



Winter mortality in the northern Yellowstone elk herd 1988-90
by Jane Park Roybal

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in
Biological Sciences
Montana State University
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Abstract:

Efforts to reestablish wolves in Yellowstone are underway. Elk constitute the largest proportion of ungulate biomass in the area and have served as the primary prey species for the reestablished wolf population. The northern Yellowstone elk herd is the single largest ungulate population in Yellowstone. Information on the extent and age/sex structure of early and mid-winter mortality within this herd would be potentially valuable in evaluating the effects of current and future management as well as the reintroduced wolf population. This study was initiated in January 1989 to evaluate Gardiner late hunt data and carcass survey information to determine the structure of early and mid-winter mortality in the northern Yellowstone elk herd. Elk harvest information from the 1982-83 to 1992-93 late hunts was obtained from the Gardiner check station, compiled and analyzed. Age structure of the harvest was estimated during 1988-89 and 1989-90, using tooth eruption/wear and cementum analysis. The two aging techniques were compared. A hunter survey was conducted to determine the effects of hunter selection on structure of the harvest. An index of winter severity was computed for 15-day intervals and used to assess the influence of weather on elk mortality. Carcass surveys were conducted during 1988-89 and 1989-90 in key elk wintering areas and along randomly located transects to determine the age and sex structure of natural mortality and spatial/temporal distribution of carcasses. Age structure of the harvest differed significantly between the two years. The majority of elk harvested during both (years) were female. Maximum ages for harvested elk were 21.5 years for cows and 13.5 years for bulls. The majority of elk were killed in Hunt Area 2 (closest to the Park boundary) in 1988-89 and 1989-90. Age structure of the harvest did not differ significantly from that of the live population when bulls were excluded from analysis. Overall frequency of differences in age estimation by eruption/wear compared to cementum analysis was 80%, with discrepancies between the 2 techniques increasing as age of the animal increased, resulting in overaging younger and underaging older class animals. Methods for improving accuracy of eruption/wear aging are discussed. Results of the hunter survey could not be used to interpret harvest data. Hunter and hunting characteristics and techniques for increasing the accuracy of survey responses are presented. Calves were over-represented in mortality surveys compared to the live population. Adult females constituted 70% of the estimated live population, but were under-represented in carcass surveys and overrepresented in the harvest.

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A thesis submitted in partial fulfillment
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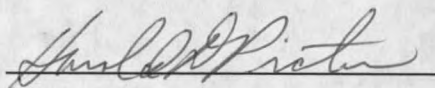
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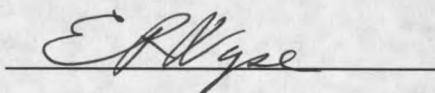
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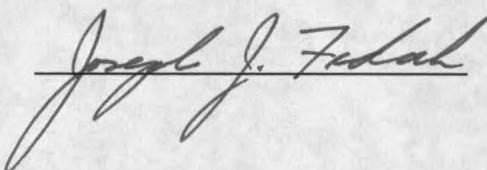
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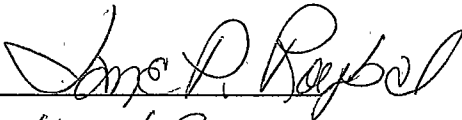

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ABSTRACT

Efforts to reestablish wolves in Yellowstone are underway. Elk constitute the largest proportion of ungulate biomass in the area and have served as the primary prey species for the reestablished wolf population. The northern Yellowstone elk herd is the single largest ungulate population in Yellowstone. Information on the extent and age/sex structure of early and mid-winter mortality within this herd would be potentially valuable in evaluating the effects of current and future management as well as the reintroduced wolf population. This study was initiated in January 1989 to evaluate Gardiner late hunt data and carcass survey information to determine the structure of early and mid-winter mortality in the northern Yellowstone elk herd. Elk harvest information from the 1982-83 to 1992-93 late hunts was obtained from the Gardiner check station, compiled and analyzed. Age structure of the harvest was estimated during 1988-89 and 1989-90, using tooth eruption/wear and cementum analysis. The two aging techniques were compared. A hunter survey was conducted to determine the effects of hunter selection on structure of the harvest. An index of winter severity was computed for 15-day intervals and used to assess the influence of weather on elk mortality. Carcass surveys were conducted during 1988-89 and 1989-90 in key elk wintering areas and along randomly located transects to determine the age and sex structure of natural mortality and spatial/temporal distribution of carcasses. Age structure of the harvest differed significantly between the two years. The majority of elk harvested during both (years) were female. Maximum ages for harvested elk were 21.5 years for cows and 13.5 years for bulls. The majority of elk were killed in Hunt Area 2 (closest to the Park boundary) in 1988-89 and 1989-90. Age structure of the harvest did not differ significantly from that of the live population when bulls were excluded from analysis. Overall frequency of differences in age estimation by eruption/wear compared to cementum analysis was 80%, with discrepancies between the 2 techniques increasing as age of the animal increased, resulting in overaging younger and underaging older class animals. Methods for improving accuracy of eruption/wear aging are discussed. Results of the hunter survey could not be used to interpret harvest data. Hunter and hunting characteristics and techniques for increasing the accuracy of survey responses are presented. Calves were over-represented in mortality surveys compared to the live population. Adult females constituted 70% of the estimated live population, but were under-represented in carcass surveys and over-represented in the harvest.

CHAPTER 1

INTRODUCTION

The gray wolf (*Canis lupus*) was essentially eradicated from most of the western United States by the 1930's (U.S. Fish and Wildlife Service (FWS) 1980). Control programs and U.S. government trappers extirpated wolves from Yellowstone National Park (YNP) between 1914 and 1926 as part of national program to eliminate all predatory animals from public lands (Weaver 1978, Houston 1982, FWS 1987).

In 1978, the gray wolf was listed under the Endangered Species Act of 1973 (ESA) (U.S.C. 1531 et seq.) as endangered in the conterminous United States, except Minnesota, where it was designated as threatened. With listing came legal protection and a mandate to recover the gray wolf. The FWS approved a revised recovery plan for the Northern Rocky Mountain wolf (*Canis lupus irremotus*) in 1987, identifying the need to reintroduce wolves into the Greater Yellowstone area and possibly central Idaho (FWS 1987). During the late 1980's and early 1990's, several wolf sighting reports were received annually from northwest Wyoming. However, pack or breeding activity was never confirmed (Cole 1971; Weaver 1978; FWS 1980, 1987, 1993).

The biological and social implications of restoring wolves in their former range in the Rocky Mountains has long been debated and has been reviewed at length

(National Park Service [NPS] 1975; Weaver 1978; FWS 1980, 1987; Yellowstone National Park (YNP) et al. 1990; Varley and Brewster 1992; FWS 1993). Aldo Leopold, as early as 1940, had proposed restoration of the wolf in Yellowstone National Park (Fritts et al. 1997). Between 1988 and 1991, the FWS and NPS, under Congressional direction, conducted or sponsored studies to evaluate the potential effects of wolf restoration to Yellowstone National Park and the surrounding area including impacts to the ungulate prey base and big game hunting (YNP et al. 1990, Varley and Brewster 1992).

In 1991, Congress directed the FWS to develop an Environmental Impact Statement (EIS) to analyze alternatives for and potential impacts of wolf recovery in Yellowstone and central Idaho. Approved and released in April 1994, the final EIS called for reintroduction of wolves into YNP and central Idaho, as experimental populations (Fritts et al. 1997). The final step in the process came in June 1994, with the signing of the Record of Decision by the Secretary of Interior. On January 12, 1995, some 70 years after their eradication, the first group of wolves arrived in Yellowstone. A second group of wolves was captured and translocated to Yellowstone and central Idaho in early 1996.

Of all the areas evaluated, Yellowstone's northern range has perhaps the greatest potential for sustaining a reintroduced wolf population year round. The region supports the area's greatest ungulate prey base, including elk (*Cervus elaphus*), bison (*Bison bison*), mule deer (*Odocoileus hemionus*), moose (*Alces alces*), white-tailed deer (*Odocoileus virginianus*), and pronghorn (*Antilocapra americana*) (Houston 1982,

Singer 1990). The Rocky Mountain elk is the most abundant of eight ungulate species occurring in Yellowstone National Park. Eight elk herds summer or reside year-round within the Park, with numbers in summer reaching between 25,000 to 31,000 individuals (Houston 1982, Mack et al. 1990, Singer 1990). The northern Yellowstone elk herd, consisting of those animals wintering in the Yellowstone River drainage within and adjacent to the Park, represents the largest single ungulate population in the area. The winter range occupied by the northern Yellowstone elk herd is often referred to as the "northern range."

Controversy concerning the need to manage elk numbers within Yellowstone National Park has made the northern Yellowstone elk herd one of the most studied ungulate populations in the world. Several NPS biologists studied the northern range: Walt Kittams 1948-58, Robert Howe 1958-62; William Barmore 1962-69 (Barmore 1980); Douglas Houston 1969-79 (Houston 1982); and Francis Singer 1980-90 (NPS 1988). Erickson (1981) and Houston (1982) have summarized the history of elk population dynamics and management in the Yellowstone area. The merits of past and possible future management scenarios including winter feeding, predator control, removal of ungulates, and natural regulation have been debated and discussed by Skinner (1928), Cahalane (1943), Cole (1969, 1971), Beetle 1974), Cayot et al. (1979), Houston (1982), Chase (1986), Despain et al. (1986), and Boyce (1991).

Skinner (1928), Rush (1932), Kittams (1963), Ellis (1964), Craighead et al. (1972), Shoesmith (1979), Houston (1982), and Vore (1990) have documented the distribution and movements of the northern Yellowstone elk herd. Vales (unpubl. Ph.D

Diss.) investigated over-winter survival strategies of mature bulls. Changes and transitions in the condition of the northern range have been discussed by Despain (1973), Tyers (1981), Houston (1982), Kay (1985, 1987, 1990), Despain et al. (1986), Coughenour (1991), Frank and McNaughton (1992, 1993), and Merrell et al. (1994). Predation on elk and use of ungulate carrion by carnivore and scavenger species have been documented (Murie 1944, Cole 1972, Houston 1978, Craighead and Sumner 1982, Schleyer 1983, Knight et al. 1984, Harting 1985). Grizzly bear predation on elk calves in Yellowstone National Park was documented by Gunther and Renkin (1990) and French and French (1990). Green and Mattson (1987) and Green (1994) examined the availability of ungulate carcasses and subsequent use by grizzly bears during early spring on the northern range and other areas of the YNP. Long-term studies were initiated on Yellowstone's northern range in 1989 to look at coyote distribution and population dynamics and gather baseline information in anticipation of potential impacts resulting from wolf reintroduction (Crabtree and Varley 1995, Gese et al. 1995, Grothe et al. 1995, Hatier and Crabtree 1995(a,b), Sheldon et al. 1995, Slade et al. 1995, Stotts et al. 1995). Between 1987 and 1995, field studies were conducted to look at mountain lion abundance, home range size, food habits and predation (Murphy and Tischendorf 1988; Murphy et al. 1995; Murphy, unpubl. Ph.D Diss.).

Elk represent an important winter and spring food source for the existing predator/scavenger fauna of Yellowstone and may be especially important during periodic severe winters (Houston 1978). Ungulates once made up the bulk of the wolf's diet across North America (Mech 1970) and although resident wolf packs were

eliminated from Yellowstone, evidence suggests at one time elk were an important year-round food source for wolves (Weaver 1978). Because of their abundance in the Park today, elk would undoubtedly serve as the primary prey species for any reintroduced wolves.

Since Houston's studies, (1970-78), the northern Yellowstone elk population as well as vegetative communities within Yellowstone have undergone considerable change. Recent studies on carcass utilization by grizzly bears (Green and Mattson 1987, Green 1994), effects of the 1988 drought and fires (Lemke 1989, Singer et al. 1989, Merrill and Boyce 1991), the ungulate prey base for wolves, and potential impacts of wolves (Garton et al. 1990, Singer 1990, YNP et al. 1990) have provided information on elk population dynamics and mortality. However, no recent information is available on the extent and age/sex structure of early and mid-winter mortality within the northern Yellowstone elk herd. Such information will be essential in determining the current status and trends in the elk population, and evaluating effects of the current natural regulation policy, wolf reintroduction, winter severity, or future management strategies. With continuing predation on the elk herd by grizzly bears, coyotes, and other predators, this knowledge will also be helpful in accurately assessing the impacts of increased predation or utilization of the northern Yellowstone elk herd by wolves or humans.

This study was initiated in December 1988 to determine the age and sex structure of early and mid-winter mortality in the northern Yellowstone elk herd.

Primary objectives of the study were:

1. Estimate the age and sex structure of mortality in the northern Yellowstone elk herd during 1988-90;
2. Determine spatial and temporal distribution and availability of carcasses;
3. Determine, when possible, cause of mortality and degree of use of carcasses by various predators species;
4. Compare, where available data make it possible, current patterns of mortality with that from earlier periods including control periods (1950's through 1970's);
5. Compare sex and age structure of mortality associated with hunted segments of the populations with that of un hunted segments remaining in the Park;
6. Compare accuracy of traditional aging techniques (tooth eruption and wear) to that of cementum analysis; and
7. Evaluate current criteria used for aging by tooth eruption and wear technique to determine if recent changes in vegetational structure of habitat are producing noticeable changes in tooth wear patterns.

Field work was conducted on the Park's northern elk winter range from January 3 through March 18, 1989, and from January 17 through March 18, 1990.

CHAPTER 2

STUDY AREA

Yellowstone National Park occupies roughly 9,065 sq km (3,500 sq mi) including portions of Wyoming, Montana, and Idaho. Straddling the Continental Divide, the Park is characterized by several broad, forested volcanic plateaus ranging in elevation from 1,500 - 3,300 m (5,000 to 11,000 ft) and bounded by mountains on all sides (Houston 1982). Underlain by sedimentary strata, the area has a history of glacial, geothermal, and volcanic activity. Meagher (1973) provided a general description of the physiography of Yellowstone. Keefer (1972) described the geology of the region.

Natural fire has greatly influenced the vegetation of Yellowstone. Prior to 1988, roughly 79% of the Park was closed canopy forest, dominated by lodgepole pine (*Pinus contorta*) (81%), generally occurring between elevations of 2,300 and 2,600 m (7,500-8,500 ft). The lodgepole pine zone consists of primarily climax lodgepole pine or seral stages with little or no spruce-fir understory. Subalpine fir (*Abies lasiocarpa*) and Engelmann spruce (*Picea engelmannii*) account for 9% of the forest, generally at elevations above 2,600 m (8,500 ft). Engelmann spruce is the major climax species in the subalpine zone, with douglas-fir (*Pseudotsuga menziesii*) found at lower elevations

(Despain 1973, Houston 1982). Grassland and sagebrush (*Artemisia spp.*) are located on slopes and ridges interspersed throughout the forest at higher elevations, with mesic meadows occurring on moist sites. Subalpine meadows occur on the upper plateaus and mountain slopes, while nonforested rock and tundra dominate higher elevations above (3,048 m) 10,000 feet (Knight et al. 1984).

The Northern Range - Location, Size, and Ownership

Many elk in the northern Yellowstone elk herd are seasonally migratory, moving from summer ranges within YNP to wintering areas outside the Park or in the central and northern portions of Yellowstone. Elk utilize a much smaller range in winter (mid-November to April), occupying primarily lower elevation areas along the Yellowstone, Lamar, and Gardiner rivers (Lemke et al. 1996). The study area consists of those wintering areas that were utilized by the northern Yellowstone elk herd both within and outside of the Park from 1988 through 1990 (Figure 1).

Through the 1980's, the occupied northern winter range (Figure 2) was estimated to include approximately 100,000 ha (247,100 acres) with roughly 83% of the range lying inside YNP and 17% occurring outside (Houston 1982) on Gallatin National Forest (13,600 ha), State (400 ha), or privately owned (3,000 ha) lands. However, increases in the northern elk herd over recent years have resulted in increased numbers of elk migrating north out of the Park. As a result of this and other factors, managers have observed an expansion of the herd's winter distribution both

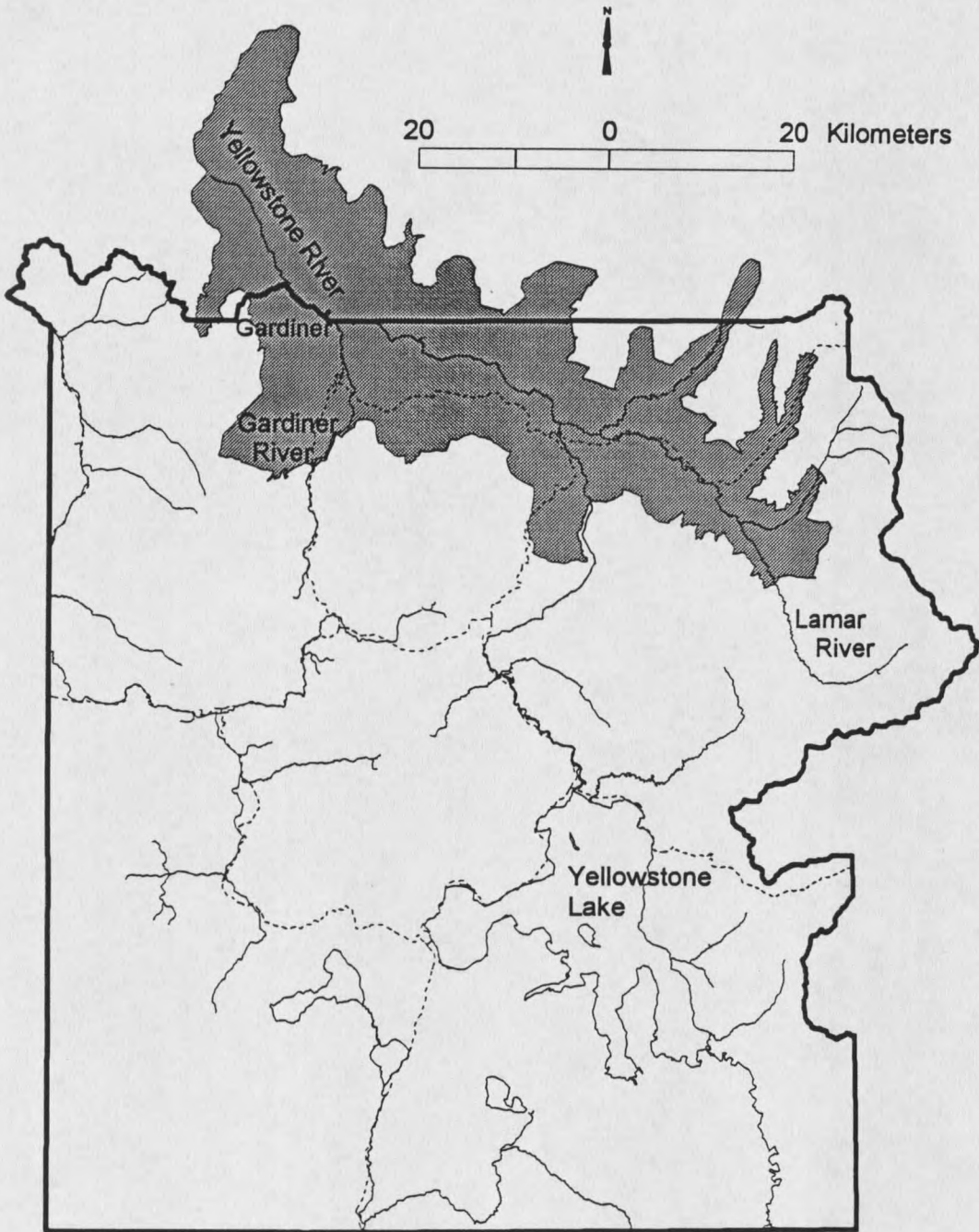


Figure 1. Map of Yellowstone National Park showing the winter range (shaded) of the northern Yellowstone elk herd.

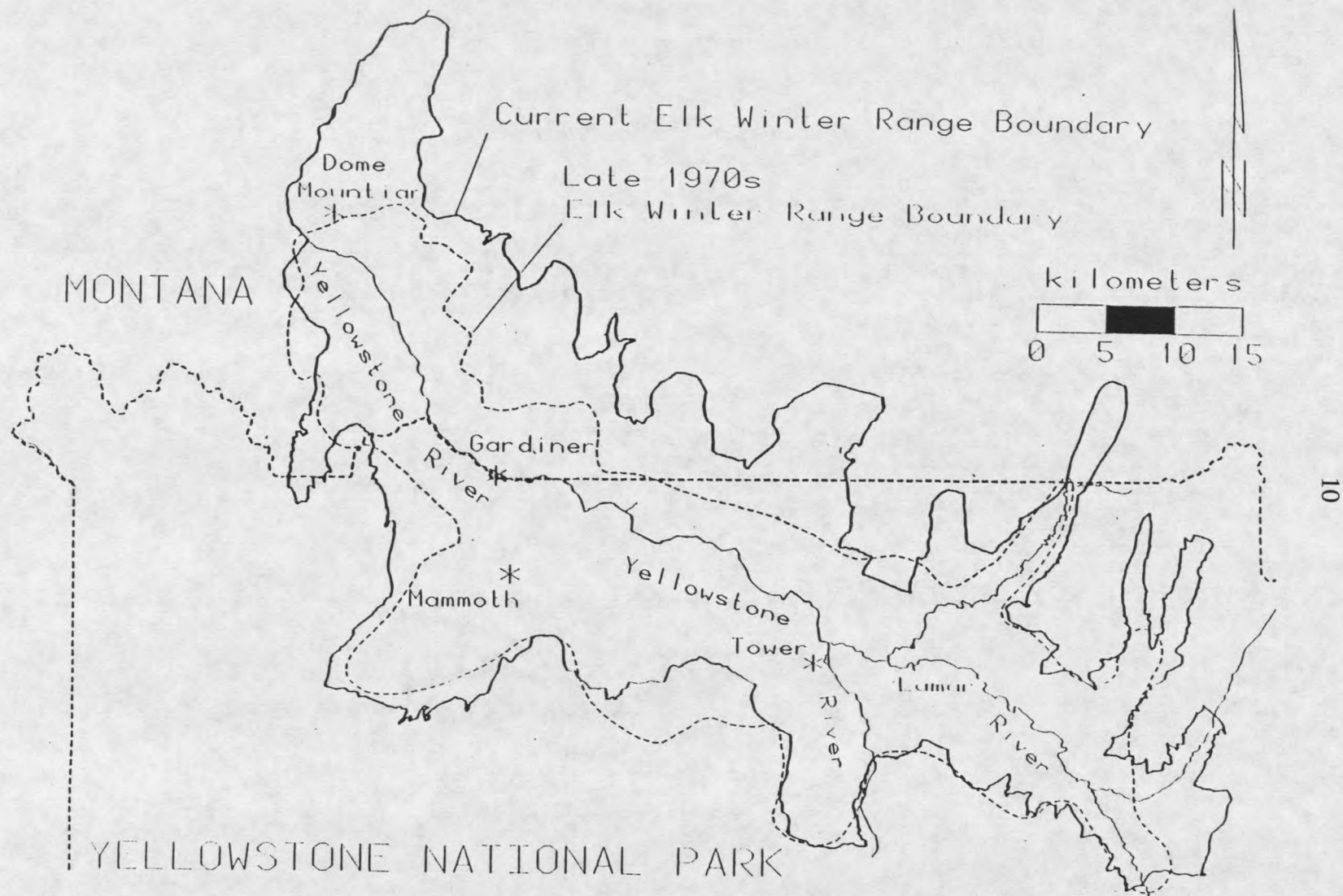


Figure 2. Boundaries of the current versus late 1970's northern Yellowstone elk winter range (from Lemke et al. 1996).

within and outside Yellowstone. Based on distribution data since 1988-89, the current occupied northern winter range area consists of 152,663 ha (377,077 acres) of primarily lower elevation areas, low-lying valleys, and high windswept ridges through portions of the Lamar, Yellowstone, and Gardiner river drainages extending from the upper Lamar River in the Park northeast to Sixmile Creek, 28 km north of YNP (Figure 2). This constitutes an increase in occupied winter range of approximately 41% including an increase in elk use north of the Park from 22,179 ha (54,800 acres) to 53,262 ha (131,610 acres) (Lemke et al. 1996). This range expansion was, in part, facilitated by the purchase private lands in historic wintering habitat north of the Park. In 1986, 1,200 ha (2,965 acres) were purchased by the State of Montana. Efforts were initiated in 1989 to protect additional winter range outside Yellowstone, resulting in the purchase of 3,500 ha (8,700 acres) by 1993, including 1,680 ha (4,148 acres) adjacent to Montana's Dome Mountain Wildlife Management Area and another 1,832 ha (4,524 acres) on the OTO Ranch and areas near Gardiner, Montana (Rocky Mountain Elk Foundation 1993).

The portion of the winter range along the Yellowstone/Lamar rivers and northern Park boundary (roughly 4,600 ha [11,367 acres]), is sometimes referred to as the "boundary line area" (BLA) (Houston 1982). Elevations on the northern winter range extend from 1,500 to 2,401 m (4,900-7,900 ft), with 52% of the range between 1,500 and 2,100 m (4,900-6,900 ft). While the majority of elk normally winter at elevations between 1,500 to 2,200 m (4,900-7,200 ft), some animals also utilize high windswept and south-facing slopes up to 2,700 m (8,800 ft), especially during low

snow periods. During more severe winters, elk from the upper and middle portions of the range, travel to low elevation areas on the lower northern range (Farnes 1991).

Climate

The climate of the Yellowstone region has been described by Meagher (1971), Dirks and Martner (1982), and Despain (1987). The climate across the northern winter range varies with topographic influences. A continental montane climate, it is characterized by long, cold winters and short, cool summers. Precipitation generally averages between 61 and 1524 cm (25 to 50 inches) per year depending on the elevation, most of which is in the form of snow. Climatic patterns vary considerably across the northern range, although most of the area lies within the semi-arid zone. In general, elevations are lower and climatic conditions somewhat milder, with many areas receiving less precipitation than the higher plateaus of the Park's interior; hence the area's ability to support more wintering ungulates (Meagher 1973, Houston 1982, Singer 1990b).

The Gardiner weather station is characteristic of the lower elevation, dry shrub/steppe habitat of the rain shadow area along the Yellowstone River north and just inside the Park. This is the driest portion of the winter range, receiving 36% less precipitation (26 cm [10-12 inches]) annually than Mammoth (40 cm [16 in]) only 6 km away, and 60% less than the Northeast Entrance (65 cm [25 in]) at the upper end of the range. In between these extremes, the Tower and Lamar Ranger Stations receive 43 cm

(17 in) and 37 cm (15 in) of annual precipitation, respectively (Soil Conservation Service (SCS), pers. commun.). From 1948 to 1993, average daily temperatures in January were: -5.5°C (22°F) at Gardiner, -7.2°C (19°F) at Mammoth, -10.5°C (13°F) at Tower and NE Entrance, and -11.1°C (12°F) at Lamar (SCS, pers. commun.).

Snow depth and characteristics appear to be the main factors limiting elk movements and use of the range. Overall, the winter range has an average annual snowfall of 500 cm (197 in) or less (Houston 1982). Wintering areas occupied by the northern elk herd generally include locations receiving 75 cm or less precipitation annually (Farnes 1991), typically lower elevation areas and high windswept ridges with less snow accumulation.

Vegetation

Winter range areas consist primarily of steppe and shrub steppe habitat with scattered small conifer stands at lower elevations and more continuous forests, sagebrush grasslands, and wet meadows occurring at higher elevations (Houston 1982, Merrill and Boyce 1991). Roughly 41% of the northern winter range is forested, primarily Douglas-fir stands with grass understory (20%). Douglas-fir occurs as small, open canopy forest stands at lower elevations generally between 1,500 and 2,100 m (4,900-6,900 ft), with larger contiguous stands occurring around the periphery of the winter range. Other forest types include lodgepole pine (13%) primarily on north slopes at 2,100 to 2,500 m (6,900-8,200 ft), Engelmann spruce/subalpine fir (8%)

