (Kasworm and Manley 1988). Jonkel and Cowan (1971) showed that by planting clover along roadsides on their study area, use of those areas by bears drastically increased during the spring months. Concurrently, there was a major increase in the number of marked bears killed by hunters. Hunters have learned that roads not only provide better access for hunting, but may also be preferred spring habitat for bears. Although most bears were killed near open roads, many (if not most) of the remaining bears were killed on and near closed roads.

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GRIZZLY BEAR AUGMENTATION IN THE CABINET MOUNTAINS OF NORTHWEST MONTANA

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Abstract: The Cabinet Mountains grizzly bear study was conducted during 1983-1988 to obtain ecological information. The study concluded that the future of the population was in serious doubt. Factors leading to that conclusion included: the capture of only 3 grizzly bears despite an extensive trap effort, the advanced age of the individuals captured, few additional grizzly bear sightings, only one observation of a female with young, and the high mortality rates of marked bears. The study recommended population augmentation with subadult females having no history of conflicts with humans. The first of four projected transplants was completed in July of 1990. The transplanted grizzly bear was a 4 year-old female that weighed 71 kg. She remained in the Cabinet Mountains following release and denned during late October. Her movements from July through October encompassed 191 km^2. Data regarding movements and habitat use were analyzed and compared with native grizzly bears in the Cabinet Mountains.

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INTRODUCTION

In 1975 the grizzly bear (*Ursus arctos horribilis*) was listed as a "threatened species" in the 48 adjacent states under the provisions of the

U.S.Endangered Species Act. Six ecosystems were identified as having evidence of grizzly bear populations (USFWS 1981). The Cabinet-Yaak Ecosystem (CYE) was one of these 6 ecosystems.

Grizzly bear ecological research was conducted in the Cabinet Mountains from 1983 to 1988 (Kasworm and Manley 1988). The study concluded that the continued existence of the grizzly bear population in the Cabinet Mountains was in serious doubt and that the probability of the loss of this population in the next few decades was high. This conclusion was based on: the capture of only 3 grizzly bears despite an extensive trap effort, the advanced age of the individuals captured, few additional grizzly bear sightings, only one observation of a female with young, and the high mortality rates of marked bears.

Two approaches to this problem were proposed (Servheen et al. 1987). The first involved transplanting adults or subadults from other areas of similar habitat to the Cabinet Mountains. Transplants would involve bears from remote areas that would have no history of conflict with humans. Use of subadult females was recommended because of their smaller home ranges and potential reproductive contribution. The second approach relied on cross-fostering captive born grizzly bear cubs to wild black bear females. Under this approach, grizzly bear cubs from zoos would be placed in the maternal dens of black bear females in the Cabinet Mountains during March or April. The fostering of orphaned black bear cubs to surrogate black bear females has proved successful (Clarke et al. 1980, Alt and Beecham 1984, Alt 1984).

During public review, many concerns were expressed, among those: human safety, conflicts with other land-uses, and long-term population goals. As a result of public review and comment, the augmentation proposal was modified to eliminate cross-fostering and reduce total numbers of transplanted bears to 4 individuals over 5 years. The beginning date of augmentation was postponed for one year to allow additional public information and education programs regarding the proposal.

OBJECTIVE

Test grizzly bear augmentation techniques in the Cabinet Mountains to determine if transplanted bears will remain in the area of release and ultimately contribute to the population through reproduction.

STUDY AREA

The Cabinet Mountains (48° N, 116° W) constitute the southern portion of the CYE. Approximately 90% of the study area was on public land administered by the Kootenai, Lolo, and Panhandle National Forests. Plum Creek Timber Company Inc. and Champion International are the main corporations holding significant amounts of land in the area. Individual ownership exists primarily along the major rivers and valley bottoms, and there are numerous patented mining claims along the Cabinet Mountains Wilderness boundary. Libby, Troy, Thompson Falls, Noxon, and Trout Creek are the primary communities adjacent to the Cabinet Mountains. The Cabinet Mountains Wilderness encompassed 381 km^2 of our study area at higher elevations of the East Cabinet Mountains.

The CYE encompasses 5360 km^2 and is located in northwest Montana and northern Idaho. The Cabinet Mountains portion of the ecosystem is 3960 km^2 in size and lies south of the Kootenai River, while the Yaak area borders Canadian grizzly populations to the north. Two 12 km wide corridors link the Yaak with the Cabinet Mountains.

Elevations in the Cabinet Mountains ranged from 610 m along the Kootenai River to 2,664 m at Snowshoe Peak. The study area had a Pacific maritime climate characterized by short, warm summers and heavy, wet winter snowfalls. The lower, drier elevations supported stands of ponderosa pine (*Pinus ponderosa*) and Douglas-fir (*Pseudotsuga menziesii*), whereas grand fir (*Abies grandis*), western red cedar (*Thuja plicata*), and western hemlock (*Tsuga heterophylla*) dominated the lower elevation moist sites. Mixed stands of subalpine fir (*Abies lasiocarpa*), spruce (*Picea engelmannii*), and mountain hemlock (*Tsuga mertensiana*) were predominant between 1,500 m and timberline. Mixed stands of coniferous and deciduous trees were interspersed with riparian shrubfields and wet meadows along the major rivers. Huckleberry (*Vaccinium spp.*) and mixed shrubfields were largely a result of the wildfires that occurred between 1910 and 1929. Effective fire suppression since then has virtually eliminated wildfire as a natural force in creating and maintaining berry-producing shrubfields.

Contemporary resource use by humans in our study area includes mineral exploration and extraction, timber harvest, and recreation. ASARCO operates the Troy mine complex 20 km south of Troy. This facility began operation in 1979. Silver and copper are the primary minerals extracted. Mineral exploration activity centers in the southwestern portion of the Cabinet Wilderness Area. Noranda Minerals began construction of a similar facility in Libby Creek during 1990 and ASARCO has proposed another mine near Noxon.

Timber harvest is the principle land management activity over much of the CYE. Total 1989 timber volume harvested on the Kootenai National Forest was 224.5 million board feet.

Various forms of recreational use occurs in the Cabinet Mountains. Summer recreation consists primarily of day hikes and overnight backpack trips. Recreational huckleberry picking and more recently commercial berry harvest occurs during the fall and primarily outside the Wilderness. The West Cabinets (Scotchman Peaks) and areas adjoining the Cabinet Wilderness are under consideration as additions to the wilderness system. Big game hunting and fishing provide seasonal recreation and are part of the local economy. The Cabinet Mountains have been closed to grizzly bear hunting since 1974.

Trapping for this study was conducted in the upper North Fork of the Flathead River drainage in British Columbia, approximately 10-30 km north of the U.S. border. Major tributaries trapped included Sage Creek, Cabin Creek, Commerce Creek, Haig Brook, Burnham Creek, and Howell Creek. Subalpine fir was the indicated climax species throughout most of the area, with lodgepole pine (*Pinus contorta*) the most prevalent. Recent wildfires in the upper elevations have had more of an influence on habitat than in the CYE. An outbreak of pine bark beetles (*Dendroctonus ponderosae*) resulted in the logging of large areas at lower elevations during the 1980's. Large portions of the upper elevations had been logged earlier in response to a spruce bark beetle (*Dendroctonus obesus*) epidemic. Although roads were relatively common in the area trapped, very little public use was observed. Grizzly bears are considered an important game animal in this portion of British Columbia and are hunted under a system of limited entry.

METHODS

Bears were trapped with foot snares (Aldrich Snare Company, Clallam Bay, Washington) in cubbies or trail sets baited with road-killed deer and miscellaneous meat scraps (Johnson and Pelton 1980). Scraps of bait were dragged along roads and trails to produce scent trails to attract bears to cubbies. Snares were boiled for several hours with bark, needles, leaves and paraffin. From that point, snares were handled only with gloves. Signs were posted to warn humans of the sets. Snares were checked daily by vehicle and/or foot.

Captured grizzly bears were immobilized with tiletamine hydrochloride and zolazepam hydrochloride (Telazol), administered at a dose of 8 mg per kg of body weight. Captured black bears were immobilized with a mixture of ketamine hydrochloride (Ketaset or Vetalar) and xylazine hydrochloride (Rompun), administered at 4.4 mg per kg of ketamine and 2.2 mg per kg of xylazine. Drugs were delivered with either a Palmer Cap-Chur gun or jab stick.

Rubberized button ear tags were used to mark captured bears. One numbered tag was placed in each ear. Although each ear may have held a different number, the tags were usually sequential. Colored armortite streamers, 3.75 cm in width and 15 cm in length, were attached to the ear tags of grizzly bears transplanted to the CYE. Physical measurements and estimates of body condition were recorded at each capture. The first premolar was extracted and used to determine the age of the individual by counting cementum annuli (Stoneberg and Jonkel 1966).

Only unmarked female grizzly bears $<$ 6 years and $>$ 68 kg were deemed suitable for transplanting to the CYE. All other captured grizzly bears were released on-site. Females $>$ 5 years old were fitted with radio collars (Telonics, Mesa, Arizona) prior to release, in agreement with the British Columbia Fish and Wildlife Branch, to aid an ongoing grizzly bear study. All radio collars were attached with a cotton splice to allow collar separation in 2-3 years (Hellgren et al. 1988). Male grizzly bears were ear tagged but not collared.

Transplanted grizzly bears were fitted with radio collars at the capture site. Monitoring was conducted from the air and ground beginning immediately after release. Locations were plotted on 1:24,000 USGS topographic maps by Universal Transverse Mercator (UTM) coordinates. Minimum convex polygons (Hayne 1959) were calculated using a computer program (McPAAL; Smithsonian Institution). Radio locations were also classified by grizzly bear habitat component (Madel 1982), U.S. Forest Service management area (USFS 1987), and elevation. Distance measurements from roads and trails to radio locations were used to examine their relationships to bear distribution (Kasworm and Manley 1990). Closed roads were considered to be trails for analysis. If open roads were closer to locations than the nearest trail, the distance to the road was entered as the measurement for the nearest trail as well. Statistical analyses were performed through use of the computer packages MSUSTAT (Lund 1983) and SPSS/PC+ (SPSS Inc. 1988).

RESULTS AND DISCUSSION

Trapping and Transport

Trapping for candidate grizzly bears in British Columbia began on 6 July 1990. Two trap teams operated for 25 days ending on 31 July. Five captures of 5 individual grizzly bears and 27 captures of 23 individual black bears occurred during 240 trap nights. Four of the 5 captured grizzly bears were released at the capture site. These were 2 adult females, 1 yearling female, and 1 subadult male. The adult females were previously captured bears and were given new radio collars. The yearling female was judged too small to be a good candidate for transplanting. All 23 black bears were ear tagged and released.

At 1000 hours on 21 July 1990 a 4 year-old female grizzly bear was located in a snare in Haig Brook. The animal weighed 71 kg and was in good body condition (Table 1). At time of capture the animal was believed to be 2 years-old based on tooth wear and weight; however, a count of cementum annuli in the extracted premolar indicated an age of 4 years-old. She was ear tagged 218 and fitted with a motion-sensitive radio collar. The collar was equipped with a partially cut cotton splice, designed to rot within the next 2 years to avoid constricting the neck of the bear. Continued monitoring of this animal will necessitate replacing the collar. Bear 218 was held in a truck-mounted aluminum culvert trap until evening for transport, in anticipation of cooler temperatures. Transport to Libby, Montana began at 2100 hours and required approximately 5 hours, including the necessary permit validations at the international border (e.g. CITES import-export, B.C. export, Montana Veterinary Health, etc.). Transport from Libby to the release site began at 600 hours on 22 July and release occurred at about 900 hours. Bear 218 was released in Lost Girl Creek of the Bull River Drainage. The release site was on a closed road and about 1 km west of the Cabinet Mountains Wilderness boundary. Total time from discovery of the animal in the trap in British Columbia to release in the Cabinet Mountains was less than 24 hours.

Table 1. Physical measurements from grizzly bear 218 at capture in the North Fork of the Flathead River Drainage.

Bear Number	218
Date	7/21/90
Age	4.5
Sex	Female
Weight (kg)	71
Total Length (cm)	147
Neck Girth (cm)	50
Chest Girth (cm)	78
Reproductive State	anestrous
Fat Index[1]	2

[1]Fat Index - Arbitrary measure of the animal's condition on a scale of 1 to 5, with 1 = emaciated, 3 = average, and 5 = very fat.

Monitoring

Daily radio location flights were made (weather permitting) for 4 weeks. Aerial radio location frequency was then reduced to 3 flights per week until denning. Fifty-five aerial radio locations were obtained on bear 218 between release on 22 July and denning on 29 October, 1990.

Movements of bear 218 during 1990 in the Cabinet Mountains encompassed 191 km^2. Locations were coded by week and plotted to show movements of the bear (Fig. 1). Bear 218 remained within a 3 km radius of the release site during the first week. During the second week she crossed to the east side of the Cabinet Mountains and began moving north. Daily movements occurred in one or two drainage increments. By the end of week 2 she was about 23 km north of the release site on Treasure Mountain.

At the beginning of week 3 she made a rapid movement north. At 830 hours on 5 August, she was located 3 km south of the Kootenai River and 5 km west of the town of Libby. Project personnel went to the area in an attempt to divert or haze the bear to another area. Upon arrival at 1200 hours, the radio signal could not be received anywhere in the Cedar Creek area. A second radio location flight was made at 1730 hours. Bear 218 was again located on Treasure Mountain, within 200 meters of the location obtained on 4 August. This movement of at least 22 km occurred over 31 hours and indicated the bear 218 was learning about habitat in the Cabinet Mountains by being able to return to places where she had been previously. Reasons for this rapid movement back to Treasure Mountain from Cedar Creek may have been related to high levels of human activity in the Cedar Creek area. Highway 2 between Libby and Troy was under major construction, which included blasting and heavy equipment. Upper Cedar Creek had numerous weekend recreationists conducting firewood cutting and berry picking, and lower Cedar Creek has several homesites. By the end of week 3 she had moved south to Bear Creek to within 8 km of the release site.

During week 4 (2nd week of August) bear 218 moved as far south as the head of Libby Creek, but returned to the East Fork of the Bull River and appeared to spend more time in specific drainages feeding on berries than in previous weeks. Weeks 5 and 6 (last 2 weeks of August) continued the trend of less movement and apparently more deliberate attempts to consume berries. Bear 218 spent almost the entire month of September in the upper Middle Fork of the Bull River. Numerous black bears were observed in the area during radio location flights indicating that huckleberries were abundant in the drainage. During October she remained in the upper elevations of the Cabinet Mountains Wilderness before denning in Big Cherry Creek about 10 km from the release site.

Distance between successive locations was analyzed to quantify movements following release. During the first four weeks following release, daily aerial radio locations were attempted. Mean daily movements were calculated by weekly interval (Table 2). Mean daily movements were lowest during week 1 (1,176 +- 180 m [$\bar{x}$ +- SE]) and highest during week 3 (5,810 +- 3,434 m), though none of the 4 weekly means were different (F = 2.47; 3,23 df; P = 0.087).

Bear 218 appeared to develop a geographical memory of specific sites. The vicinity of the release site was revisited during weeks 4 and 6 and several other small drainages or basins were used repeatedly during the 14 weeks she was active before denning.

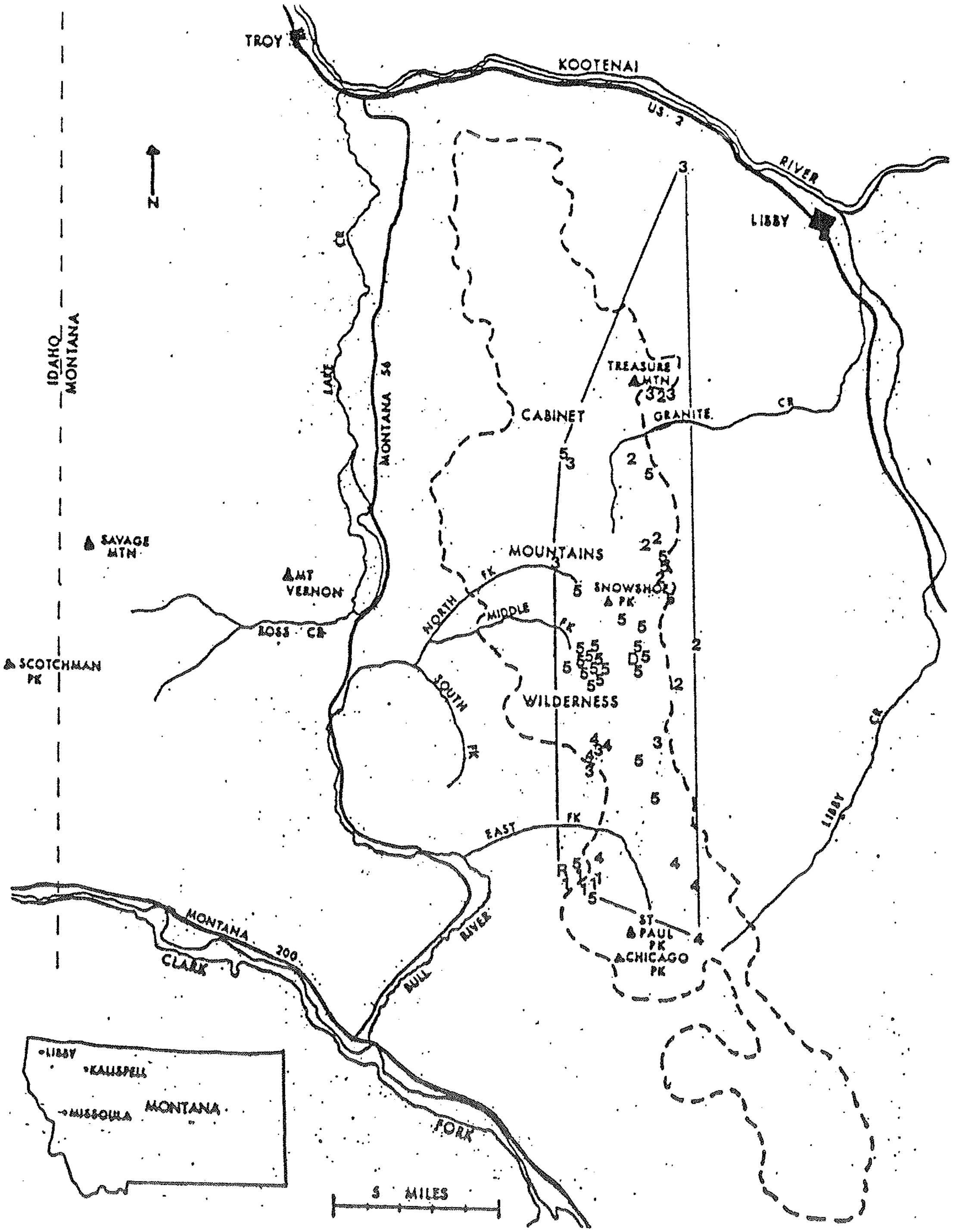


Fig. 1. Home range of grizzly bear 218 in the Cabinet Mountains, 1990 (R - release site, D - den site, 1-4 indicate radio locations during the corresponding week after release, 5 indicates radio locations during week 5 and subsequent locations).

Table 2. Mean distance between successive aerial radio locations of bear 218 in the Cabinet Mountains, 1990.

Period	*n*	*x* (m)	SE	Range
22 Jul - 28 Jul	5	1,176	182	600-1,530
29 Jul - 4 Aug	7	3,647	1,069	500-9,460
5 Aug - 11 Aug	8	5,810	1,452	420-10,600
12 Aug - 18 Aug	7	3,629	987	640-7,910
19 Aug - 29 Oct	27	3,607	742	0-13,220
TOTAL	54	3,720	481	1-13,220

Habitat Characteristics

Habitat information from 53 specific aerial radio locations of bear 218 were analyzed and compared with 99 aerial locations from native grizzly bears in the Cabinet Mountains during autumn of 1983-1988 (Kasworm and Manley 1988).

Monthly mean elevation of radio locations from bear 218 varied from a low of 1710 +- 49 m during July to a high of 1912 +- 88 m during October (Fig. 2). Elevation of radio locations from bear 218 ranged from a minimum of 1061 m to a maximum of 2134 m. Mean elevation of radio locations from bear 218 (1808 +- 25 m) was greater than mean elevation of native grizzly bears (1641 +- 20 m) during the same time period ($t = 5.04$, $df = 150$, $P < 0.001$). This difference may be related to annual variation in food production and habitat use.

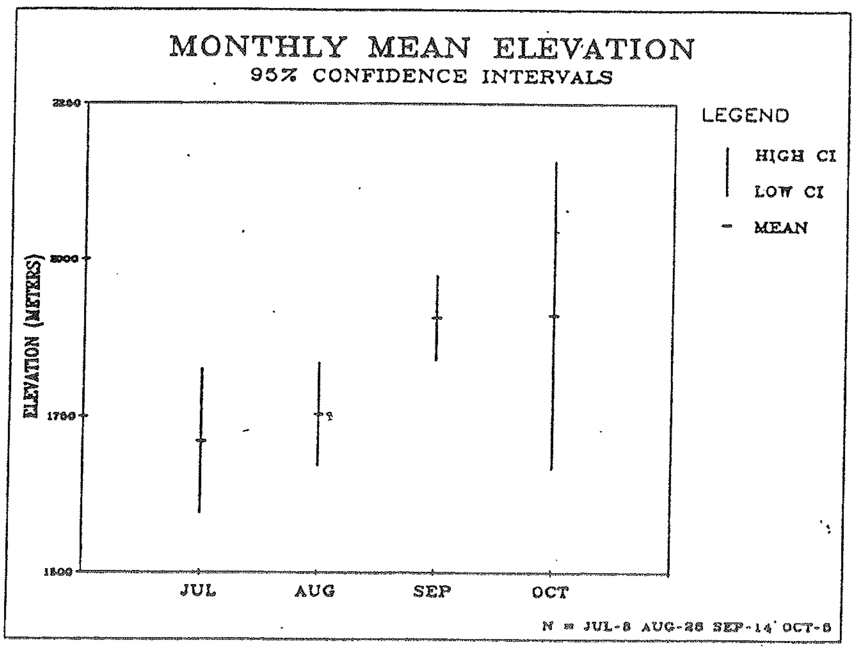
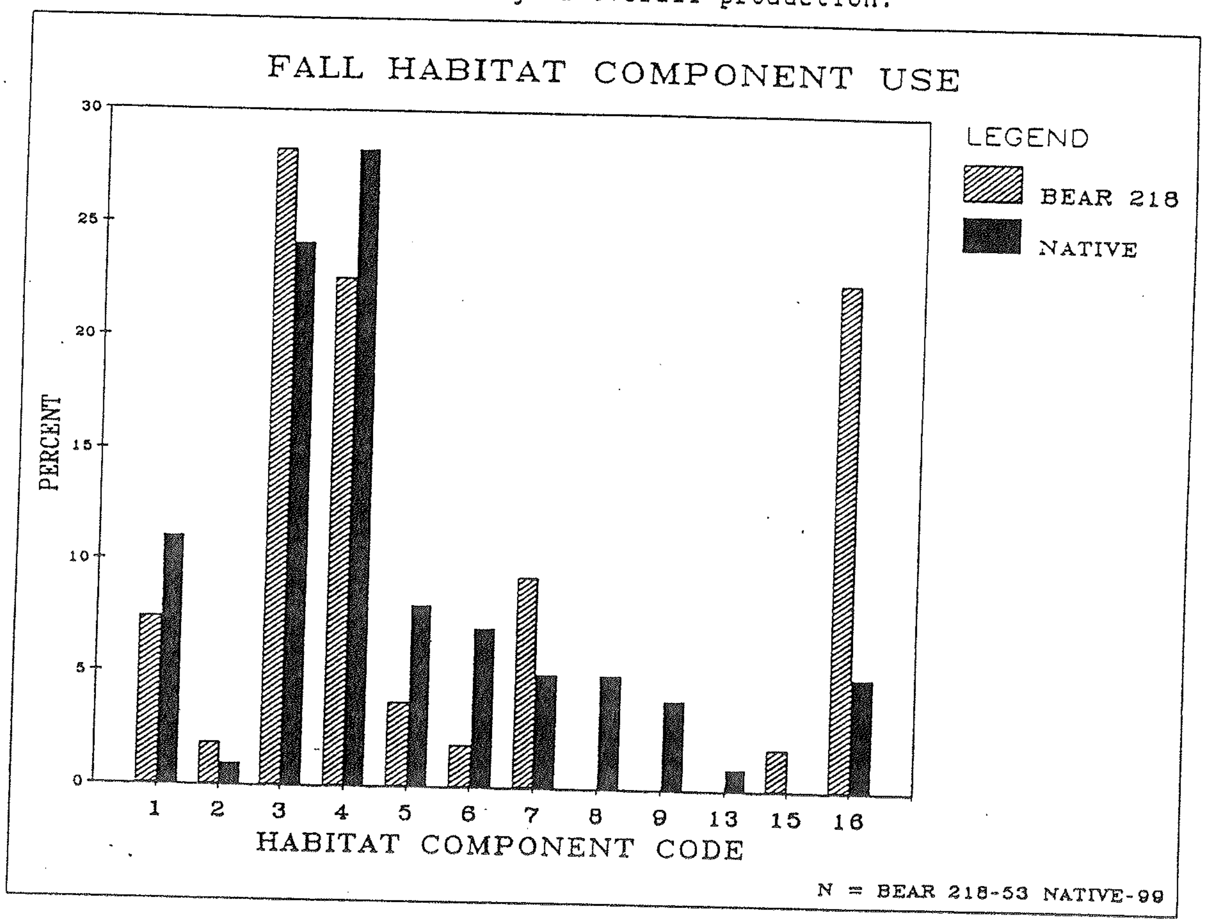


Fig. 2. Monthly mean elevation of grizzly bear 218 radio locations in the Cabinet Mountains, 1990.

Grizzly bear radio locations were classified by habitat component (Madel 1982). Habitat components are vegetation types based on existing vegetation structure and composition. Seventy-three percent of bear 218's radio locations occurred in the timbered shrubfield, mixed shrub snowchute, and beargrass park habitat components (Fig. 3). Fifty-eight percent of locations from native grizzly bears occurred in the same components. The distribution of bear 218's locations across all habitat components appeared similar to native grizzly bear locations with the exception of greater use of beargrass sidehill parks. Greater use of this component by bear 218 may have been related to the distribution of huckleberries during 1990. Production of huckleberries in beargrass sidehill park components may be more variable than other components because these sites lack timber cover which may protect plants from frost damage and provide shading to plants during dry conditions. Good production on these sites may be indicative of good overall production.



1 - Closed Timber
2 - Open Timber
3 - Timbered Shrubfield
4 - Shrubfield Snowchute
5 - Shrubfield Cutting Units
6 - Shrubfield Burn
7 - Alder Shrubfield
8 - Huckleberry Shrubfield
9 - Riparian
13 - Drainage Forbfield
15 - Graminoid Sidehill Park
16 - Beargrass Sidehill Park

Fig. 3. Fall habitat component use by grizzly bear 218 during 1990 and native grizzly bears in the Cabinet Mountains, 1983-1988.

Relations to Human Activity

All radio locations obtained from bear 218 were on U. S. Forest Service administered lands (Kootenai National Forest). Classification of radio locations by USFS management area indicated that 90% of use by bear 218 occurred on wilderness, proposed wilderness, or non-motorized recreational lands.

Aerial radio locations of bear 218 were analyzed to determine their relationship to open roads and trails (including closed roads). Monthly mean distance from radio locations to the nearest open road varied from 1882 +- 194 m during July to 3938 +- 525 m during October (Fig. 4). Distance to the nearest open road ranged from a minimum of 61 m to a maximum of 6066 m. Mean distance of radio locations from bear 218 to the nearest open road (2973 +- 194 m) was not different from mean distance of radio locations from native grizzly bears (3139 +- 171 m) during the fall (t = 0.61, df = 150, P = 0.545).

Monthly mean distance from radio locations to the nearest trail varied from 476 +- 143 m during July to 2176 +- 233 m during October (Fig. 5). Distance from locations to the nearest trail ranged from a minimum of 0 m to a maximum of 2743 m. Mean distance of radio locations from bear 218 to the nearest trail (1341 +- 115 m) was different from the mean distance of radio locations of native grizzly bears (872 +- 81 m) during fall (t = 3.36, df = 150, P = 0.001). This difference appears largely explained by bear 218's use of higher elevations which have fewer trails.

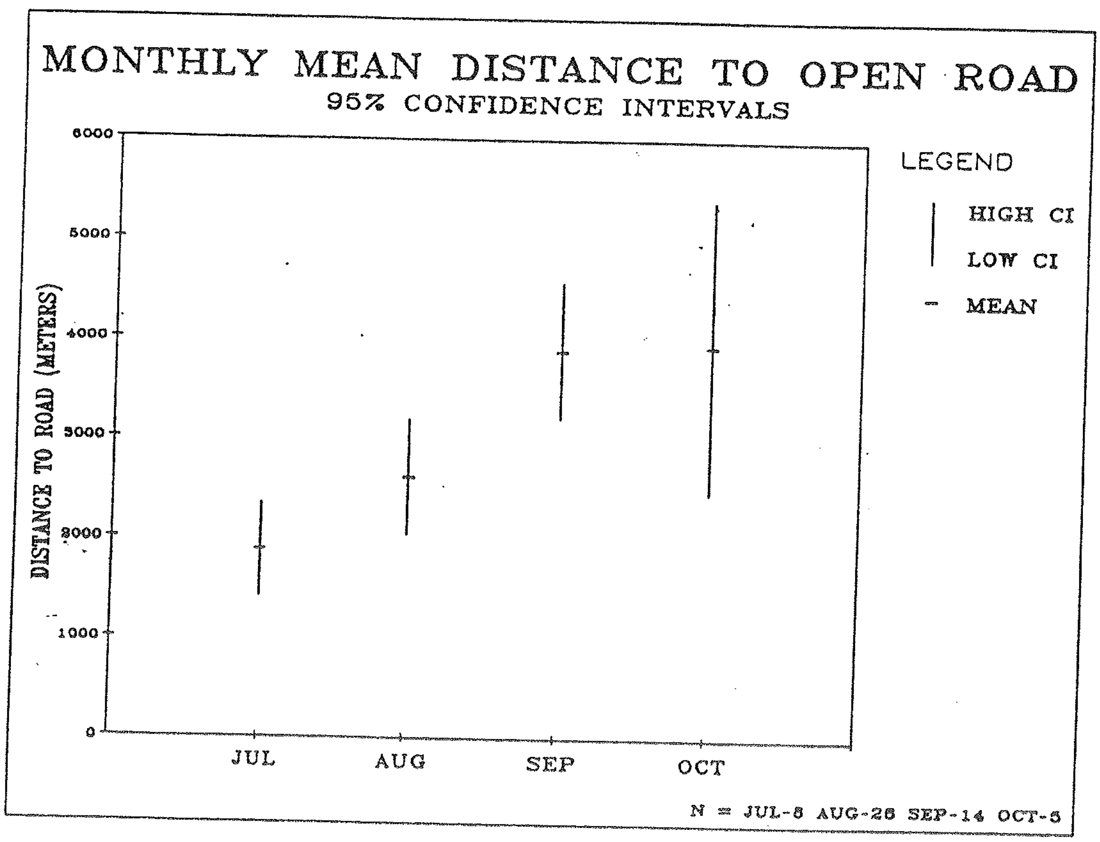


Fig. 4. Monthly mean distance from grizzly bear 218 radio locations to the nearest open road in the Cabinet Mountains, 1990.

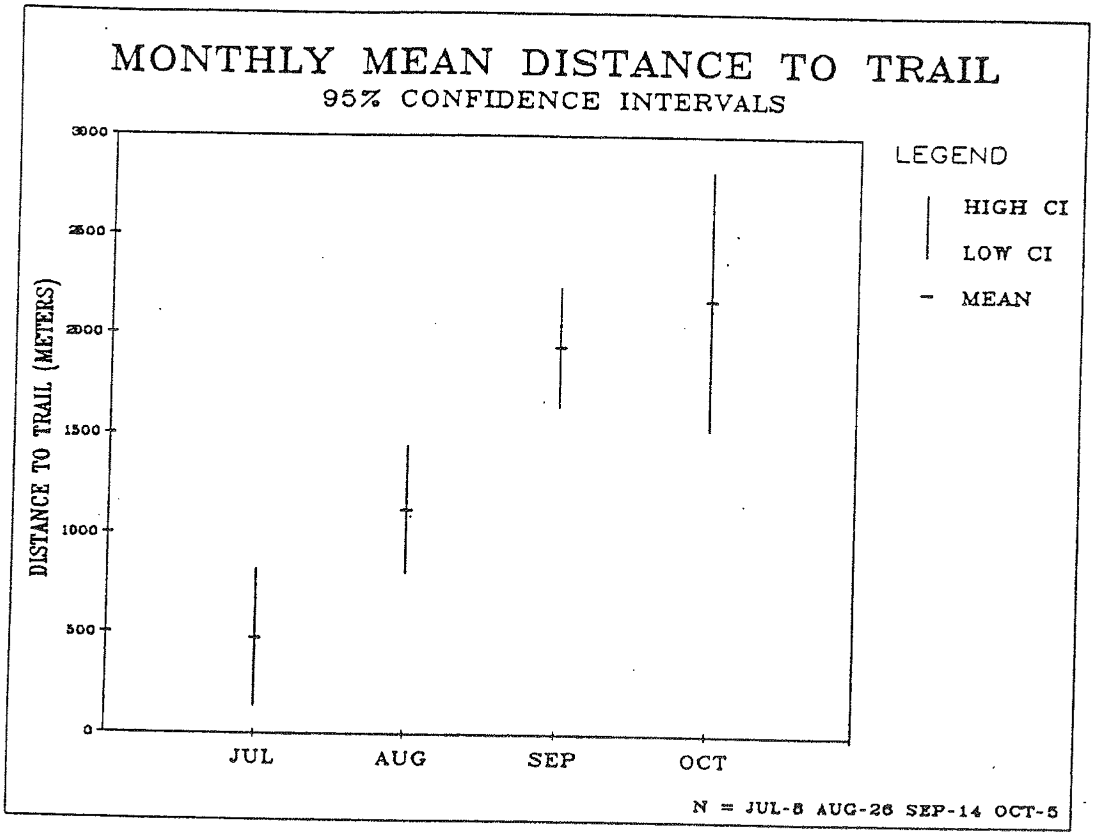


Fig. 5. Monthly mean distance from grizzly bear 218 radio locations to the nearest trail in the Cabinet Mountains, 1990.

MANAGEMENT IMPLICATIONS

Conclusions regarding the success of bear 218 as a transplant would be premature at this point. However, she has remained within the Cabinet Mountains from 22 July until denning and has had little, if any, reported contact with people. She has yet to locate suitable food and habitat during spring, a normally stressful time for bears because of snow cover. Continued monitoring will help to evaluate her success.

Helicopter transport of the bear to a wilderness release site was discussed in the Environmental Assessment (USFWS 1987); however, ground transport and release was used in this transplant. Reasons for this action include: limited helicopter availability during forest fire season, difficulty in coordination because of little advance warning for the need of a helicopter, and an administrative appeal of the decision to allow the use of a helicopter in the wilderness. Because of these factors and the success of the ground release of bear 218, continued ground release of transplanted bears is recommended.

Bear 218 was 4 years-old when transplanted and could possibly have been bred before capture. However, weight and body condition of the animal at capture would indicate that cub production during 1991 would be unlikely. If cubs were not produced, bear 218 could be expected to go into estrous during May or June and attract a male consort. Intensive monitoring during this time will provide additional information.

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INCREASING MOUNTAIN LION POPULATIONS AND HUMAN-LION INTERACTIONS IN MONTANA

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During 1989 and 1990 an increased number of human-lion conflicts occurred. These encounters included one serious mauling of a 9 year old boy and the fatality of another male child. The hypothesis that increased lion populations were a factor in recent interactions with humans was tested. Information was compiled from 52 case reports of lion-human conflicts in 1989 and 1990. Nineteen (36.5 %) of the conflicts involved livestock attacks. Other conflicts included nuisance situations (15.4 %), pet attacks (11.5%) predatory/aggressive behavior towards humans (32.7 %), and human attacks (3.9 %). Age and sex determinations were made in 29 of the reported cases and 16 lion carcasses were examined to determine the relative health of offending lions. The mountain lions examined were characterized as healthy but young lions. Sex ratios were even (45%F/50%M) for human involved confrontations while the ratios were skewed toward males (20%F/80%M) for encounters involving livestock. Potential population indicators such as harvest trend, trend of animal damage complaints, and nonhunting mortality were examined. Harvest trend was strongly correlated with license sales (Correl. Coef. = 90.7, R-squared = 82.43). All indicators exhibited upward trends for the period 1971-1990. The relationship of these trends to supposed increasing populations are discussed. The hypothesis that increasing lion populations were a significant factor in the recent lion encounters was generally supported. However, critical population survey data are not available for analysis. Other causes for increased conflict including human encroachment into lion habitat are discussed.

MOOSE-HABITAT RELATIONSHIPS IN NORHTWESTERN MONTANA AND SOUTHEASTERN BRITISH COLUMBIA

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The North Fork of the Flathead River northwestern Montana and southeastern British Columbia is unique due to the presence of numerous predator and prey species. Moose (Alces alces) are the largest prey item and have been taken by wolves (Canis lupus), grizzly bear (Ursus arctos) and hunters. During winter 1989-90 and 1990-91, 35 cow moose were radio-collared to study cause-specific mortality, habitat selection, and calving site selection. Two mortalities occurred during the first year of the study, both in July, 1990, both from grizzly bear. Thirteen animals exhibited 'migratory' behavior between lowland winter range and higher elevation spring and summer range, with movements ranging from 10-50 km. Seven animals moved little throughout the year. Use of clearcut areas was observed in all seasons and at various elevations, with use decreasing in late winter. Age and sex composition of the population was determined by flying 5 survey flights during early winter in 1990-91. A calf:cow ratio of 50:100 was found with a bull:cow ratio of 80:100. Calving sites were located and intensively sampled for habitat features as were random sites within the spring-summer home range of each moose. Field work will continue though the summer of 1991.

SOME POPULATION CHARACTERISTICS OF THE YELLOWSTONE BISON HERD DURING THE WINTER OF 1988-89

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Abstract

A total of 569 bison were killed in the 1988-89 removal. Of these 516 were adults and subadults and 53 were calves of the year. Sex ratios were 57% male and 43% female. Age structure of the harvested animals were analyzed by three methods. Seventy-four percent of the females tested were pregnant. Fetal measurements indicate a prolonged calving season, with most (76%) completed by early June. Eighty-five percent of the bison were tested for brucellosis, 54% tested positive to the presence of brucella antibody. A higher percentage of males tested positive than females. Physical measurements of adults harvested are included.

Summer habitat use of white-tailed deer on the Tally Lake Ranger District, Flathead National Forest: A preliminary report

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Abstract: Summer habitat use of white-tailed deer (*Odocoileus virginianus*) was studied on the Tally Lake Ranger District of the Flathead National Forest, northwest of Kalispell, Montana. Fires, timber harvesting, and road building have markedly altered the forest, potentially influencing patterns of activity and habitat use by deer. Thirty-eight and 57 radio-collared deer were monitored during the 1989 and 1990 field seasons (1 April - 30 November), respectively. Habitat use will be analyzed with the aid of LANDSAT imagery and the geographic information system (GIS) ERDAS. One more field season remains with a final report to be completed by fall 1992.

White-tailed deer summer use of coniferous forest in northwestern Montana was previously reported by Leach (1982) and Mundinger (1984) in the Swan River Valley, and Krahmer (1989) along the North Fork of the Flathead River. The Salish Mountains which include the Tally Lake Ranger District northwest of Kalispell, also provide important whitetail summer and transitional range (Mundinger and Riley 1982, 1983).

The Tally Lake District has a history of habitat alteration through natural and human causes. Fires during the early part of this century and more recent timber harvesting and associated road building have created a mosaic of mature mixed conifer, large tracts of lodgepole pine (*Pinus contorta*), clearcuts in various stages of regrowth, riparian areas, and natural willow and grass meadows. Such alterations may profoundly influence patterns of activity and habitat use by deer.

This study was initiated in spring 1989 to investigate season-long and diel patterns of activity and habitat use of white-tailed deer on summer and transitional ranges on the Tally Lake District.

Specific objectives include:

1. Determine use and importance of various seral stages of coniferous forest and riparian communities and how spatial distribution of these communities to form habitat complexes influences distribution and abundance of deer.

2. Determine importance of various habitat features such as: slope, aspect, elevation, vegetative structure and species composition of forest stands, and distance to cover, riparian areas, and roads.

Although only two-thirds of the field effort has been completed, this paper describes the study area, approaches to meet the project objectives, and provides some initial results and observations.

I would like to thank the Montana Department of Fish, Wildlife, and Parks (MDFWP); the U.S. Forest Service (USFS); and the Department of Biology at Montana State University (MSU) for financial and logistical support. I also would like to thank Gary Dusek (MDFWP) for his data collection, assistance in the field, and review of this manuscript; Dr. Richard Mackie for guidance in all aspects of the project; and the numerous individuals who have assisted with this project, particularly Leonard Howke.

STUDY AREA

The Tally Lake District has been described previously by Mundinger and Riley (1982), Dusek (1989), and Dusek and Morgan (1990). My study area includes that portion of the district north of Ashley Mountain, east of the Flathead/Lincoln County Line, south of Martin Falls, and west of Tally Lake (Fig. 1).

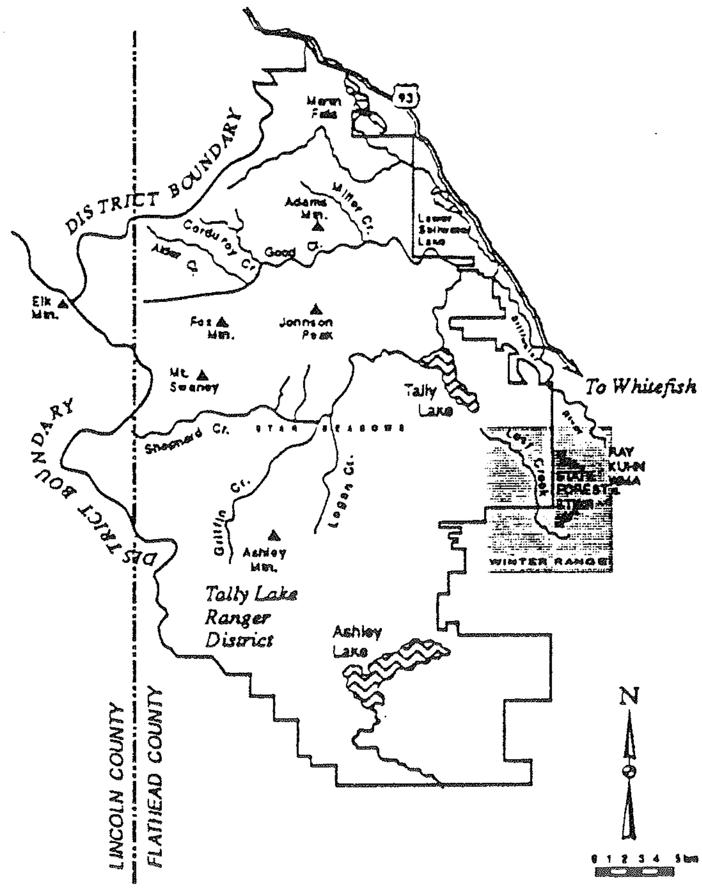

Figure 1. Tally Lake Ranger District of the Flathead National Forest northwest of Kalispell, MT

The study area drains to northeast into the Stillwater River via Good, Logan, and Martin Creeks. Elevation ranges from 1020 m at Tally Lake to 1935 m on Mount Swaney. Although, subalpine fir/queen's cup beadlilly (Abies lasiocarpa/Clintonia uniflora) is the major habitat type throughout the study area (Pfister et al. 1977), fires and logging throughout most of the study area has resulted in a patchwork of various sub-climax vegetation types. Major vegetation species are discussed by Dusek and Morgan (1990).

While deer were distributed throughout much of the study area there were 2 primary areas of concentration. The Star Meadows complex is formed by the confluence of Logan, Griffin, and Sheppard Creeks (Fig. 1). The meadow bottom consists of a mixture of open meadowlands, willows, and scattered timber. The slopes are a mosaic of timber and cutover areas. The second area of deer concentration is the Alder,

Good, Corduroy Creek complex. Contrastingly, this area primarily consists of large stands of 60-70 year old lodgepole pine, a remnant of large fires during the early part of this century. This complex lacks large meadows but a number of small wet meadows are associated with each drainage.

METHODS

Deer were captured using Clover traps (Clover 1954) on both summer and winter ranges with a sample equipped with radio transmitters (Dusek and Morgan 1990). Deer relocations were obtained via fixed-wing aircraft 2-3 times/month, ground triangulation using a hand-held H-antennae (1989 only), bimonthly 24-hr telemetry sessions using 3 truck mounted null antennae arrays, remote camera surveys, and visual sightings. Test transmitters were placed at known locations to check accuracy of relocation procedures (White and Garrot 1990). Date, time, and UTM coordinates were recorded for each relocation and plotted on aerial photographs and/or topographic maps.

Assessment of habitat use will be accomplished through the development of geographic information system (GIS) layers. Using LANDSAT imagery and the GIS program ERDAS (ERDAS Inc, 1987), vegetation will be segregated into 6 types: young clearcuts, natural grass openings, sapling stands, natural willow/shrub stands, mature mixed conifer, and mature lodgepole pine. Other GIS layers will be slope, aspect, elevation, riparian areas, and roads.

Use versus availability of vegetational types will be determined through comparison of individual deer relocations to random points and tested by X^2 goodness-of-fit tests and Bonferroni confidence intervals (Neu et al. 1974). Preference or avoidance of roads, riparian areas, and topographic features again will determined by comparing deer locations to random points and tested for by Wilcoxon rank sum tests. If a preference for riparian areas is shown zones of influence around such areas will be determined using the proportion of relocations falling within several distance bands. Use of habitat complexes will be analyzed by determining the preferred habitat components comprising an activity zone around individual deer relocations.

RESULTS

A maximum of 38 and 57 radio-equipped deer were monitored during the 1989 and 1990 field seasons, respectively. Approximately 20 relocations/deer/field season were obtained primarily from aerial surveys. Twenty-four hour telemetry sessions were conducted monthly at Star meadows and Corduroy Creek during July and August 1989 and June-September 1990, and once respectively at Star Meadows and Corduroy Creek during April and May 1990. Over 20 relocations/session were obtained on 9 deer in 1989 and 14 deer in 1990.

Summer distribution showed clustering of deer in certain parts of the study area with little use elsewhere (Fig. 2). In 1989, 23 of 38 deer monitored moved to the northern portion of the study area. These deer primarily used the Good Creek bottom and south facing slopes as a travel corridor and transitional area, moving to higher elevations as the snow melted. Of these 23, 4 deer summered in each Alder and Corduroy Creeks and 6 summered in the Adams Mountain/Miller Creek area.

The remaining 15 (39%) deer monitored in 1989 summered in the southern portion of the study area primarily in and around Star Meadows. Initially, many deer around Star Meadows restricted their movements to south facing slopes as much of the bottom was flooded during spring. In

June, deer made use of the meadow for foraging and fawning, retreating back to the slopes as the meadow dried out later in the summer.

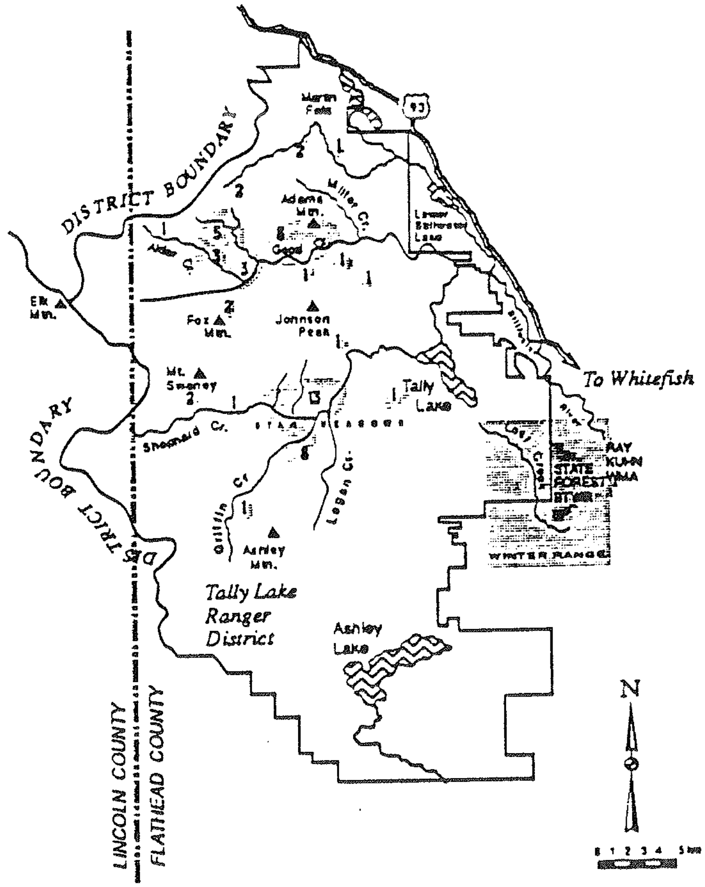

Figure 2. Distribution of 57 white-tailed deer (numbers indicate individual deer) on the Tally Lake Ranger District, summer 1990.

Distribution and movement was similar in 1990 when a larger sample of radio-collared deer was available (Fig. 2). During 1990, 30 of 57 radioed deer used the northern portion of the study area, primarily the Corduroy/Alder/Good Creek complex, while the remaining 27 used the southern portion near Star Meadows.

Elevational use by deer ranged from 1100 m at the confluence of Miller and Good Creeks to 1585 m near the peak of Adams Mountain with some intra-seasonal movement. Little use was made of uplands exceeding 1600 m within the center of the study area, the southeast corner of the study area, the upper portions of Logan Creek, or the lower portions of Logan and Good Creeks. The latter however were used as transitional areas.

Summer home ranges of almost every radio-collared deer included a riparian site such as a creek drainage or wet area. Many drainages only flow intermittently on the surface or flow underground for part of their course. However for the most part they are mesic sites.

A vegetation cover map of the study area is still being developed. Generally, it should be noted that most individual deer relocations occurred in timbered areas, although often along edges of cutover areas. Summer home ranges of individual deer encompassed areas of mixed timber, stands of lodgepole, cutover sites, open meadows, and riparian areas. Such a complex of vegetation communities as influenced by topography and climate may determine seasonal deer distribution and habitat use.

FUTURE WORK

Field work during the final season will follow a similar schedule as preceding years with deer being relocated 2-3 times/month, 24-hr sessions twice a month, and a continuation of summer trapping to boost deer numbers in specific drainages. The major additional task to be accomplished this summer is development of the GIS layer designating vegetation types. Analyzing all deer relocations with respect to the GIS layers will be the primary task of winter and spring 1992 with a final report expected in fall 1992.

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THE FLYING D RANCH AND ITS SIGNIFICANCE TO WILDLIFE MANAGEMENT IN SOUTHWEST MONTANA

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Abstract: The Flying D Ranch contains about 110,000 deeded acres and another 20,000 acres of State and Federal leases. During the last 30 years the Ranch has gone through 3 different types of ranch management direction which influenced wildlife management on the property and vicinity. The period covering the 1960's - 1978 was characterized by: a cattle operation with relatively low tolerance for elk; a winter elk population of 150 - 250; and very little public hunting. The period from 1979 - June 1989 was characterized by: a cattle operation with high tolerance for elk; a winter elk population which grew from 200 in 1979 to 1800 by 1989; severely restrictive bull hunting; a trophy bull management/fee hunting program; and a late season antlerless only elk hunt (implemented by the Department) first established in 1982. The period from June 1989 to present is characterized by: a wildlife operation with bison replacing cattle; a high tolerance for elk; a winter elk population which grew from 1800 to 2500; continued fee hunting for bull elk; an expanded late season antlerless only hunt; and most significantly by a conservation easement which prevents subdivision and acknowledges the need for responsible population control. Because the Ranch was maintaining a very high bull/cow ratio the Department was interested in documenting the extent of bull emigration to public land to the south. The Department radio collared 44 bulls (primarily yearlings) on the ranch in 1986 and 1987. In general, 67% and 55% were on public land south of the Ranch in September and October, respectively. By 1988, 35% of the marked sample had been harvested on public land south of the Ranch.

HOME RANGE USE OF HISTORICAL AND PRESENT ELK POPULATIONS IN SOUTH-CENTRAL MONTANA

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Abstract: We compared home range use and movement patterns of radio-collared elk (Cervus elaphus) in the Picket Pin (PP) and Line Creek (LC) populations of south-central Montana and northwestern Wyoming in 1988-90 to range use and movement in the same populations from 1979-82. Seasonal herd ranges of historical populations varied from 3-172 km^2 while present populations used 14-153 km^2. Shifts in geometric activity centers (GACs) of herd ranges between 1979-82 and 1988-90 were greatest in the Wyoming segment of the LC herd (6.5 km) and least in the Montana segment of the same herd (2.3 km). Percent range size decreased exponentially with increased distance between GACs of corresponding historical and present populations. Seasonal daily movement rates of historical populations were $\leq$ those of present population (X=75 m/day vs. 138 m/day, respectively). Elevational use by all populations was highest in summer (X=2140-2726 m) and lowest in spring (X=1585-2010 m). Distances between individuals from 1988-90 was lowest in spring (X=0.2-3.5 km) and highest in fall (X=4.1-6.4 km), but showed no consistent seasonal pattern in historical populations.

Management of elk (Cervus elaphus) populations requires not only knowledge of movement, range, and demographic characteristics, but also an understanding of behavioral strategies in response to environmental conditions. Elk are ecological and behavioral generalists which adjust rapidly to new situations by learning (Geist 1982:225-226). Migration is an important behavioral mechanism through which elk mediate changes in their physical and social environment. Rickard et al. (1977), McCorquodale et al. (1986), Begon and Mortimer (1981:17), and others have hypothesized that density-dependent factors associated with net increases in population size trigger migration. Migration can reduce intraspecific competition and increase overall fitness of migrants. Migration allows previously unused habitats to be exploited without competition, leading to increased fecundity and survivorship (McCorquodale et al. 1988) and decreased mortality. Density-independent factors also may influence migration. Franklin and Lieb (1979), Singer (1979), and Peek and Eastman (1983) have suggested that such density-independent factors as disease, snow cover, and access to specific preferred vegetation are important proximate determinants of migratory behavior.

Studies of seasonal migrations (Knight 1970, Lovaas 1970, Craighead et al. 1972, Craighead et al. 1973, Adams 1982) have provided important documentation of general movement patterns from low-elevation winter ranges to higher elevation summer ranges. However, while short-term studies of seasonal elk migrations have proliferated, most generally have failed to advance our understanding of specific behavioral mechanisms triggering migrations.

A second type of migration, the gradual shift of seasonal range boundaries over a long-term period, may be of even more significance to distribution, demography, and management of elk. Relatively sudden movements from traditional range to new areas by individuals or herds have been documented (Craighead et al. 1972, Picton and Picton 1975, Rickard et al. 1977). However, few studies (Craighead et al. 1972, Craighead et al. 1973, Shoesmith 1979) have examined detailed movements and migrations of elk populations for >3 consecutive years, and we could find no studies which quantitatively addressed range use by the same population during different time periods. Yet such information is vital to the long-term maintenance of elk populations, as well as in assessing whether land management units identified in past research efforts are still meaningful.

In this study, we examined long-term range use in elk by documenting home range characteristics and movement patterns of 2 populations in south-central Montana at periods approximately 10 years apart. Historical movement patterns were documented in 1979-82, and compared to recent documentation of the same population from 1988-90. Our objective was to compare such characteristics in order to identify specific home range use and movement strategies employed by traditional, sedentary elk populations. We sought to gain a better understanding of how such populations adjust to varying environments and to evaluate the strength of their fidelity to traditional ranges.

This study represents a cooperative effort by the Montana Department of Fish, Wildlife, and Parks (MDFWP) and the U.S. Forest Service (USFS) to document seasonal home range of elk in the Beartooth Mountains of south-central Montana as a basis for development of an integrated timber-wildlife management plan for the Beartooth Ranger District, Custer National Forest. We thank K. Iverson, MDFWP, and B. and J. Ferguson, Yellowstone Air Service, for piloting flights to locate and count elk. S. C. Thomas, Covenant College, assisted with field work during 1988. C. H. Goodall, Ipswich, MA, assisted with field work during 1989. T. N. Lonner, MDFWP, Region 3, Bozeman, assisted with computer processing of home range data. All members of the USFS staff, Beartooth Ranger Dist., Custer Natl. For., provided valuable assistance and support. The AuSable Inst. of Environ. Studies, Mancelona, MI, assisted in selection and support of summer interns. Major funding was provided by USFS, Montana Chapter of the Safari Club International, Phillips Petroleum, Rocky Mountain Elk Fdn., and Amoco Oil Corp. S. T. Stewart and C. Simmons, MDFWP, provided valuable support and advice on study design and data collection, as well as information on previous studies, historical elk range use and historical land use patterns. W. Anderson of the Grove Creek Ranch, Belfry, MT, provided access to elk winter and spring ranges via private land and information on private land use since 1979. The authors are most grateful to C. Eustace, Regional Game Manager, Region 5, MDFWP, Billings, for his continued support and encouragement.

STUDY AREAS

Elk populations in this study summer in the Beartooth Mountains and associated plateaus of south-central Montana (Carbon, Stillwater, and Sweetgrass Counties), and winter in adjoining lower elevation foothills. The Beartooth portion of the district consists of mountainous terrain along the northeastern edge of the Yellowstone ecosystem. Foothills with predominantly N- and E-facing slopes rise from about 2000 m to a series of plateaus further south, with average elevations $\geq$2700 m. The climate is characterized by long, cold winters and short, cool summers. Mean January and July temperatures at Red Lodge, Montana, near the center of the study area, are $-6^{\circ}C$ and $20^{\circ}C$, respectively (Montana Department of Commerce, 1986, unpubl. data).

Vegetation varies with elevation. Forests are dominated, from lowest to highest elevation, by limber pine (Pinus flexilis), lodgepole pine (Pinus contorta), Douglas fir (Pseudotsuga menziesii), Engelmann spruce (Picea engelmannii), subalpine fir (Abies lasiocarpa), and white bark pine (Pinus albicaulis), respectively, with interspersions of trembling aspen (Populus tremuloides). Non-forested habitats are dominated at lower elevations by bunchgrass (Agropyron spicatum-Festuca idahoensis)-forb and bunchgrass-sagebrush (Artemesia spp.) associations. Above timberline, vegetation is characterized by wet and dry alpine environments dominated by sedges (Carex spp.), cottongrass (Eriophorum spp.), alpine bluegrass (Poa alpina), and various alpine forbs, especially cinquefoil (Potentilla gracilis) and yellow avens (Geum rossii).

Elk populations were investigated in 2 areas: 1) the Line Creek Plateau and its associated east-facing drainages, and 2) the E Boulder River drainage, especially between Placer Basin, and Brownlee Creek, and associated elk winter ranges in the W Fork of the Stillwater River and Picket Pin Creek drainages. Populations associated with these study areas will be referred to as the Line Creek (LC), and Picket Pin (PP) herds, respectively. The LC herd consisted of 2 segments, one of which summered in Montana and the other in Wyoming. These will be referred to as the Montana (MT) and Wyoming (WY) segments, respectively.

METHODS

In previous studies (S.T. Stewart, pers. commun., Youmans et al. 1982), 10 cow elk and 1 bull elk in the LC population and 5 cow elk and 1 bull elk in the PP population were radio-collared by darting from a helicopter in 1979 and 1980, respectively. A Cap-Chur gun which fired liquid darts containing Anectine was used on PP elk (Youmans et al. 1982). Darts containing powdered Sucostrin were used on LC elk (S.T. Stewart, pers. commun.). The same method was employed to radio-collar 14 cow elk and 2 bull elk in the LC population and 8 cow elk in the PP population in 1988 and 1989 in an on-going study of elk home range characteristics in south-central Montana (Skubinna and Van Dyke 1990a), except that Carphentenol was used. Home areas of individual elk and elk herds were documented by relocation of radio-collared animals from March 1979 to June 1982 and from January 1988 to May 1990. In all studies locations were determined by visual observation or close triangulation ($\geq$2 azimuths in $\leq$10 minutes at $\leq$200 m) on the ground or by visual observation or close triangulation (signal within a circle of $\leq$200 m radius) from a fixed wing aircraft.

Locations were specified to Universal Transverse Mercator (UTM) coordinates to the nearest 100 m. Locations were analyzed through the TELDAY program at Region 3 headquarters of MDFWP, Bozeman. TELDAY computed home areas (minimum convex polygon method) of individual elk and designated groups during specified seasons, associated geometric activity centers (GACs) in each home area, animal movement rates (distances between successive fixes of individuals/time between fixes), seasonal average elevation of locations, seasonal distances between same herd individuals (association indices), and average distances between GACs in successive years (fidelity indices). After initial analysis it was determined that all bulls except the LC bull captured in 1979 would be excluded from calculations of seasonal home and herd ranges, movement characteristics, elevational use, and association indices. With the exception of the 1979 LC bull, which was usually with or near cow groups, other bulls did not associate with cows and used different areas and elevations.

Seasons were delimited as: winter, 1 December to 29 February; spring, 1 March to 31 May; summer, 1 June to 31 August; and fall, 1 September to 30

November. Because of considerable overlap in winter and spring ranges, winter and spring ranges were combined on range maps and will be referred to as "winter-spring" ranges. In subsequent discussion, elk observed from 1979-82 will be referred to as "historical" populations, and those observed from 1988-90 as "present" populations.

Herd and individual home range sizes, association indices, and elevational use were compared between seasons and populations by one-way ANOVA. Where significant differences occurred, differences between individual pairwise seasonal and population combinations were compared through t-tests (home range and association) or z-tests (elevational use). Fidelity indices were of different populations were compared by t-tests. Actual elevational use in each season was compared to expected seasonal elevation use by t-test comparisons between elevations at elk relocations and 30 randomly selected locations in each seasonal range of each population. $P<0.05$ was considered significant in all cases.

RESULTS

Seasonal Home Range Sizes

Herd range sizes varied by population and season (Table 1). Historical and present PP elk followed the same seasonal pattern of range size use, with the smallest ranges in winter and the largest in summer. The present population had smaller herd ranges than the 1981-82 population in all seasons. Spring showed the greatest decrease (90%) and summer the least (10%). Historical LC populations used the largest areas in summer and the smallest in winter. Present range use patterns by the MT segment of the LC population show the largest areas in spring and the smallest in winter. The WY segment used larger areas in winter than in spring. Increases in range use by the MT population have been greatest in spring (314%) and smallest in summer (23%).

Seasonal home ranges of individual radio-collared elk in both historical and present PP populations were consistently lower than corresponding population home range sizes (Table 2), indicating that no elk, in historical or present populations, used its entire herd range. Sizes of individual home ranges were not independent of season ($P<0.05$, one-way ANOVA). In the current population, seasonal changes in individual home range size followed the same pattern as herd range changes, increasing from winter to summer ($P<0.05$, t-tests). This differed from seasonal patterns of use by elk in 1981-82, which used their largest areas in spring. There were insufficient relocations of individual elk in historical LC populations to permit comparison to present LC individuals.

Range Fidelity

Overall seasonal boundaries and calculated GACs of present populations changed little between years. Distances between successive GACs were ≤ 2 km during winter, spring, and summer. In the fall, distances between successive GACs ranged from 2.9 km in the LC herd to 5.1 km in the PP herd. In historical populations, distances between successive GACs in all seasons were similar to those in present populations, $\geq 2 \leq 5$ km. In the PP herd, distances between calculated GACs of the present and historical populations were greater in summer (6.3 km, Fig. 1) than in winter-spring (5.4 km, Fig. 2). Summer range shift was generally SW into the upper E Boulder River valley. Winter-spring range shift has been S toward the W fork of the Stillwater River. In the MT

population used lower than expected elevations in spring (P<0.01, z-test). Historical populations generally followed the same pattern. Historical elevational use by PP elk was generally higher in all seasons, except in summer when it was lower than present populations (P<0.05, t-tests). Historical elevational use by the MT segment of the LC herd used higher elevations in fall than did present populations (P<0.05, t-test). Historical use by the WY segment was higher in winter and spring than the present WY segment (P<0.05, t-tests).

DISCUSSION

Historical and Seasonal Range Adjustments

Distances between historical and present GACs and shifts in seasonal boundaries of seasonal herd ranges indicated varying degrees of range migration in each population. The MT segment of the LC population has used essentially the same herd range since 1979. Comparisons of GACs between and within time periods indicated high range fidelity. Use was concentrated within well-defined boundaries of the Line Creek Plateau and its associated E- and S-facing slopes. All home ranges of elk from 1979-82 were within present herd range, and most relocations of both present and historical populations were concentrated in similar areas, especially (in summer) around the heads of the Spring, Corral, and Seeley Creek drainages on the Line Creek Plateau. Similar elevational use and high herd cohesiveness also indicated a traditional use of preferred areas typical of stable herds (Franklin and Lieb 1979, Shoesmith 1979). Increased movement rates and increased range size since 1982 may be due to population growth (135% since 1977, Van Dyke and Stewart 1989). As intraspecific competition has increased, exploration of new areas to provide forage, cover and security may have contributed to range expansion in traditional habitats and attempted colonization of nearby, but disjunct, ranges in non-traditional habitats (Skubinna and Van Dyke 1990b).

The PP population has used essentially the same herd range since 1980, but has shifted activity centers to exploit previously unused areas. Winter-spring relocations from 1980-82 suggest that the animals radio-collared in the historical PP herd may actually have represented two populations, 1 concentrated near the junction of Meyers and Lodgepole Creeks and the other between Picket Pin Creek and the W Fork of the Stillwater River. Relocations of elk in the present PP population were all within the area defined by the Picket Pin segment of the historical population. This appears to be the cause of the observed winter-spring GAC shift between historical and present herds. Summer range use has shown an increased tendency to concentrate activity in the upper E Boulder River drainage, a region used less intensively in historical populations (Youmans et al. 1982, C. Simmons, pers. commun.).

Range of the WY segment of the LC population has shifted southward. Historically this herd has had winter associations with the MT segment, possibly because of a lack of suitable winter range in Wyoming. The recent southern migration of the WY segment has functionally separated the MT and WY segments into 2 distinct populations even in winter-spring range use. Both length and degree of association between herds have declined dramatically on winter range since 1982, including noticeable declines in each winter since 1988. There may be 4 reasons for this: 1) disturbance has increased in Montana or decreased in Wyoming; 2) numerical growth in both herd segments (Van Dyke and Stewart 1989, Stewart, unpubl. data) has caused increased competition on Montana winter range, encouraging use of Wyoming winter range; 3) there has been a regeneration of forage availability and quality on Wyoming winter-spring

segment of the LC population, distances between GACs shifted W and SW by 2.1 km in both summer and winter-spring, respectively (Figs. 1 and 2, respectively). In the WY segment, distances between GACs were greatest in winter-spring (6.0 km, Fig. 3) and least in summer (3.7 km, Fig. 4). Range shift in the WY segment in all seasons was S, moving this segment further into Wyoming. The magnitude of range shift between historical and present populations, from lowest to highest, was 1) MT segment of LC population, 2) WY segment of LC population, and 3) PP population . Differences in range shift between the LC population (both segments) and the PP population approached significance (P<0.10, t-tests), and WY elk showed greater range shift than MT elk in the LC population (P<0.05, t-test). Percent change in seasonal range use decreased exponentially with an increase in distance between historical and present GACs (Fig. 5).

Daily Seasonal Movement Rate

Seasonal movement rates (m/day) were similar in all present populations (Table 3). From highest to lowest, the ranking of seasonal movement rates was: 1) summer, 2) fall, 3) spring, and 4) winter, ranging from highs of 268-310 m/day in summer to lows of 54-56 m/day in winter. Historical populations of the WY segment of the LC herd followed the same pattern, but historical PP and LC elk, MT segment, did not. Historical PP elk movement rates were nearly identical in all seasons. They were identical to movement rates of present populations in spring, greater in winter and less in summer. Both segments of the historical LC population had lower movement rates than present populations in every season. Movement rates in the historical MT segment were greatest during spring and least during fall.

Seasonal Herd Cohesiveness

Same-day average distances (km) between individual elk in the same herd (association indices), an index of herd cohesiveness, were not independent of season or population (Table 4, P<0.05, one-way ANOVA). Distances between individuals were lowest in spring and highest in fall in all present populations of PP and LC elk (MT segment), and spring distances were < other seasons (P<0.05, t-tests). Compared to the present population, distances between PP elk in 1981-82 were greater in all seasons. Historically, PP individuals were most dispersed in summer and least dispersed in spring. Both historical and present populations of the MT segment of the LC herd had greatest distances between individuals in fall. Fall dispersion was greater in 1988-90 than in 1979-82, but differences were not significant (P>0.10, t-test). The WY segment historically showed greatest distances between individuals during summer, but relocations from 1988-90 in this segment were insufficient to determine if this trend has continued. Present WY elk increased individual distances in winter compared to 1979-82 (P<0.05, t-test), but both populations had lower individual distances in winter than at any other season.

Seasonal Elevational Use

Average elevational use (m) differed by population and season (Table 5, P<0.05, one-way ANOVA). The basic seasonal pattern of elevational increase in present populations was: 1) spring, 2) winter, 3) fall, and 4) summer. All herds used higher than expected elevations during fall (P<0.01, z-test), lower than expected elevations in summer (P<0.05, z-tests), and the present PP

range due to several years of non-use; or 4) changes in land use patterns, particularly increases in lands planted to early spring crops of hay and alfalfa and reductions or removals of cattle on spring ranges in Wyoming (W. Anderson, pers. commun.) have led elk to exploit areas further S. These possibilities are not mutually exclusive and can be synergistic in effect. The fourth is especially well-supported by this population's extensive spring use of private agricultural lands, especially alfalfa fields, in Wyoming.

Tradition

Similar range boundaries and relatively small shifts in GACs between most present and historical populations support the importance of tradition in the social behavior of elk herds (Franklin and Lieb 1979). Edge et al. (1985) noted that home range fidelity was advantageous of elk, because of knowledge it provided of seasonal resource availability. Craighead et al. (1972) and Shoesmith (1979) noted that individually marked elk were observed in the same home range for >4 summers, indicating extended traditional use of summer range by some individuals. In all 3 populations in this study, range fidelity was evident in most seasons for ≤ 12 years.

Though home range fidelity is advantageous to elk and well-documented in individuals, the loose social structure of herd units makes it somewhat remarkable that more range shift was not observed. Craighead et al. (1973) concluded that elk in Yellowstone National Park (YNP) occurred in bands whose composition changed as animals left one band and joined another. Knight (1970) reported no lasting associations between individuals in Montana's Sun River herd. On YNP's Mirror Plateau, Shoesmith (1979) found that only cows and their calves consistently sought each other's company. Despite such loose social bonding, it is possible that a combined herd knowledge of range use is facilitated in cow herd units by leadership of an older female who combines long range tenure with direct mother-offspring links to elk of several different generations within the herd (Franklin and Lieb 1979). Such mother-daughter relationships are the most stable social bonds in elk (Darling 1937) and may persist throughout life (Franklin and Lieb 1979). When combined with long residency on a given range, this may be the mechanism by which range boundaries can remain essentially unchanged for periods $>$ the life span of individual elk. We conclude that Murie's (1951) simple but insightful hypothesis about range fidelity, namely, that elk learn traditional range use patterns by following their mothers, is, with some qualifications, basically correct.

The importance of tradition was also reflected in the exponential decrease of herd range size with increase in range shift. Loyalty to traditional home range is an expression of the law of least effort (Geist 1982:234). Those populations that were not loyal to traditional range, i. e. that showed a gradual migration to new ranges, probably did not have extensive collective knowledge of available resources within the new area. To use the new habitat optimally, such populations would be required to restrict movement within the new range's most productive habitats. As knowledge of the environment accumulated over time, a greater diversity of habitats could be exploited, because increasing knowledge of habitat quality would allow exploring elk to retreat to the more traditional habitat when or if the new habitats did not meet energetic and security needs. Such a hypothesis is consistent with with both the law of least effort and with movement patterns and habitat use observed in colonist elk in these populations. In such cases, colonists have

explored new home ranges, but retreated to traditional herd ranges in times of environmental stress (Skubinna and Van Dyke 1990b).

Management Implications

Tradition appears to be a key behavioral factor in elk range use. Established use traditions provide knowledge of favorable habitats and of refuges in times of stress. Barring catastrophic events, such traditions ensure that elk management units like the Line Creek Plateau and its associated eastern and southern drainages could be managed for elk use for periods >10 years without loss of the population to migration. However, range shifts do occur in elk populations, especially after habitat-altering events, and an understanding of these shifts can help to predict elk adjustment behaviors. This understanding can help managers to provide suitable refuges in traditional areas as well as adjacent areas not traditionally used by elk. Such range expansion and adjustment ultimately can lead to increases in numbers and add to greater collective health of elk herds (McCorquodale et al. 1988).

Herd range boundaries should be systematically reinvestigated at least every 10 years, even in stable and (supposedly) sedentary elk populations. Even more importantly, range use within such boundaries should also be periodically re-examined because animals generally use space disproportionately within their home ranges (Samuel et al. 1985). This comparison of present and historical populations demonstrates that, though tradition and learned behavior are strong contributors to a stable pattern of traditional range use, elk range boundaries and range use can change over time. Failure to consistently and accurately update population range use could lead to inappropriate management actions detrimental to both elk populations and their recreational use.

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Table 1. Seasonal herd range sizes (km^2) of historical (1979-82) and present (1988-90) Picket Pin and Line Creek elk populations. Numbers of relocations in parentheses. MT and WY refer to Montana and Wyoming segments of the Line Creek populations, respectively.

	Population					
	Picket Pin		Line Creek			
Season	1981-82	1988-90	1979-82		1988-90	
			MT	WY	MT	WY
Winter	29 (12)	14 (61)	---	3 (12)	51 (55)	27 (20)
Spring	139 (65)	14 (77)	35 (13)	104 (41)	145 (91)	9 (16)
Summer	169 (46)	153 (107)	69 (20)	172 (48)	85 (94)	---
Fall	71 (10)	118 (28)	26 (9)	170 (30)	66 (64)	---

Table 2. Average seasonal home range sizes (km^2) of individual elk in the Picket Pin population during 1981-82 and 1988-90. Numbers of relocations (N) and standard deviations (X) in parentheses, respectively. Individual home range sizes different by season (P<0.05, one-way ANOVA). Insufficient data available for computation of fall ranges.

	Picket Pin Population			
	1981-82		1988-90[a]	
Season	N	X	N	X
Winter	2 (6)	3.9 (0.4)	6 (61)	7.4 (3.7)
Spring	3 (46)	61.7 (50.6)	7 (154)	11.1 (6.5)
Summer	5 (45)	38.5 (38.4)	7 (107)	47.5 (16.7)

[a]Summer different from winter and spring. P<0.05, t-tests.

Table 3. Daily seasonal movement rates (m/day) of historical (1979-82) and present (1988-90) Picket Pin and Line Creek elk populations. Numbers of relocations in parentheses. MT and WY refer to Montana and Wyoming segments of the Line Creek population, respectively.

	Population					
	Picket Pin		Line Creek			
Season	1981-82	1988-90	1979-82		1988-90	
			MT	WY	MT	WY
Winter	119 (12)	54 (61)	---	---	56 (55)	104 (20)
Spring	118 (65)	118 (77)	72 (13)	37 (41)	74 (91)	---
Summer	115 (46)	310 (107)	49 (20)	77 (48)	268 (94)	---
Fall	---	127 (28)	37 (9)	53 (30)	133 (64)	---

Table 4. Distances (km) between individuals (association indices) of historical (1979-82) and present (1988-90) Picket Pin and Line Creek elk populations. Standard deviations in parentheses. Distances between individual elk different by season and population ($P<0.05$, one-way ANOVA). MT and WY refer to Montana and Wyoming segments of the Line Creek population, respectively.

	Population					
	Picket Pin		Line Creek			
Season	1981-82[a]	1988-90[b]	1979-82		1988-90	
			MT	WY[cd]	MT[e]	WY[f]
Winter	6.3 (4.6)	0.8 (0.5)	---	0.2 (0.1)	2.7 (2.4)	0.8 (0.7)
Spring	5.4 (3.4)	0.2 (0.2)	1.9 (1.6)	5.7 (5.5)	1.3 (0.6)	3.5 (2.8)
Summer	10.3 (6.6)	3.0 (1.1)	1.7 (1.4)	6.6 (3.5)	1.8 (1.1)	---
Fall	9.4 (4.3)	6.4 (7.2)	2.7 (1.6)	5.4 (4.4)	4.1 (1.5)	---

[a] Spring different from summer, same herd. $P<0.05$, t-test.

[b] All seasons different except summer and fall, same herd. $P<0.05$, t-tests.

[c] Winter different from spring, summer, and fall, same herd. $P<0.05$, t-tests.

[d] Winter different from 1988-90 WY segment. $P<0.05$, t-test.

[e] Winter, summer, and fall different from spring, same herd. $P<0.05$, t-tests.

Table 5. Average seasonal elevational use (m) of historical (1979-82) and present (1988-90) Picket Pin and Line Creek elk populations. Standard deviations in parentheses. Elevational use different by season and population (P<0.05, one-way ANOVA). MT and WY refer to Montana and Wyoming segment of the Line Creek population, respectively.

	Population					
	Picket Pin		Line Creek			
Season	1981-82[ab]	1988-90[c]	1979-82		1988-90[c]	
			MT[ad]	WY[ef]	MT	WY
Winter	1887 (123)	1852 (86)	2069 (127)	2068 (113)	2115 (181)	1878 (186)
Spring	1854 (119)	1818 (61)	1992 (212)	2010 (204)	1944 (210)	1585 (89)
Summer	2140 (367)	2495 (403)	2598 (400)	2722 (526)	2726 (375)	---
Fall	2322 (328)	2073 (324)	2518 (145)	2415 (579)	2269 (413)	---

[a] Winter and spring different from summer and fall, same herd. P<0.05, t-and z-tests.

[b] Spring, summer, and fall different from 1988-90 PP population. P<0.05, t-and z-tests.

[c] All seasons different, same herd. P<0.01, t- and z-tests.

[d] Fall different from 1988-90 MT segment. P<0.05, t-tests.

[e] All seasons different except winter and spring, same herd. P<0.05, t-and z-tests.

[f] Winter and spring different from 1988-90 WY segment. P<0.05, t-tests.

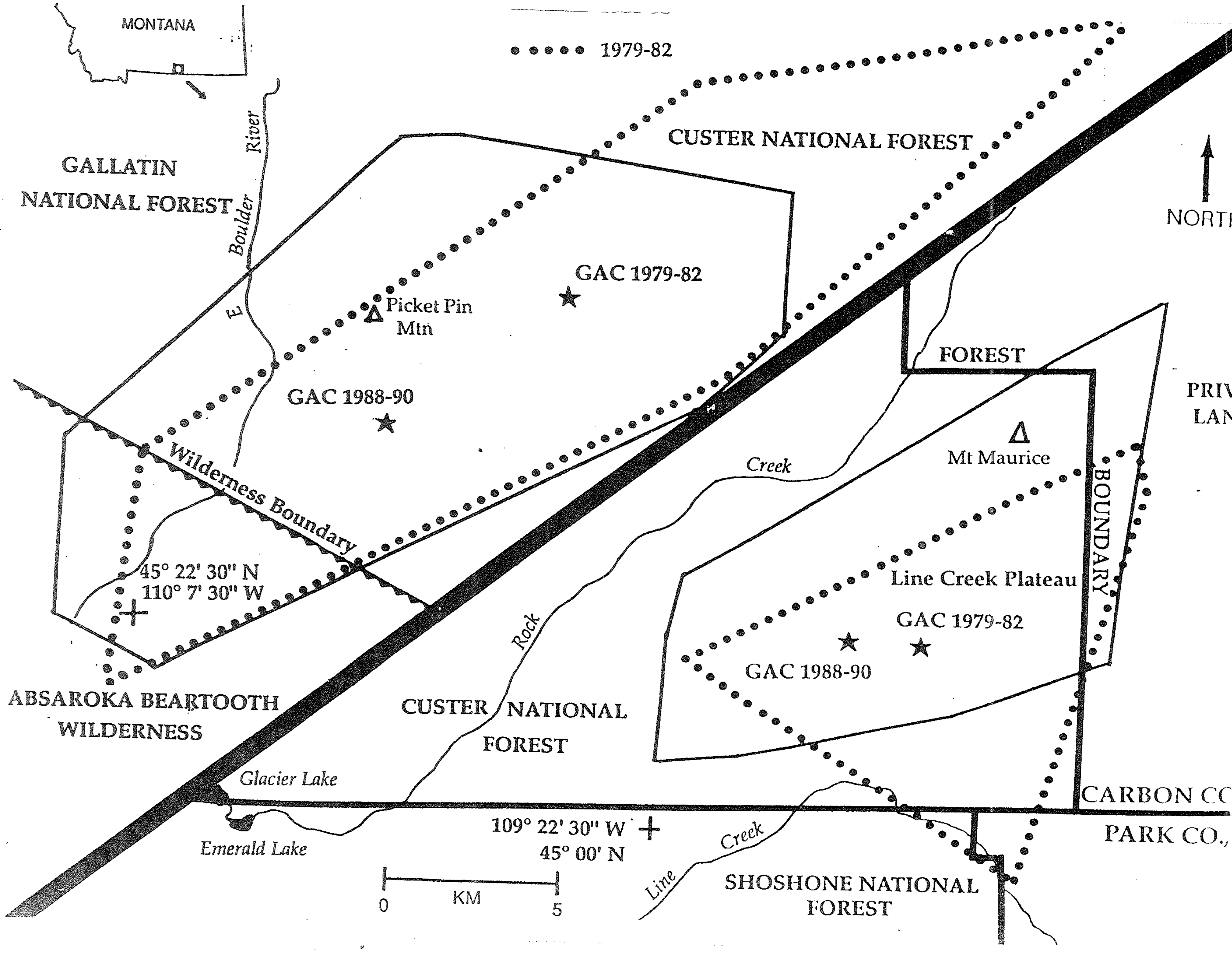
FIG. 1--Summer ranges and geometric activity centers (GACs) of present (1988-90) historical (1979-82) populations of Picket Pin (left half) and Line Creek, Montana segment (right half) elk herds in south-central Montana.

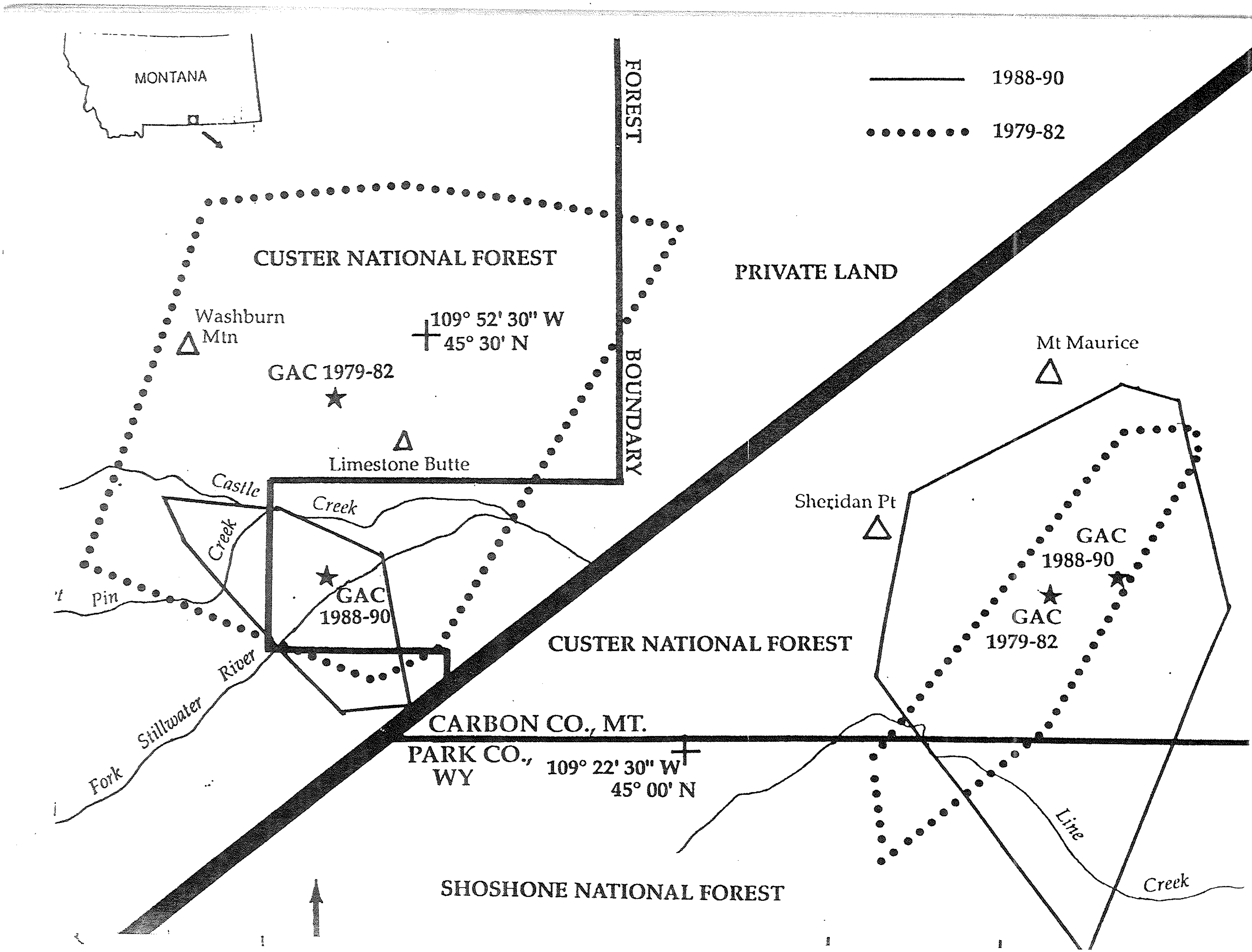
FIG. 2--Winter-spring ranges and geometric activity centers (GACs) of present (1988-90) historical (1979-82) populations of Picket Pin (left half) and Line Creek, Montana segment (right half) elk herds in south-central Montana.

FIG. 3--Winter-spring ranges and geometric activity centers (GACs) of present (1988-90) historical (1979-82) populations of Line Creek elk, Wyoming segment, in south-central Montana and northwestern Wyoming.

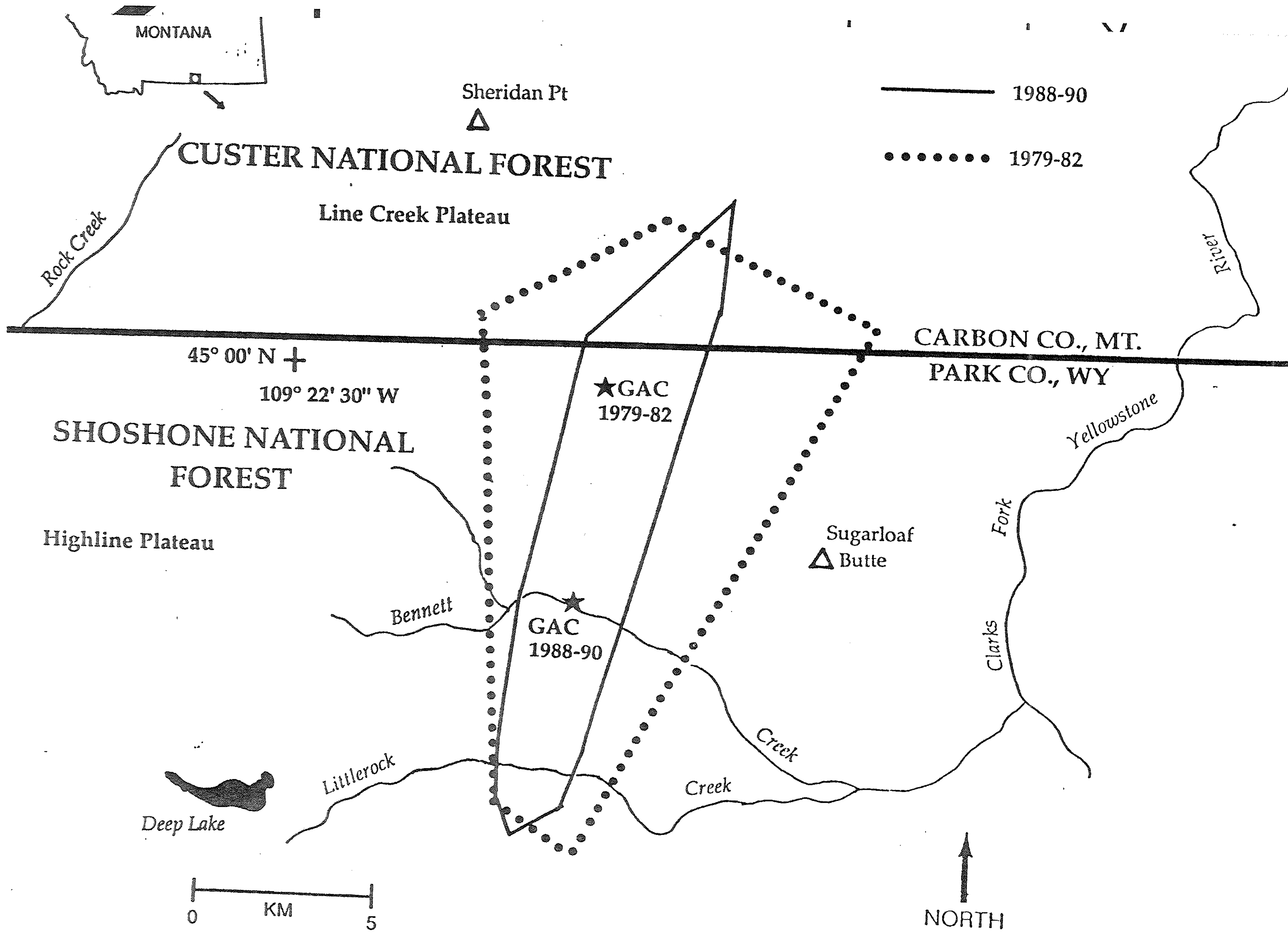
FIG. 4--Summer ranges and geometric activity centers (GACs) of present (1988-90) and historical (1979-82) populations of Line Creek elk, Wyoming segment, in south-central Montana and northwestern Wyoming.

FIG. 5. Relationship between percent difference in seasonal range size and distance between seasonal geometric activity centers (same season) of present (1988-90) and historical (1979-82) Picket Pin and Line Creek (Montana and Wyoming segments) elk populations in south-central Montana and northwestern Wyoming.

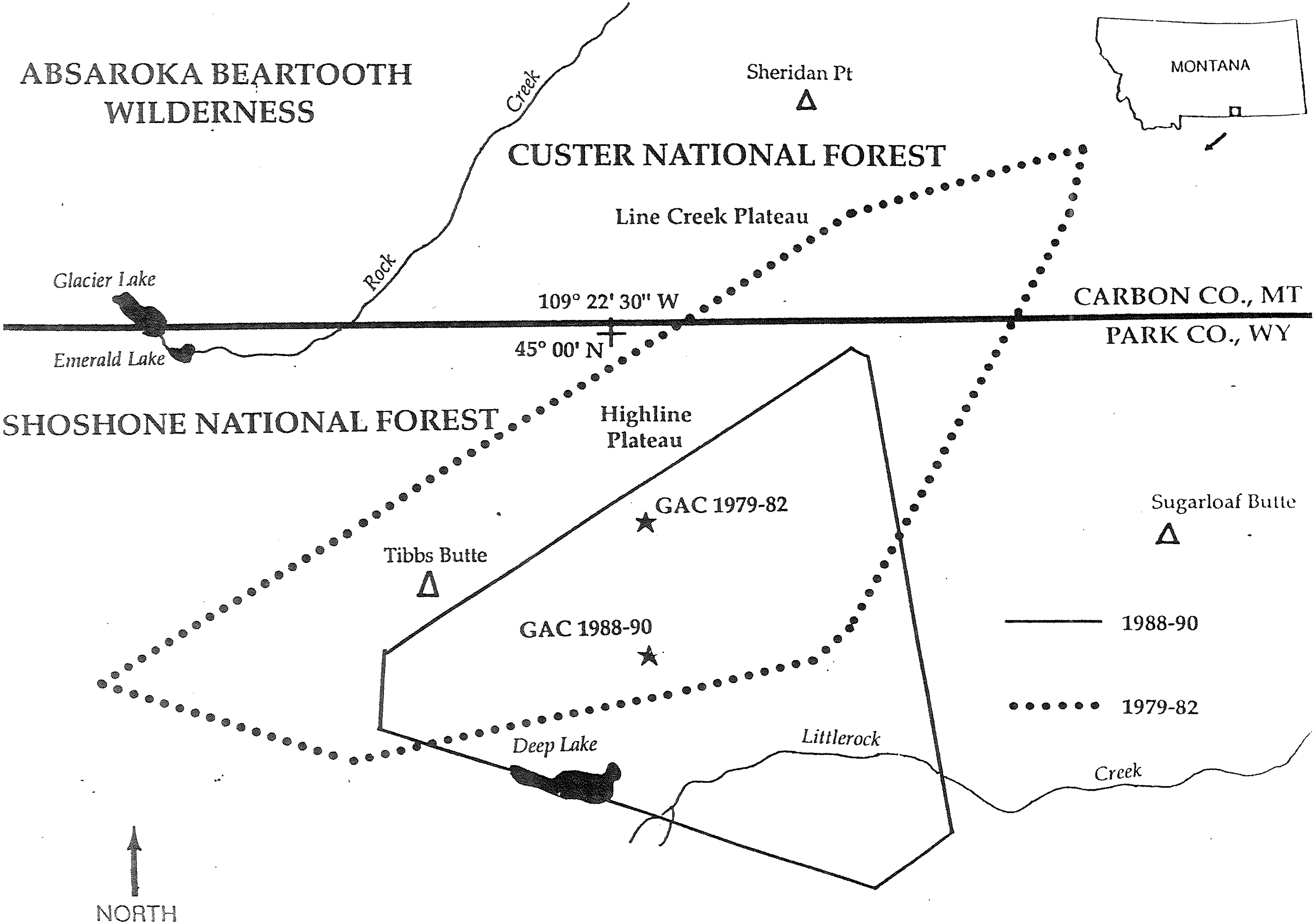

MONTANA
1979-82
GALLATIN NATIONAL FOREST
Boulder River
E
CUSTER NATIONAL FOREST
NORTH
GAC 1979-82
Picket Pin Mtn
GAC 1988-90
Wilderness Boundary
45° 22' 30" N
110° 7' 30" W
ABSAROKA BEARTOOTH WILDERNESS
FOREST
PRIVA
LAN
Mt Maurice
BOUNDARY
Creek
Line Creek Plateau
GAC 1979-82
GAC 1988-90
Rock
CUSTER NATIONAL FOREST
Glacier Lake
Emerald Lake
109° 22' 30" W
45° 00' N
KM
0
5
Line Creek
SHOSHONE NATIONAL FOREST
CARBON CC
PARK CO.,

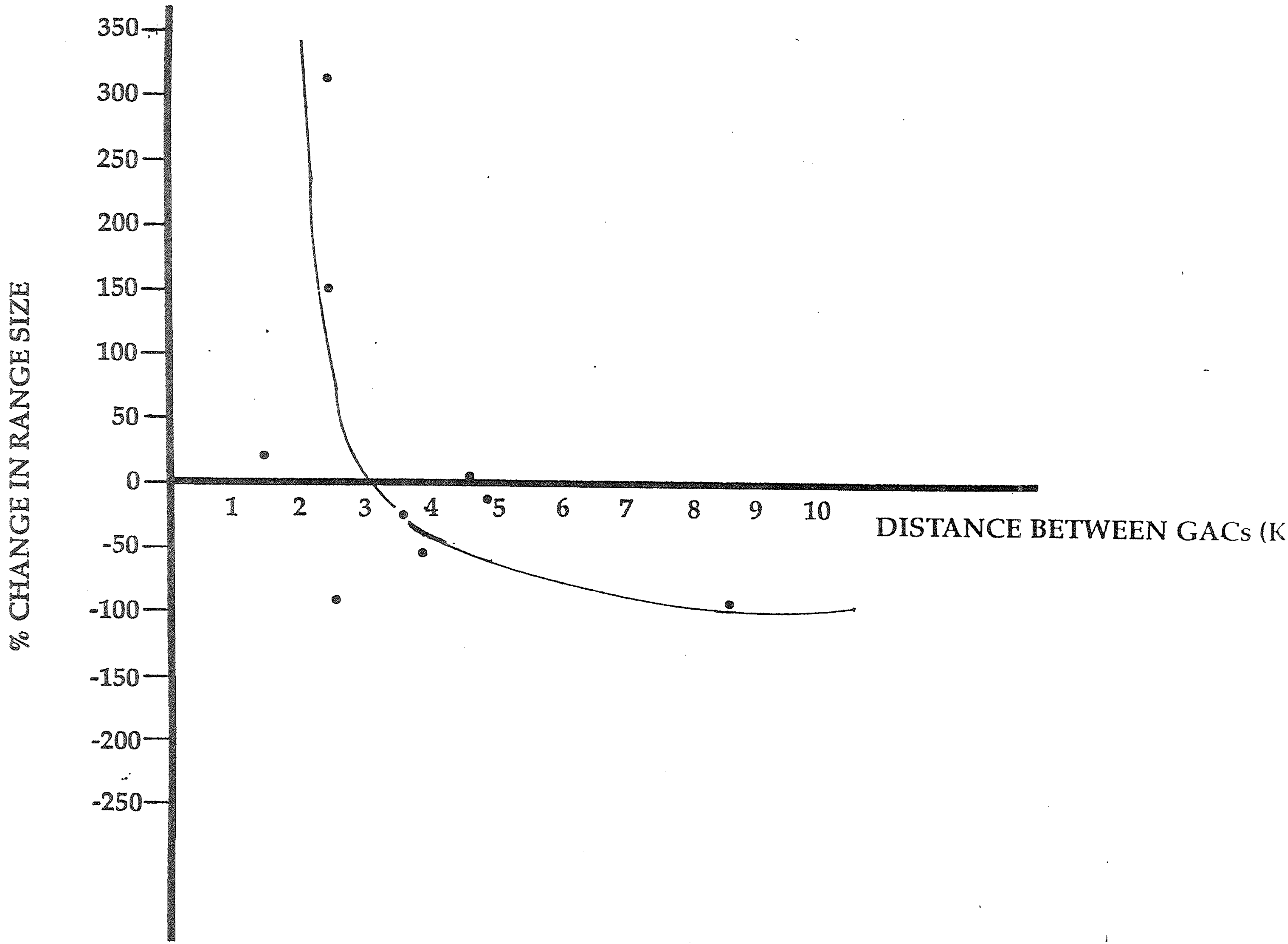


MONTANA
FOREST
BOUNDARY
1988-90
1979-82
CUSTER NATIONAL FOREST
PRIVATE LAND
Washburn Mtn
109° 52' 30" W
45° 30' N
GAC 1979-82
Limestone Butte
Mt Maurice
Sheridan Pt
Castle
Creek
Creek
Pin
GAC
1988-90
GAC
1988-90
GAC
1979-82
CUSTER NATIONAL FOREST
River
Stillwater
Fork
CARBON CO., MT.
PARK CO., WY
109° 22' 30" W
45° 00' N
Line
Creek
SHOSHONE NATIONAL FOREST



MONTANA
Sheridan Pt
CUSTER NATIONAL FOREST
Line Creek Plateau
Rock Creek
1988-90
1979-82
River
CARBON CO., MT.
PARK CO., WY
45° 00' N
109° 22' 30" W
SHOSHONE NATIONAL FOREST
GAC 1979-82
Yellowstone
Fork
Highline Plateau
Sugarloaf Butte
Bennett
GAC 1988-90
Clarks
Creek
Littlerock
Creek
Deep Lake
0
KM
5
NORTH


ABSAROKA BEARTOOTH
WILDERNESS
Sheridan Pt
MONTANA
Creek
Rock
CUSTER NATIONAL FOREST
Line Creek Plateau
Glacier Lake
Emerald Lake
109° 22' 30" W
45° 00' N
CARBON CO., MT
PARK CO., WY
SHOSHONE NATIONAL FOREST
Highline
Plateau
GAC 1979-82
Tibbs Butte
GAC 1988-90
Sugarloaf Butte
1988-90
1979-82
Deep Lake
Littlerock
Creek
NORTH



% CHANGE IN RANGE SIZE
350
300
250
200
150
100
50
0
-50
-100
-150
-200
-250
1
2
3
4
5
6
7
8
9
10
DISTANCE BETWEEN GACs (K

ELK PLUS COWS TIMES POLITICS EQUALS?
(Looking Beyond the Fencelines!)

KURT ALT and FRED KING, Montana Department of Fish, Wildlife and Parks
MARK PETRONI AND RON SCHOTT, Madison Ranger District, USFS

Abstract: Can the Montana Department of Fish, Wildlife and Parks and the United States Forest Service actually agree on something? If they can, what is it? This presentation will use the Wall Creek Grazing program to focus on agency philosophies and how those philosophies can change. The thought processes leading into the program, the program itself, and the influences on both the wildlife and agricultural resources in the upper Madison Valley will be presented. While it will take a number of years of vegetative monitoring to establish the degree of range improvement, the initial success of the program has been encouraging. Join with the four speakers to become acquainted with a program that integrates wildlife and agricultural interests.