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Wildlife and the Effects of Mining in the Kantishna Hills, Denali National Park and Preserve

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WILDLIFE AND THE EFFECTS OF MINING IN THE KANTISHNA HILLS, DENALI NATIONAL PARK AND PRESERVE

by Kenneth Kertel

NATIONAL PARK SERVICE - Alaska Region

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INTRODUCTION

In 1980, the Alaska National Interest Lands Conservation Act (ANILCA) expanded the size of Mount McKinley National Park, and redesignated the area Denali National Park and Preserve. Included in the park expansion were the Kantishna Hills, an area of historic and recent mineral development. One of the mandates of ANILCA [Sec. 202(3)(b)] was that the resources of the Kantishna Hills be evaluated.

The purpose of this report is to document current and historic terrestrial wildlife use in the Kantishna Hills and to evaluate the effects of placer mining on wildlife and vegetation. Placer mining disturbs wildlife habitat through alteration of the soil, vegetation, and microclimate of an area (Brown et al. 1978, Rutherford and Meyer 1981, Holmes 1982). Specific objectivies of the evaluation included a descriptive survey of terrestrial vertebrates and determining the rate and degree of wildlife habitat recovery at a mined site of known age.

The report is intended to aid resource managers at Denali National Park and elsewhere in the evaluation of mining activities and the development of guidelines for the mitigation of mining impacts on terrestrial wildlife habitat. Although data collection was limited to a single field season, the project represents a first evaluation of terrestrial wildlife resources of the Kantishna Hills and a foundation for future research.

STUDY AREA

Location

The Kantishna Hills are a northeast-southwest trending range of low mountains located in the north central portion of Denali National Park (lat. 63°45'N., long. 150°40'W.). The present study focused on the southwest portion of the Kantishna Hills, where the mountains form a divide between the Clearwater Fork of the Toklat River to the east and the Bearpaw-Moose Creek drainage to the west (Figure 1). Elevations in the

study area range from less than 300 m near the confluence of Glacier Creek and the Bearpaw River, to about 1500 m at Kankone Peak. In contrast to the turbid, glacial-fed streams common to Denali National Park, the sources of the streams in the Kantishna Hills are rainfall, snowmelt, and surface aquifers and, as a result, the streams flow clear.

Description of Intensive Study Sites

Two intensive study sites were choosen, one on Caribou Creek and one on Glacier Creek (Figure 1). Both sites were located in streamside habitat. Elevations were 305 m at the Glacier Creek site and 350 m at the Caribou Creek site. The slope was about one percent at each site. The Caribou Creek site was placer mined with a dragline (dry-land dredge) between 1939-41, and about 10 percent of the site was mined again in 1977 (T. Bundtzen, pers. comm. 1983). The site was characterized by a combination of symmetrical tailings mounds, gravel roads, small streams, and tailings ponds (Figure 2). Tailings mounds were generally between 4-5 m in height. Vegetation was scattered and generally low, with the exception of the southernmost 100 m where a gravel road cut through the remnants of a single tall willow community. The Glacier Creek site was unmined and located in tall willows (Figure 3). The site bordered Glacier Creek and was bisected by Flat Creek at the northern end.

Climate

According to weather data collected about 5 km south of the study area at the Wonder Lake Ranger Station, the mean annual temperature in the Kantishna Hills is about -4°C(24°F). Average monthly mean temperatures range from about -30°C(-22°F) in January to about 12°C(52.7°F) in July. Annual precipitation averages about 50 cm (20 inches), with summer rains and occasional summer snow accounting for half the total. August is the wettest month with a mean precipitation of about 8 cm (3 inches). Winter snow accumulations range from 60-150 cm (20-60 inches). In 1983, snowbeds remained well into June at higher elevations.

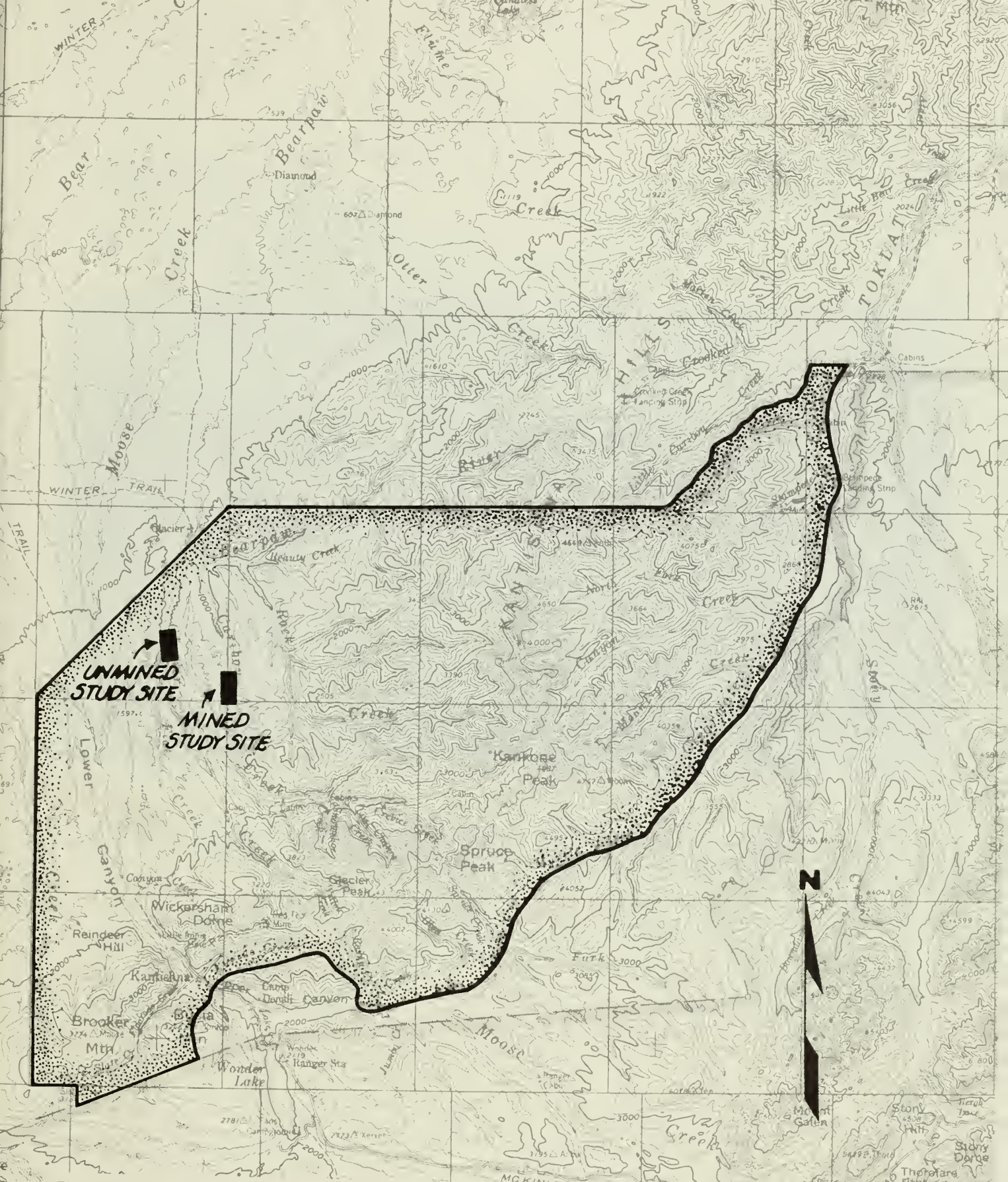


Figure 1. Kantishna Hills study area and 1983 study sites, Denali National Park and Preserve.

Figure 2. Mined Study site on Caribou Creek, Kantishna Hills, Denali National Park and Preserve, Alaska, 1983.

Figure 3. Unmined Study site on Glacier Creek, Kantishna Hills, Denali National Park and Preserve, Alaska, 1983.

Vegetation

The following description of vegetation is adapted from Valkenburg (1976), who typed vegetation in the northeastern addition to Denali National Park using U.S. Geological Survey aerial photographs and 35 mm ground photographs. Areas where vegetation types intersperse were expressed as a mixture, and the vegetation type named first in the mixture was the one that covered the most area. General descriptions of each vegetation type and the percent composition of each mixture in the Kantishna Hills study area are presented below.

A mixture of spruce woodland and dwarf birch-willow occurs at elevations generally below 485 m and makes up about 52 percent of the study area. The overstory is dominated by black spruce (Picea mariana). Generally, tree heights do not exceed 15 m and stands are not dense. A few larch (Larix laricina) occur in wet areas. An understory of dwarf birch (Betula nana) dominates the better drained areas. Willows (Salix spp.) replace dwarf birch as the dominant understory species along streams and in low areas. Salix planifolia pulchra and Salix alaxensis are most abundant, but other species of willows are present, and in places alder (Alnus crispa) predominates. Salix alaxensis frequently grows as high as 300 cm. At the northern end of the study area, the spruce woodland and dwarf birch-willow mixture is replaced by a mixture of aspen-birch forest and spruce woodland, which makes up 14 percent of the study area. Aspen (Populus tremuloides) occurs most commonly on south slopes of ridges, whereas birch (Betula papyrifera) is predominant on north slopes. Varying amounts of white spruce are interspersed with aspen and birch at these sites. Wild rose (Rosa acicularis) and highbush cranberry (Viburnum edule) are important understory plants. Aspen-birch forest is usually a seral stage in succession toward spruce woodland. Along river margins and on southerly slopes, dense stands of tall white spruce occur, making up about 2 percent of the study area.

Above 485 m, most commonly on well drained slopes between 650-970 m, the dwarf birch-willow type occurs without spruce and makes up about 7 percent of the study area. Dryas tundra (Dryas octopetala) is predominant in 21

percent of the study area, forming extensive mats above 970 m and on ridgetops below that elevation. Included in this type are wet alpine meadows which support little Dryas but contain a lush growth of grasses and forbs. A mixture of Dryas tundra and dwarf birch-willow makes up 4 percent of the study area.

History of Mining

The following history of mining in the Kantishna Hills is taken largely from Bundtzen (1978).

Since 1905, lode and placer mining have occurred with varying degrees of intensity in the Kantishna Hills. Although some mining occurred in the Clearwater watershed, most activity was concentrated in the southwest portion of the study area, in Glacier and Caribou Creeks of the Bearpaw River drainage, and in the upper Moose Creek drainage.

Prior to 1922, only limited hand methods were employed in the extraction of gold. In 1922, however, two hydraulic placer operations removed a combined total of 120,000 square feet of gravel on Moose and Caribou Creeks. Mining became even more mechanized in the late 1930's. Between 1939-41, a dragline processed approximately three million bedrock feet of gravel on Caribou Creek.

From 1945 to about 1972, mining activity in the Kantishna Hills was limited to ore shipments from Stampede and Slate Creek mines, some exploratory drilling, and scattered small placer operations. With the rise in the price of gold in 1972, however, came the modern era of placer mining. Utilizing bulldozers and front end loaders, miners were able to re-work gravels that had been mined in the past or reach gravels that were not previously accessible.

Eighteen placer and two lode mines were in operation in 1983. Placer operations in the Kantishna Hills processed between 75-200 yards of gravel per hour and the average daily length of operation was 10-12 hours. Two lode mines shipped approximately 180 tons of ore in 1983.

MATERIALS AND METHODS

Field Observations

Fieldwork in 1983 was conducted between May 16 and August 28. Descriptive surveys were conducted on foot. At least a portion of most of the major drainages in the Kantishna Hills study area were inspected. Although emphasis was placed on streamside habitat, representative alpine habitat also was surveyed. The numbers and general locations of all terrestrial vertebrates detected by direct observation or from interpretation of sign were recorded. The presence of large mammals often was determined from scats and/or tracks. Rock outcrops were surveyed for nesting raptorial birds from both helicopter flights and the ground. Areas of known wolf activity were closely examined for denning sites or evidence of current use. Major caribou trails were mapped, and alpine areas were searched for evidence of recent Dall sheep use. Individuals who had spent time in the study area were interviewed and their observations of wildlife there were recorded. Scientific names of birds and mammals are listed in Appendix 2 and Part II, respectively.

Quantitative Sampling

Quantitative sampling to determine the effects of placer mining on wildlife and wildlife habitat were conducted between June 15 and June 30 in the intensive study sites.

A belt transect was established at each study site to determine breeding bird species composition and density. Transect methodology followed Burnham et. al. (1980). Transect length and width were based on the extent of homogeneous streamside habitat. Width of transects was 80 m. The Caribou Creek transect was 750 m long and the Glacier Creek transect was 475 m long. Transect lines were marked at regular intervals with flagged wooden stakes. In densely vegetated areas, conspicuous vegetation was flagged. Each transect was sampled twice a day, at 0300 and 1900 hours, for four consecutive days, and once at 0300 hours on the fifth day. Birds were identified by song and/or with 9x binoculars.

Twenty 17.8 m^2 (8 x 24 ft.) plots were established on each study site for counts of moose pellet groups (Oldemeyer and Franzmann 1981). Plots were paired and placed at intervals along the bird transect lines. At Caribou Creek, plots were placed at 75 m intervals, with the members of each pair 30 m apart on either side of, and equidistant from, the transect center line. On Glacier Creek, plots were placed at 50 m intervals with the members of each pair 20 m apart on either side of, and equidistant from, the transect center line. All pellet groups for which either the center or at least half of the pellets fell within the plot were counted. Summer and winter droppings were recorded separately.

Twenty 5 m^2 (1 x 5 m) vegetation plots were established on each study site to determine the degree of revegetation on the mined site and to compare the two sites in terms of their potential for moose browse. The 5 m^2 plots were nested in the southeast corner of the 17.8 m^2 moose pellet plots. In each plot an estimate was made of composition, relative density, and mean height of tall willows, other tall shrubs, and trees (Nelson et. al. 1983). Shrubs were defined as tall shrubs if their mature heights reached at least 92 cm (Foote 1983). All tall shrubs were counted by species and the height of one plant per species nearest the southeast corner of the plot was recorded. In shrub clumps, main stems were counted at a height of 10 cm above ground level. Height measurements were made to the nearest 1 cm. Willows were identified with the aid of Viereck and Little (1972) and Argus (1973). Identifications were verified by Leslie Viereck and Joan Foote of the Institute of Northern Forestry, Fairbanks.

Twenty 1 m^2 (1 x 1 m) plots were established on each study site to estimate the percent coverage of the lichen, moss, herb, and low shrub layers (Nelson et. al. 1983). The 1 m^2 plots were nested in the southeast corner of the 5 m^2 plots. Low shrubs were defined as woody perennials less than 92 cm, and herbs as any non-woody plants other than mosses and lichens (Foote 1983). Also recorded was the estimated percent coverage of non-living organic matter, segregated into debris (woody material over $\frac{1}{4}$ inch in diameter) and litter (undecayed plant material), bare ground (exposed mineral soil), and standing water. Coverages were derived from midpoints of coverage classes (Nelson et. al. 1983). At the southeast corner of each 1

m^2 plot the depths of the duff layer (non-living organic matter) and moss layer were measured to the nearest 1 cm.

Microtines were trapped at each study site. Fifty live traps were set on each of five consecutive nights following two nights of prebaiting. A combination of rolled oats and peanut butter was used as bait. Traps were placed around the periphery of the vegetation plots.

Vegetation, moose pellet, bird, and small mammal data were analyzed using Two-Sample t Tests (Zar 1974).

PART I. COMPARISON OF MINED AND UNMINED STREAMSIDE SITES

Results of Comparative Plots on Mined and Unmined Streamside Sites

Tall Shrubs and Trees. There were more stems of tall shrubs and trees on the mined versus the unmined site ($P<0.05$, Table 1) with the differences due largely to presence of more non-willow stems on the mined site. Numbers of stems of willows alone did not differ significantly between the two sites. Stems of Salix alaxensis were about five times more abundant on mined plots ($P<0.05$), whereas S. planifolia stems were much more abundant on unmined plots ($P<0.05$). Non-willow species contributed 24 stems/plot at the mined site and only 2 stems/plot at the unmined site. Stems of Alnus crispa were about seven times more abundant, and stems of Populus balsamifera were about 35 times more abundant on mined plots. Stems of non-willow species made up 43 percent of total stems on mined plots, but only 6 percent of total stems on unmined plots. The combined stems of both A. crispa and P. balsamifera made up 42 percent of the total stems on mined but only 5 percent on unmined plots.

Tall shrubs and trees were taller on unmined plots ($P<0.05$, Table 2). Stems of S. alaxensis, for example, were about four times taller on unmined versus mined plots ($P<0.05$).

Ground Cover. Percent coverage of vegetation was significantly greater for all categories at the unmined site (Table 3). Coverage of the herb, moss,

Table 1. Tall shrubs and trees at unmined and mined streamside sites, Kantishna Hills, Denali National Park and Preserve, 1983.

	Unmined (n=20 $5m^2$ plots)			Mined (n=20 $5m^2$ plots)		
Species	Mean No. Stems/ Plot ± S.D.	Percent of Total Stems	Stems/ Hectare	Mean No. Stems/ Plot ± S.D.	Percent of Total Stems	Stems/ Hectare
Salix alaxensis	5.5 ± 7.9	18	11000	29.2 ± 28.4*	52	58300
Salix planifolia pulchra	17.0 ± 18.7	57	34000	0.6 ± 1.6*	1	1100
Salix hastata	5.5 ± 9.8	18	11000	2.1 ± 6.6*	3	4100
Salix arbusculoides	0.4 ± 1.2	1	700	0.6 ± 1.8	1	1100
Alnus crispa	1.3 ± 2.6	4	25000	9.0 ± 15.5*	16	17900
Populus balsamifera	0.4 ± 1.8	2	800	14.8 ± 13.7*	26	29500
Betula papyrifera				0.8 ± 1.6	1	700
Picea glauca	0.1 ± 0.2	T	100			
Combined	30.1 ± 16.6	100	60100	56.4 ± 45.7*	100	112700

* denotes significant difference at $P<0.05$ level. t-test, between unmined and mined.

T denotes less than 1%.

Table 2. Height of tall shrubs and trees at unmined and mined streamside sites, Kantishna Hills, Denali National Park and Preserve, 1983.

Species	Unmined (n=20 5m^2 plots) No. of Stems Measured	Mean Height (cm)	±	S.D.	Mined (n=20 5m^2 plots) No. of Stems Measured	Mean Height (cm)	±	S.D.
Salix alaxensis	11	227	±	86	18	58	±	91*
Salix planifolia pulchra	14	122	±	68	3	122	±	112
Salix hastata	10	81	±	42	2	114	+	37
Salix arbusculoides	2	175	±	120	3	33	±	16
Alnus crispa	5	29	±	31	9	70	±	97
Populus balsamifera	1	230			16	44	±	94
Betula papyrifera					1	14		
Picea glauca	1	800						
Combined	44	148	±	136	52	60	±	89*

* denotes significant difference at $P<0.05$, t-test, between unmined and mined.

Table 3. Vegetation and ground cover at unmined and mined streamside sites, Kantishna Hills, Denali National Park and Preserve, 1983.

Coverage Categories	Unmined (n=20 $1m^2$ plots) Mean Percent Coverage/ Plot	± S.D.	Mined (n=20 $1m^2$ plots) Mean Percent Coverage/ Plot	± S.D.
Vegetation				
low shrub layer	20	± 26	0	± 0*
herb layer	76	± 20	11	± 17*
moss layer	25	± 31	3	± 11*
lichen layer				
Non-living Organic Matter				
debris	18	± 16	2	± 3*
litter	78	± 24	25	± 38*
bare ground	0	± 0	62	± 37*
standing water	0	± 0	5	± 20

* denotes significant difference at $P<0.05$, t-test, between unmined and mined.

and low shrub layers was over seven times greater on unmined plots ($P < 0.05$). There were no low shrubs on mined plots. Unmined plots also had 12 times greater coverage of debris, and about three times greater coverage of litter than mined plots ($P<0.05$). Conversely, amounts of bare ground were significantly greater on mined plots ($P<0.05$). No bare ground or standing water were recorded on unmined plots.

Depth of moss and duff was significantly greater at the unmined versus the mined site ($P<0.05$). Duff was 11 times deeper on unmined (4.4 cm/plot) versus mined plots (0.4 cm/plot), and moss was about 20 times deeper on unmined (2.0 cm/plot) versus mined plots (0.1 cm/plot).

Moose Pellet Groups. Moose winter pellet groups were about 15 times more abundant at the unmined streamside site ($P<0.05$, Table 4), however, there were too few summer pellet groups to justify analysis.

Breeding Bird Comparisons. Over four times more birds were observed on the transect at the unmined streamside site in comparison to the mined site ($P < 0.05$, Table 5). In addition, more species of birds were recorded at the unmined site (16) than at the mined site (11). Six species were observed at the unmined site, whereas one species was observed at the mined site.

Eight bird species were more abundant at the unmined site ($P<0.05$). Relative differences in abundance between six species were as follows; gray-cheeked thrush (about 35x), fox sparrow (about 30x), white-crowned sparrow (about 8x), blackpoll warbler (about 6x), Wilson's warbler (about 4x), and common redpoll (about 3x). Only spotted sandpipers were more abundant at the mined site ($P<0.05$). Observations of alder flycatchers were similar at both sites.

There were distinct differences in avian community structure between the two sites. For example, spotted sandpipers and alder flycatchers combined to make up 42 percent of total observations on transects at the mined site, but only about 8 percent of total observations on transects at the unmined

Table 4. Moose pellet groups at unmined and mined streamside sites, Kantishna Hills, Denali National Park and Preserve, 1983.

Categories	Unmined (n=20 17.8 m^2 plots) Mean No. Pellet Groups/ Plot ± S.D.	Mined (n=20 17.8 m^2 plots) Mean No. Pellet Groups/ Plot ± S.D.
Winter Pellet Groups	1.6 ± 1.9	0.1 ± 0.3*
Summer Pellet Groups	0.1 ± 0.3	0.0 ± 0.0

* denotes significant difference at $P<0.05$, t-test, between unmined and mined.

Table 5. Birds at unmined and mined streamside sites, Kantishna Hills, Denali National Park and Preserve, 1983.

Species	Unmined (n=14.2 transect runs)[1] Mean No. Birds/ 475 m Transects	± S.D.	Percent of Total Birds	Mined (n=9 transect runs) Mean No. Birds/ 475 m Transect[2]	± S.D.	Percent of Total Birds
Solitary sandpiper	1.0	± 0.5	4		*	
Spotted sandpiper	0.1	± 0.3	T	0.8	± 1.0*	14
Belted kingfisher	0.1	± 0.3	T			
Alder flycatcher	1.9	± 0.8	8	1.6	± 1.3	28
Hammond's flycatcher	0.2	± 0.4	1			
Gray-cheeked thrush	2.7	± 0.9	11	0.1	± 0.3*	1
Swainson's thrush	0.2	± 0.4	1	0.1	± 0.3	1
American robin				0.1	± 0.3	1
Varied thrush	0.4	± 0.7	2			
Blackpoll warbler	1.3	± 1.1	6	0.2	± 0.5*	4
Northern waterthrush	0.7	± 0.7	3	0.4	± 0.7	8
Wilson's warbler	3.9	± 2.3	16	0.9	± 1.1*	17
Fox sparrow	2.2	± 0.7	9	0.1	± 0.3*	1
Lincoln's sparrow	1.0	± 0.7	4		*	
White-crowned sparrow	4.6	± 1.9	19	0.6	± 0.8*	10

Table 5. (continued)

Dark-eyed junco	0.3	±	0.6	1				
Common redpoll	2.8	±	1.9	12	0.8	±	1.0*	14
Unidentified	0.8	±	1.8	3	0.1	±	0.3*	1
Combined	24.2	±	4.6	100	5.5	±	2.2*	100
Total No. of Species	16				11			

[1] to express mean number of birds/475 transect, nine runs at 750 m/transect were assumed to equal 14.2 runs at 475 m/transect.

[2] values were derived by multiplying number of birds/750 m transect by 475/750.

* denotes significant difference at $P<0.05$ level, t-test, between unmined and mined.

T denotes less than 1%.

site. Gray-cheeked thrushes made up a larger portion of total observations on transects at the unmined site (11 percent) verus the mined site (1 percent).

Small Mammal Comparisons. Trapping results were very limited. Two species (red-backed vole and tundra vole) were trapped on unmined plots whereas one species (red-backed vole) was trapped on mined plots.

Discussion of Comparative Plots on Mined and Unmined Streamside Sites

Moose. Unmined streamside sites in the Kantishna Hills supported a tall willow community important to moose. Among the willow species occurring in interior Alaska, Milke (1969) believed that Salix alaxensis and S. planifolia were of greatest importance to moose and S. hastata was one of the least preferred species. Murie (1961) also found S. alaxensis and S. planifolia to be highly preferred over other available species at Denali National Park. In recent studies at Denali National Park, Wolf and Cowling (1981) found that percentages of available browse consumed were greatest in small, dense single species stands of S. alaxensis while Vic Van Ballenberge (pers. comm. 1984) found S. planifolia to be most highly preferred. Machida (1979) also found S. alaxensis to be an extremely important browse plant in interior Alaska. In the Kantishna Hills, S. alaxensis and S. planifolia dominated the tall willow community at the unmined site.

Mining greatly affected the amount and availability of willow browse for moose in specific streamside sites in the Kantishna Hills. Studies in Alaska suggest that preference for certain willow species may be related to height. Milke (1969), Machida (1979), and Zasada et. al. (1981) found that willow species most utilized tended to be the tallest available. Snow depth and the need for cover were suggested as possible causes for the height preference. Zasada et. al. (1981) noted that only tall willow stands, dominated by S. alaxensis provided the combination of large quantities of browse and cover that moose require for long term winter use. In the Kantishna Hills, stems of willow species important to moose may be unavailable at the mined site depending on snow depth. In addition, cover

may be lacking. Milke (1969), and Machida (1979) found that S. alaxensis dominated interior riparian sites in terms of biomass production.

Based on data collected in 1983 (Tables 1,2,3), natural revegetation of streamside placer mined areas to conditions suitable for winter moose utilization is greater than 40 years in the Kantishna Hills. Singleton et. al. (1981) found that winter feeding habitats recovered to control levels in less than 20 years in placer mined valley bottoms in the Klondike, Yukon, however placer mined benches required 40-50 years to recover. During a study of natural revegetation of tailings in interior Alaska, Holmes (1981, 1982) found no consistant correlation between date of cessation of mining and subsequent development of woody cover. In some cases tailings had essentially no vegetation 50 years after mining, while other tailings of similar age supported dense stands of trees. As a rule, Holmes (1982) found that the key to natural revegetation of mined lands is the presence of fine textured material at the surface. According to Singleton et. al. (1981), without soil fines, tailings from placer operations may require over 100 years to establish a vascular plant cover of more than 10 percent. Durst (pers. corres. 1983) found that the presence of surface overburden (topsoil and/or organic material) was crucial to the establishment of appreciable herbaceous cover on mined sites at Nyac, Alaska. Further, he found cases where tailings with a soil layer of only about 10 cm supported dense herbaceous and woody cover. Based on the findings of these authors, recovery of placer mined areas to natural levels of moose utilization probably requires 70 years in the Kantishna Hills.

Recovery of winter moose habitat in placer mined areas in the Kantishna Hills probably could be accelerated through the application of overburden and fines to mined surfaces, and through plantings of native vegetation. In addition, leaving corridors of undisturbed vegetation would provide habitat and a readily available source of seed during the revegetation period (Rutherford and Meyer 1981, Holmes 1982).

Small Mammals. Although trapping results in the Kantishna Hills were inconclusive, studies of placer mined areas in the Klondike, Yukon by

Singleton et. al. (1981) and Wier (1981) and in western Alaska by Durst (pers. corres. 1983) indicate that mined sites have fewer species and fewer individuals than unmined sites. Durst (pers. corres. 1983) found that species occurring in low numbers on undisturbed sites were absent on disturbed sites.

Most authors have suggested that impovished understory vegetation resulting in lack of food and cover is the reason for low small mammal densities in mined areas (Singleton et. al. 1981, Wier 1981, Durst, pers. corres. 1983). Weir (1981) suggested that red-backed vole densities were greatest in older, low tree/shrub communities. Singleton et. al. (1981) concluded that the most important limiting factors for red-backed voles at mined sites were the low percent cover of Betula glandulosa, B. nana, and other low shrubs, and herbs, and the incompleteness of the ground cover. These authors rated sites with less than 50 percent ground cover as having no capacity as red-backed vole habitat.

Singleton et. al. (1981) found that after 30 years, placer mined valley bottoms in the Yukon had very low red-backed vole densities compared to unmined valley bottoms. Based on this finding, they suggested that a return to original red-backed vole densities on placer mined benches may take in excess of 100 years in the Klondike, Yukon.

Birds. According to Spindler and Kessel (1979), streamside habitats in interior Alaska often support over 250 birds per 100 acres during the breeding season. Birds also use streamside habitats extensively during migration (Stevens et. al. 1977).

Mining decreased productivity of streamside willow communities for breeding birds in the Kantishna Hills. Species particularly sensitive to habitat alterations, such as Lincoln's sparrow, solitary sandpiper, and gray-cheeked thrush, were not observed at the mined site. Northern waterthrushes and blackpoll warblers were observed at the mined site only in a single remnant tall willow stand. In the Yukon, Lincoln's sparrow was chosen as a potential indicator of recovery of surface vegetation at mined sites

(Singleton et. al. 1981). In the only study comparable to ours, Wier (1981) found about 50 percent more birds on 20-65 year old mined areas than on unmined areas in the Klondike, Yukon. However, unmined areas were frequently dominated by black and white spruce, with a moss or ericaceous shrub understory, while seral stages in the mined area were dominated by willows. Willow communities support greater numbers of birds than do climax black or white spruce communities in Alaska (Spindler and Kessel 1979). In the Kantishna Hills, breeding bird populations at a mined streamside site were compared with those at an unmined site dominated by willows, not spruce.

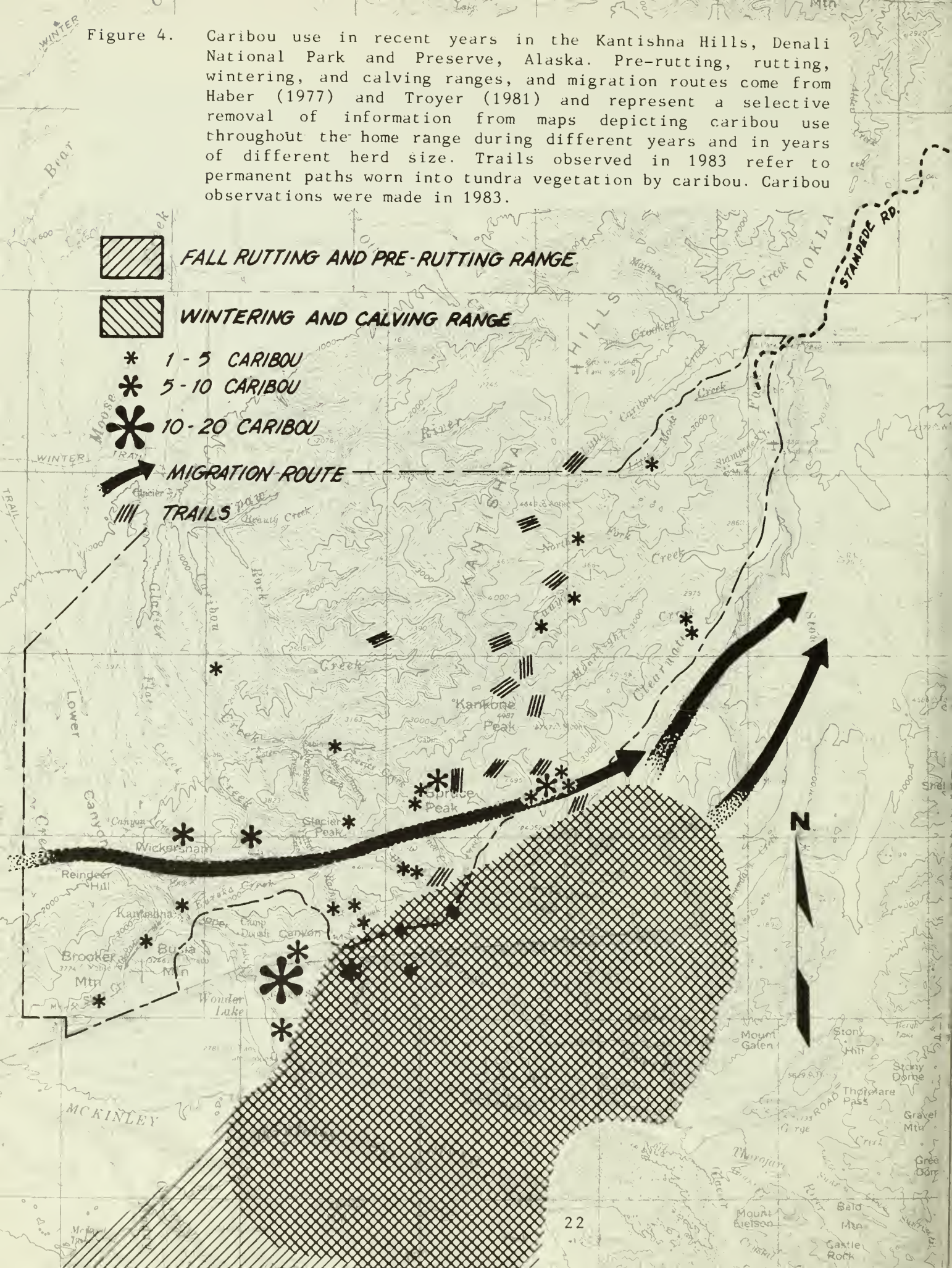
Based on data collected in 1983 and extrapolating from the reports of others, natural revegetation of placer mined areas in the Kantishna Hills to conditions of breeding bird utilization comparable to unmined areas may require up to 80 years. The development of a tall, layered overstory and adequate surface vegetation is essential for maximum breeding bird utilization. Anderson and Ohmart (1977) have shown that avian abundance in the riparian ecosystem is primarily a function of the complexity of vegetation. Similarly, MacArthur (1964) correlated high bird species diversity with a large number of vegetation layers. In the Kantishna Hills, it would be possible to accelerate both vegetative and breeding bird recovery through application of surface overburden, plantings of natural vegetation, and by leaving corridors of undisturbed vegetation and soils during mining.

PART II. WILDLIFE OF THE KANTISHNA HILLS

Description of Wildlife Use

Caribou. The Kantishna Hills are primarily important to caribou (Rangifer tarandus) as a pre-rutting, rutting, and wintering area (Murie 1935, Murie 1944, Haber 1977, Troyer 1977, 1978, 1979, 1980, 1981). Also, the seasonal migration routes of a portion of the herd have frequently crossed the study area, particularly in the spring (Figure 4). Of less importance has been the periodic use of the southern portion of the Kantishna Hills for

Figure 4. Caribou use in recent years in the Kantishna Hills, Denali National Park and Preserve, Alaska. Pre-rutting, rutting, wintering, and calving ranges, and migration routes come from Haber (1977) and Troyer (1981) and represent a selective removal of information from maps depicting caribou use throughout the home range during different years and in years of different herd size. Trails observed in 1983 refer to permanent paths worn into tundra vegetation by caribou. Caribou observations were made in 1983.



calving. Two major factors have contributed to variance in caribou use of the Kantishna Hills. First, the relative intensity of caribou use of traditional sites in Denali National Park has varied from year to year. Second, there has been a significant decline in the size of the Denali herd since the 1940's. From a peak of 20,000-30,000 animals in 1910-1940 (Murie 1944), the herd has declined to between 1200-1500 animals. When caribou herds are at low levels, their movements may be more tenuous and possibly more easily disrupted (Klein 1980).

Several reasons for the decline of the Denali herd have been suggested, but emigration to neighboring herds is considered likely (Haber and Walters 1980). Even though the Kantishna Hills were not used heavily during the study period, use may increase in the future when and if herd size increases.

The Kantishna Hills were more heavily used by caribou when the herd was larger (Murie 1935). According to Murie (1935:62), "In the Kantishna district a favorite winter range lies about Stony, Myrtle, Moonlight, and Clearwater Creeks, tributaries of the Toklat River...". Based on past Park Superintendents' reports, portions of the herd wintered in the Wonder Lake-Kantishna area through the 1930's. For example, 1500 were reported there in December 1927, and "large herds" were seen during the winter of 1937-38. In May 1938, 20,000 caribou were in the Kantishna and Moose Creek area, many apparently moving east. In 1940 and 1941, rutting activity occurred in the vicinity of upper Moose Creek westward and on September 6, 1940, there were about 500 caribou near Wonder Lake and "large herds" north of Wonder Lake in the Kantishna Hills. In summer 1941, an estimated 3-4,000 caribou were seen by miners in the Glacier and Caribou Creeks area (Vera Dul, pers. comm. 1983).

Park Superintendents' reports indicate that the Wonder Lake-Kantishna area was used by lesser yet still large numbers of caribou after 1941 when the herd first declined significantly in size. The area continued to be important as a rutting and wintering ground, and for some calving. Caribou frequently migrated through the area. For example, in September 1949, 2,000

caribou moved into the area just north of Wonder Lake. Caribou were "common" in the Wonder Lake-Kantishna area in August 1956, and September 1958. In September 1962, caribou were numerous in the Wonder Lake area until mid-month. Arley Taylor (pers. comm. 1983) observed heavy caribou use in the southern Kantishna Hills during the 1950's and 1960's. During those years, "hundreds" of caribou moved through the area, particularly in the fall.

More recently, Haber (1977) considered the Wonder Lake area, including the southern portion of the Kantishna Hills, one of several important wintering areas as well as the major rutting area for the Denali herd (Figure 4). Prior to the rut, caribou used the area as early as July each year. Those caribou wintering west of Wonder Lake often migrated through the southern Kantishna Hills in early spring enroute to areas east of the Toklat River. In late April and early May of 1971, most of the caribou that had earlier moved east of the study area moved back westward to the upper Moose Creek region, where calving occurred. Calving also occurred on upper Moose Creek and southeast of Wonder Lake in 1972.

Troyer (1977, 1978, 1979, 1980, 1981) also found the Wonder Lake-Kantishna area to be an important rutting and wintering area. Because calving occurred regularly in the vicinity of the Kantishna Hills, Troyer referred to the area as the Wonder Lake calving grounds, which included the southern portion of the study area along Moose Creek. In 1978, some cows also calved on Brooker Mountain and about 25 cows calved on the north slope of the Kantishna Hills near the Bearpaw River.

According to Troyer (1981), nearly the entire Denali herd was concentrated near Wonder Lake in November of 1977-80. Each year about two-thirds of the herd split and moved northeast down the Clearwater Fork and Stony Creek drainages to areas east of the Kantishna Hills. The remainder of the herd usually wintered near Wonder Lake, including Brooker Mountain. In 1977-78, a "small group" wintered along the north side of the Kantishna Hills from the headwaters of the Bearpaw River to Glacier Peak.

Troyer (1977, 1978, 1979, 1980, 1981) found that pre-calving and post-calving movements were erratic, often involving repeated migrations through the study area. Typically, most caribou wintering in the Wonder Lake-Kantishna area would move down the Clearwater and Stony Creek drainages to the Stampede calving grounds in spring. In 1978 and 1979, caribou wintering west of the Kantishna Hills moved east through the study area, joining the Wonder Lake group before migrating east. In 1977, 1978, and 1979 many of the caribou that calved on the Stampede calving grounds moved back up to the Clearwater and over the Kantishna Hills toward Wonder Lake. Movements of radio-collared caribou through the study area were frequently documented.

In 1983, single caribou and small groups, including cows with calves, were observed in and adjacent to the study area (Figure 4). Numerous old caribou tracks were observed at a mineral lick on Moose Creek a few km north of Kantishna on July 28. Limited observations indicate that the Wonder Lake-Kantishna area was again important for late summer grazing prior to the rut in 1983. On August 6, for example, 15 bulls were moving north along the eastern edge of Wonder Lake. Smaller groups of bulls were frequently seen near Wonder Lake throughout August, and near Wickersham Dome.

Several well defined caribou trails were mapped in 1983 (Figure 4). Trails centered around Myrtle Creek and the upper Clearwater Fork, and along the crest of the Kantishna Hills, primarily from Kankone Peak north to the head of Canyon Creek. Trails form more readily in certain vegetation types and topography, and are particularly obvious on ridgetops and passes.

Mineral Licks. A lick was discovered on Moose Creek approximately 2 km north of the Kantishna Airstrip. It was a wet muddy area fed by springs, resulting in a small creek which flowed into Moose Creek. A single caribou was at the lick when it was first discovered on July 28. Old tracks around the lick, however, indicated that it had been used earlier in the year by a number of caribou and several moose.

On July 26, a second lick was found on Myrtle Creek about 2 km west of the confluence of Myrtle Creek and the Clearwater Fork. The lick was es-

sentially a dirt bank about 10 m long with water seeping from it. The surrounding rocks were stained red and smelled sulphurous. On two separate days, a single caribou was observed motionless with its muzzle pressed against the bank. A number of caribou tracks were observed in wet sand surrounding the lick.

According to Boertje (1981), caribou, and other herbivores, frequently use mineral licks or springs presumably to obtain sufficient sodium. He found that adult female caribou of the Denali herd visited licks several times prior to and following the beginning of early spring vegetative growth. Similarly, Tankersley (1981) found that moose in Denali National park used licks most intensely from mid-May through June. She concluded that licks should be protected from destruction so that moose can obtain needed minerals from traditional sites.

Dall Sheep. There are no reports of recent Dall sheep (Ovis dalli) sightings in the Kantishna Hills, although Haber (1977) reported tracks of 3-4 sheep on upper Crooked Creek during the winter of 1970-71.

There is more substantial evidence that sheep were present in very small numbers in the 1920's and 1930's. In the late 1920's, sheep were present on the headwaters of Clearwater Fork and Moose Creek, and at least periodically on Moonlight Creek (Schneider et. al. 1983). According to Ernie Maurer (pers. comm. 1983), Bill Julian observed three sheep on upper Glacier Creek during the winter of 1935-36. Also, Fanny Quigley stated that for three winters in the late 1930's there were sheep in the Kantishna Hills near Wonder Lake (Berle Mercer, pers. comm. 1983). According to Mercer, Quigley saw the sheep during winters of heavy snow. More recently, John Parker (pers. comm. 1983) found well-bleached ram horns on Spruce, Glacier, and Kankone Peaks.

Moose. Significant numbers of moose (Alces alces) were found in the Kantishna Hills, primarily in the Clearwater watershed, during aerial surveys in 1973 (Haber 1977) and 1978 (Troyer 1978). In October 1973, Haber surveyed moose in the Clearwater watershed and from the headwaters of North

Fork Moose Creek to the Kantishna area. Ninety-three moose were counted in the Clearwater watershed between Myrtle and Little Moose Creeks (Figure 5). Based on correction factors, Haber estimated a total of 123 moose along the Clearwater. This represents about 50 percent of the moose estimated by Haber to be within the range of the Toklat wolf pack. In the Kantishna Hills, Haber noted concentrations on Myrtle and Canyon Creeks and observed very few moose in the Moose Creek watershed. Haber also found notable moose activity within the Bearpaw River and Crooked Creek watersheds but did not comment on numbers in those areas. Troyer censused moose throughout the northern addition to Denali National Park in March 1978, and found that the Kantishna Hills had the greatest numbers of moose per square mile of habitat. He reported that the greatest concentration of moose in the northern areas was again in the Clearwater watershed, particularly on Canyon and Little Moose Creeks (Figure 5). Troyer also observed concentrations of moose on the Bearpaw River just north of the study area.

Observations of moose in summer 1983 were centered in the Clearwater watershed and on lower Moose Creek (Figure 5), and paralleled winter concentrations reported above.

Market and Subsistence Hunting. Early settlers in the Denali region may have greatly influenced local ungulate populations. According to Murie (1944), there was considerable sheep hunting in the park up to 1920. On East Fork, for example, at least 70 rams were brought to one hunting camp. Dixon (1938) claimed that hundreds of sheep were slaughtered each winter. Market hunters apparently sold the meat to mining camps at Fairbanks and Kantishna. With the construction of the Alaska Railroad, greater numbers of sheep were taken by hunters and shipped to local markets.

According to Bishop (1978), besides taking game for themselves, up to the 1940's miners and trappers in the Kantishna Hills fed caribou meat to their dogs. The period of greatest use was apparently the 1920's and 1930's when miners, trappers and prospectors were most active. Clinton Tracy (pers. comm. 1983), a miner in the Kantishna Hills during the 1930's, reported

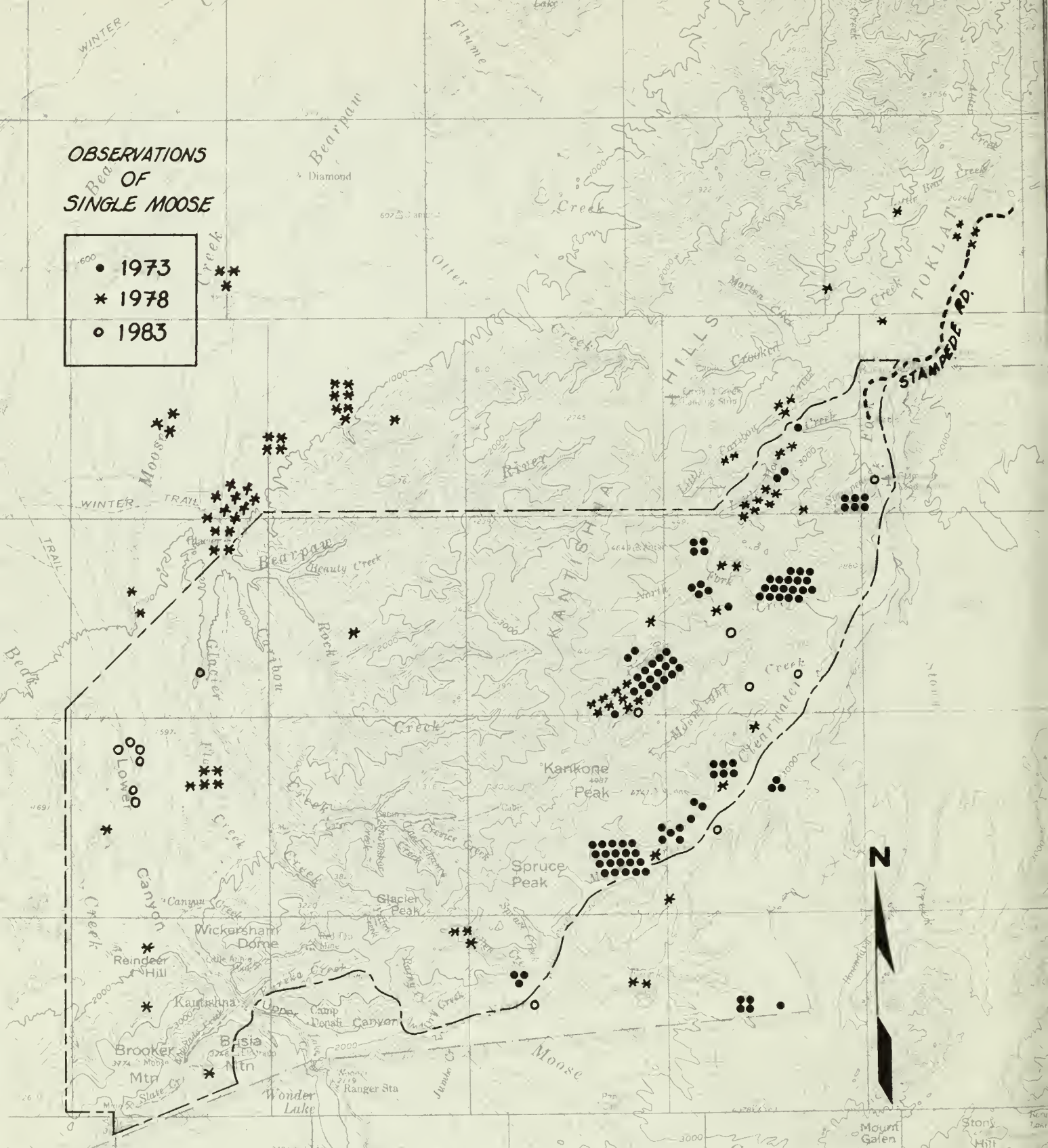


Figure 5. Moose observations in the Kantishna Hills in 1973, 1978, and 1983, Denali National Park and Preserve, Alaska. Observations in 1973 are from Haber (1977) and observations in 1978 from Troyer (1978).

that one resident by himself killed 130 caribou and 17 moose during the winter of 1937 to feed his dogs and himself. Miners reportedly hunted sheep when they crossed the park boundary into Moonlight Creek in the late 1920's and 1930's (Schneider et. al. 1983). As late as the winter of 1964, Arley Taylor (pers. comm. 1983) found the heads of 30 freshly killed moose on Eldorado Creek.

Bear. Large numbers of brown bear (Ursus arctos) are found in the Kantishna Hills. About 70 percent (n=35) of the observations reported in the northern additions to Denali National Park between 1950-75 were in or near the Kantishna Hills study area (Valkenburg 1976). Brown bears were also observed frequently in 1983 in the Kantishna Hills (Figure 6).

The Kantishna Hills support the only large amount of alpine habitat in the northern additions according to Valkenburg (1976). As a result, brown bears utilize the study area not only in spring and fall, but extensively in June and July to graze on the lush growth of grasses and herbs in alpine meadows. Preferred summer sites in the study area include Canyon Creek, Caribou Creek, and Myrtle Creek (Valkenburg 1976).

The Kantishna Hills are close to important salmon spawning areas, which are used by bears in fall. For example, on October 11, 1976, 12-15 brown bears were observed on a short stretch of Moose Creek above Diamond north of the study area. Valkenburg (1976) suspects that many of the bears visiting the Moose Creek and Toklat Springs spawning areas come from the Kantishna Hills or cross the Kantishna Hills enroute to the Springs.

Black bears (Ursus americanus) were sighted as frequently as brown bears in 1983 (Figure 6). Most observations were in the southwestern portion of the study area on Moose and Caribou Creeks. In the northeastern portion of the study area near the Stampede Mine, Earl Pilgrim saw about seven black bears for each brown bear during a period of residency from 1936 to about 1978 (Valkenburg 1976).

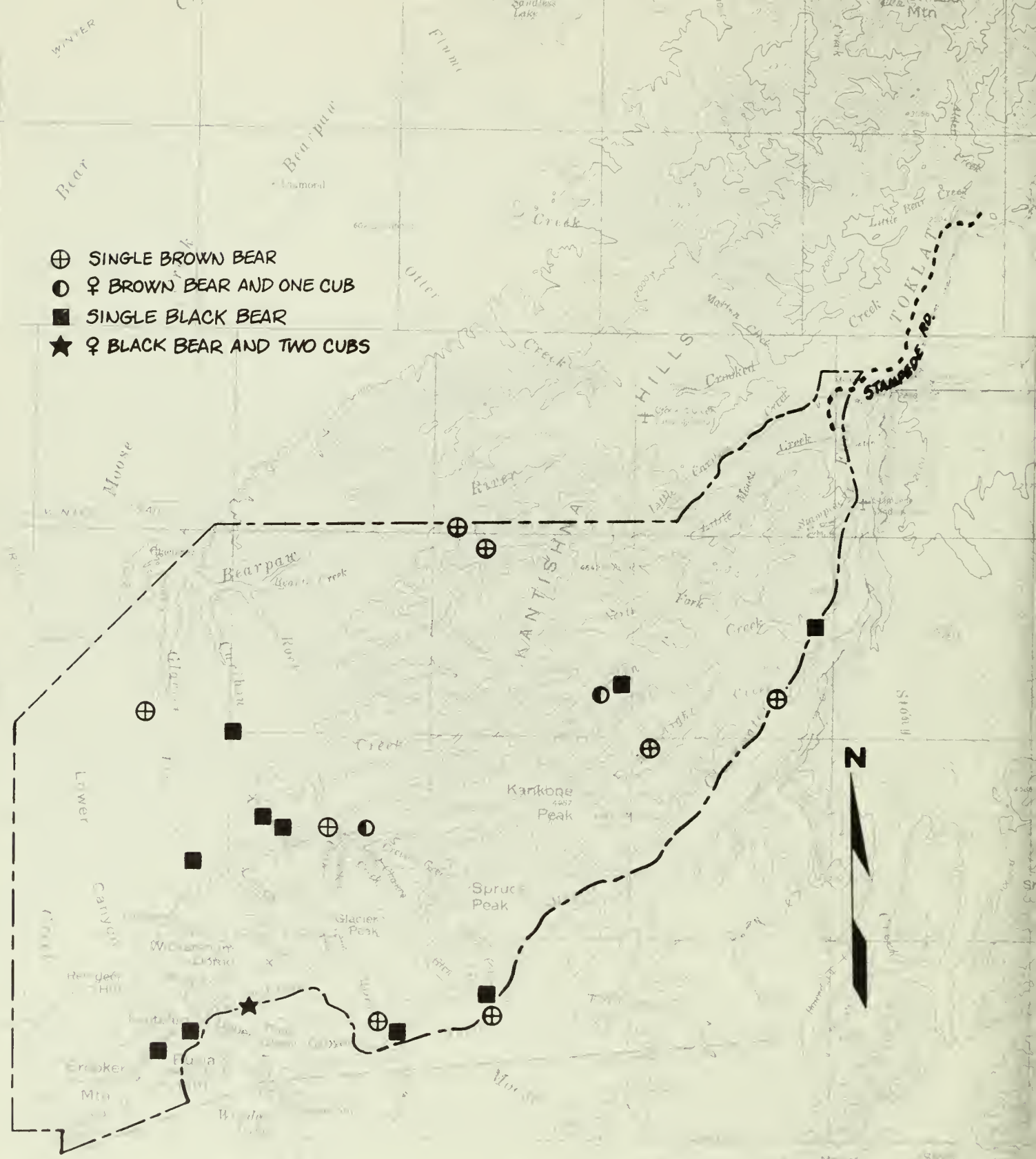


Figure 6. Bear observations in the Kantishna Hills in 1983, Denali National Park and Preserve, Alaska.

Wolf. The western portion of the Kantishna Hills study area comprises one-third of the home range of the Toklat wolf pack (Canis lupus) (Figure 7) according to Haber (1977). The Wonder Lake pack, apparently an offshoot of the original Toklat pack, used the western one-third of the latter's home range in 1974. Observations by Haber (1977) and others indicate that the Toklat pack depends on the Clearwater watershed and the southern one-third of the study area, particularly upper Moose Creek (Appendix 1). Haber's (1977) sightings of wolves of the Wonder Lake pack were centered along Moose Creek from Kantishna to the confluence of Glen Creek. Haber did not study wolf use in the northern and northwestern portions of the study area.

There are no records of historic or recent wolf dens in the Kantishna Hills study area. However, it is important to emphasize that wolf use in the northern and northwestern portions of the study area remains poorly studied (John DalleMolle, pers. comm. 1983). In 1969, Haber (1977) located a rendezvous site in the eastern Kantishna Hills on the Clearwater Fork near the confluence of Canyon Creek. A rendezvous site is defined as a site without tunnels or chambers where pups are often moved following parturition at a nursery den. The site was used for 13-30 days between early August and early September. During that time four adults and/or yearlings and at least one pup were present. In mid-August 1982, a dead wolf pup was discovered about 3 km up Stampede Creek, or roughly 7 km north of the 1969 rendezvous site (Harrison, pers. comm. 1983). In 1983, I flew the Clearwater several times and camped overnight on the Clearwater at the mouth of Canyon and Moonlight Creeks, and on the Toklat just north of the confluence of the Clearwater, but observed no wolves.

Records indicate that three packs of wolves have denned near the Kantishna Hills study area in recent years (Figure 7). Haber's (1977) findings suggest that the Toklat pack has consistently denned within 15 km of the eastern boundary of the study area on the lower Toklat River since at least the 1930's. The pack currently numbers approximately 10-15 wolves (Haber, pers. comm. 1983). In 1983, a different pack of wolves denned within 10 km of the northeastern end of the study area (John Dalle-Molle, pers. comm.

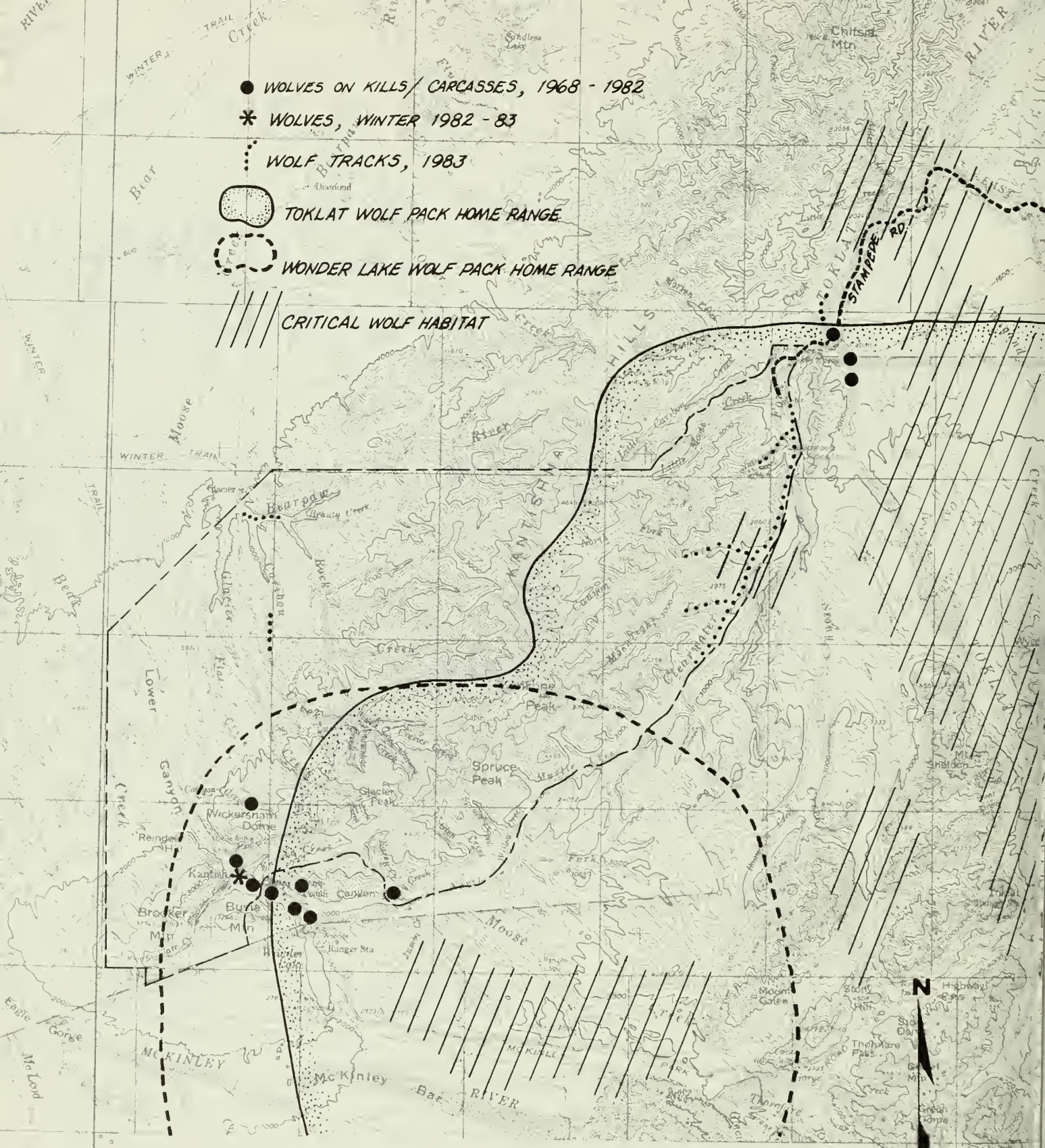


Figure 7. Wolf use in the Kantishna Hills between 1968-1983, Denali National Park and Preserve, Alaska. Home ranges, homesites, and several observations of wolves on kills/carcasses are from Haber (1977). Critical wolf habitat is based on the location of active and/or historical homesites (denning sites and rendezvous sites).

1983). Beginning in 1970 or 1971, when the Toklat pack split to form the Wonder Lake pack, wolves denned southeast of Wonder Lake, approximately 7 km from the southern boundary of the Kantishna Hills study area. In 1972 or 1973, the Wonder Lake pack consisted of nine wolves and pups were successfully raised both years. In 1957, an active den was located on upper Moose Creek but has apparently not been used since (J. Van Horn, pers. comm. 1983). If wolves denning near Wonder Lake were actually a loosely associated family unit of the Toklat pack (Haber 1977), wolves will likely den near Wonder Lake in the future if the Toklat pack reaches a large size and a splinter pack forms.

Even though no dens have yet been found in the Kantishna Hills, on several occasions the wolves have been observed feeding in the study area on either killed or scavenged prey (Figure 7), usually moose (Haber 1977). Observers frequently have sighted wolves on the lower Clearwater and on the Toklat near the confluence of the Clearwater (Appendix 2), suggesting that wolves denning on or near the Toklat often reach the study area by traveling along the Toklat and then up the Clearwater. In summer 1983, evidence of wolf activity also was centered along the Clearwater Fork (Figure 7).

Wolf Trapping and Hunting. In recent years, wolves were trapped legally in or near the Kantishna Hills study area by at least two registered subsistence trappers. Wolves trapped near Kantishna included 2 during the winter of 1979-80, 2 (1 pup and 1 adult) during the winter of 1981-82, and at least 1 during the winter of 1982-83 (R. Ashbrook, pers. comm. 1983). At least one wolf was trapped at the confluence of the Toklat River and Clearwater Fork during the winter of 1982-83 (L. Johnson, pers. comm. 1983).

There are four records of wolves being shot in the study area. During summer 1941, a wolf was shot in the Glacier/Caribou Creek area (V. Dul, pers. comm. 1983). In winter 1956-57, 12 wolves were shot in the "Kantishna Hills area" by a single member of the Tanana Sportsman Association (F. Dean, pers. comm. 1984). On August 25, 1966, two adults were shot by hunters near the Red Top Mine (Haber 1977). In July or early August 1979 a wolf was shot on Eureka Creek (B. Looney, pers. comm. 1983).

Furbearers

Marten. Marten (Martes americanus) is the most important furbearer in the Kantishna Hills. Interviews with local trappers indicated marten are fairly common, particularly at low elevations at the north end of the Kantishna Hills study area (R. Ashbrook, pers. comm. 1983). Marten reach their greatest densities in the extensive black spruce forests north of the Kantishna Hills (Bishop 1978).

In recent winters, about 90 marten per winter were trapped on 100 miles of trapline running from Kantishna north (R. Ashbrook, pers. comm. 1983). A particularly productive area was the burned site on lower Moose Creek. During winter 1976-77, 60 marten were trapped, most on lower Moose and Glacier Creeks (L. Shank, pers. comm. 1983). In the eastern portion of the study area in the late 1970's, marten were common along creeks running into the lower Clearwater, particularly Stampede Creek (B. Lee, pers. comm. 1983). During 42 years of residency on Stampede Creek, Earl Pilgrim observed marten frequently each year (E. Pilgrim, pers. comm. 1983).

Wolverine. Wolverines (Gulo gulo) are sparsely distributed throughout the Kantishna Hills study area. In 1983, fresh tracks were observed on Moonlight Creek on May 17 and on Stampede Creek on August 11. Other recent records include 2 seen between Crevice and Last Chance Creeks in August 1975 (T. Bundtzen, pers. comm. 1983), and an adult with young observed on Willow Creek in 1972 or 1973 (B. Mercer, pers. comm. 1983).

Recent trapping records include 1 wolverine taken on Caribou Creek in November 1975 (S. Carwile, pers. comm. 1983), and 2 taken during the winter of 1976-77 (1 on Slate Creek and 1 on lower Moose Creek) (L. Shank, pers. comm. 1983). Four were trapped in the western portion of the study area in winter 1981-82 (R. Ashbrook, pers. comm. 1983).

Mink. Mink (Mustela vison) are much less common in the Kantishna Hills study area than marten (r. Ashbrook, pers. comm. 1983). Although 1 mink was trapped on upper Moose Creek at the mouth of Rainy Creek during winter

1976-77 (R. Ashbrook, pers. comm. 1983), according to Bishop (1978) mink require a trapping technique somewhat different than that for marten and are seldom trapped in the study area. Mink are more common outside the Kantishna Hills to the north (Bishop 1978).

River Otter. Although otter (Lutra canadensis) are common residents of slower flowing waterways near Minchumina (Bishop 1978), they have been observed only infrequently in the Kantishna Hills. The only recent sighting is a report of two seen on open water on Moose Creek near Kantishna during winter in the late 1970's or early 1980's (R. Ashbrook, pers. comm. 1983).

Beaver. Evidence of beaver (Castor canadensis) activity was noted at several locations in the Kantishna Hills in 1983. Single beavers were observed on lower Glacier Creek on June 24, and on Moose Creek at the confluence of Rainy Creek on July 26. Dammed ponds with lodges occurred on Moose Creek about 2 km east of camp Denali, on Moose Creek near the confluence with Glen Creek, and on Moose Creek at the north end of the Kantishna airstrip. Additional lodges were found on four separate ponds in the western portion of the study area in a black spruce area near Bear Creek.

Red Fox. In 1983, tracks of red fox (Vulpus vulpes) were observed on a ridge above Friday Creek on May 21, and along Rainy Creek on August 9. During winter 1981-82, approximately 20 fox were trapped in the western section of the study area (R. Ashbrook, pers. comm. 1983).

Lynx. Although lynx (Felis lynx) have been observed in the Kantishna Hills, none were reported trapped in recent winters (R. Ashbrook, pers. comm. 1983) and none were seen in 1983.

Other Mammals

Short-tailed Weasel. A single short-tailed weasel (Mustela erminea) was observed on lower Caribou Creek on August 27, 1983.

Least Weasel. One least weasel (Mustela nivalis) was observed on Moose Creek near the confluence of Friday Creek on August 8, 1983.

Collared Pika. Pikas (Ochotona collaris) were fairly common in rock fields above treeline in the Kantishna Hills in 1983. On July 8, for example, 5 were calling on upper Canyon Creek. They were also heard and/or seen on upper Glen Creek, upper Rock Creek, upper Little Moose Creek, upper Stampede Creek, upper Caribou Creek, and upper Rainy Creek.

Snowshoe Hare. Observed evidence of hare (Lepus americanus) in the study area in 1983 was restricted to a partially eaten willow on lower Caribou Creek. Hare were common in the Kantishna area in winter 1976-77 (L. Shank, pers. comm. 1983).

Hoary Marmot. In 1983, marmots (Marmota caligata) were heard and/or observed regularly above treeline in the Kantishna Hills on upper Canyon Creek, upper Glen Creek, and upper Little Moose Creek. The remains of a marmot were found at a gryfalcon nest on Caribou Creek.

Arctic Ground Squirrel. Arctic ground squirrels (Spermophilus parryii) were fairly common at scattered locations on well drained ridges above and below treeline in 1983. The remains of 13 were found at a gryfalcon nest on Little Caribou Creek.

Red Squirrel. In the Kantishna Hills, red squirrel (Tamiasciurus hudsonicus) are largely restricted to river bars where there are stands of white spruce. In 1983, they rarely were observed along the Clearwater and its tributaries, but were fairly common along lower Moose Creek and the lower Bearpaw drainage.

Porcupine. In 1983, a single porcupine (Erethizon dorsatum) was observed on upper Canyon Creek on July 6.

Cricetid Rodents. Three red-backed voles (Clethrionomys rutilus), and 1 tundra vole (Microtus oeconomus) were captured during a small mammal census in riparian willow habitat on lower Glacier Creek in June 1983. Runways and tunnels of yellow-cheeked voles (Microtus xanthognathus) were observed in black spruce woodland near lower Moose Creek on August 22 and 23.

Birds. Eighty-five species of birds were observed in the Kantishna Hills study area in 1983 (Appendix 3). This represents about 60 percent of the species thus far recorded in Denali National Park. With the exception of Hammond's flycatcher, all species observed in the Kantishna Hills were previously recorded in Denali National Park. Records of Hammond's flycatchers in the Kantishna Hills represent a southern extension of the previously known range of the species in Alaska. Records of surfbirds are notable because their breeding range is largely restricted to the mountains of southcentral Alaska. Northern wheatears and arctic warblers are two species of primarily Asiatic distribution which in North America breed only in Alaska.

Only two active raptor stick nests were located in 1983. Based on the number of inactive stick nests and their wide distribution throughout the study area (Appendix 3), cliff nesting raptors may have been more abundant in previous years. Golden eagles, probably subadults, were twice observed using inactive nests as perch sites. The following raptor species were observed in 1983: bald eagle, northern harrier, sharp-shinned hawk, red-tailed hawk, golden eagle, American kestrel, merlin, and gryfalcon, of which northern harrier, golden eagle, American kestrel, merlin, and gryfalcon nested. The golden eagle and gryfalcon nests were located just outside the northern boundary of the study area (Appendix 3).

No endangered raptor species were observed in the Kantishna Hills in 1983. In addition, there were no significant densities of waterfowl or other economically important game birds in the study area. Numbers of waterfowl were very low because of the lack of lakes and ponds. Even though all three ptarmigan species were noted, observations were very scattered.

Amphibians. A single wood frog (Rana sylvatica) was observed on lower Caribou Creek on June 15, 1983.

Discussion of Wildlife Relative to Mining

Caribou

Significance of the Denali Caribou Herd

1. As a Biosphere Reserve, Denali National Park is representative of a functioning, subarctic large mammal ecosystem of which caribou are an important part.
2. The Denali herd, presently the 13th largest of 22 herds in the State, is one of the most accessible herds in North America. The Denali herd is a worldwide tourist attraction, generating substantial revenues for the state of Alaska (Cunningham 1983). In 1983, an average of about 44 caribou were seen during each vehicle trip into the park (Singer and Beattie, unpublished data). Disturbance of caribou in the Kantishna Hills could alter use patterns and lead to diminished use of areas adjacent to the Park Road.
3. The Kantishna Hills are important to Denali caribou as a pre-rutting and rutting area, and to a limited extent for wintering and calving. Migration routes cross the study area. There is evidence that caribou used the Kantishna Hills to a greater degree when the herd was larger.

Potential Effects of Mining on Caribou

1. If the proposed Stampede road followed major caribou migration routes, such as the Clearwater Fork or the mainstream Toklat River, caribou would likely be forced to alter local use patterns. Noise and increased human access could have adverse effects on caribou depending on the level and frequency of traffic. Winter vehicular use of the Stampede road could affect caribou behavior, resulting in disturbance related injuries during a critical period in the annual cycle. For example, disturbances during periods of severe cold, deep crusted snow or food shortage in winter could cause abortions, injuries, additional stress, and death (Geist 1971).
2. There is no evidence that present poaching levels are threatening caribou populations in the Kantishna Hills. In 1983, approximately six caribou and/or moose were poached near Kantishna (Swift, pers. comm.

1983). Illegal harvest of game is often associated with any remote community in Alaska and should be considered a secondary effect of mining. A continued increase in the number of mining operations and in numbers of local residents would lead to an increase in poaching if law enforcement efforts are not also increased. An increase in numbers of local residents would not lead to a greater legal subsistence harvest of caribou, however, since the Kantishna Hills and surrounding area has been closed to caribou hunting since 1977.

Moose

Significance of the Denali Moose Population

1. Moose are an important member of the large mammal ecosystem at Denali National Park. As a natural, unhunted population they provide unique opportunities for research, photography, and observation.
2. Alaska is one of only a few states with harvestable moose populations. However, the main significance of moose in Denali National Park is not sport hunting (only about 13 moose were harvested in the Preserve in 1983), but their value as a visitor attraction in 1983, each vehicle trip into the park averaged about 3 moose sightings (Singer and Beattie, unpublished data).
3. About 50 percent of the moose estimated to be within the range of the Toklat wolf pack live in the Kantishna Hills study area. The Kantishna population represents the second largest concentration of moose in the park, and the Clearwater watershed is the single most important area for the Kantishna Hills moose population.

Potential Effects of Mining on Moose

1. Placer mining operations in the Kantishna Hills are conducted largely in valley bottoms where they substantially damage riparian willow stands. Vegetation study indicates that, 40 years after mining and in the absence of reclamation, revegetation is not sufficient to attract wintering moose. It is possible that this degree of habitat alteration

could reduce moose numbers depending upon the extent of placer mining and availability of alternate moose habitat.

2. Poaching of moose in the Kantishna Hills is minimal, but poaching could increase if the human population increases. There is currently only one subsistence user of wildlife in the Kantishna Hills study area with a yearly take of about 2 animals. It is unclear whether new mining residents would qualify for subsistence permits (J. Dalle-Molle, pers. comm. 1984).

Bears

Significance of the Denali Bear Population

1. Bears are an integral part of the large mammal ecosystem at Denali National Park.
2. Brown bears are an important visitor attraction because Denali National Park is one of the best places in North America to view them. In 1983, each vehicle trip into the park averaged about 4 bear sightings (Singer and Beattie, unpublished data).
3. Brown bears are sighted frequently in the Kantishna Hills study area. In the northern additions, the only extensive alpine habitat for brown bears is in the Kantishna Hills. Black bears are far more common in the Kantishna Hills than elsewhere in the old park.

Potential Effects of Mining on Bears

1. Disturbance of alpine areas, such as Canyon and Myrtle Creek, would eliminate important summer habitat for brown bears and cause a reduction in bear numbers.
2. The effects of noise, human contact, and other disturbances would cause bears to avoid portions of the study area.
3. Those bears attracted to garbage generated by mining operations could be destroyed or relocated to avoid human conflict, and problem bears could eventually threaten life and property in areas adjacent to the Kantishna Hills. Regulations concerning the disposal of garbage should be strictly enforced.

4. Poaching levels would increase if the Stampede road were built and if law enforcement efforts are not also increased.

Wolf

Significance of the Denali Wolf Population

1. The park has one of the largest totally protected large mammal ecosystems in North America. Wolves occupy the top level of the trophic pyramid in this ecosystem. Because of the long history of research (Murie 1944, Haber 1977), wolf populations in Denali National Park should serve as a reference for studies of the comparative health of predator-prey systems in other subarctic areas.
2. The possibility of seeing wolves in a natural setting is of interest to many Denali Park visitors, and a primary tourist attraction in the State of Alaska. The Toklat pack is currently one of two packs visible to park visitors and its protection is important, particularly in light of the recent disappearance of the Savage pack (J. Dalle-Molle, pers. comm. 1983).
3. The western portion of the Kantishna Hills study area comprises one-third of the home range of the Toklat wolf pack. Wolves rendezvous along the Clearwater Fork and frequently travel through the study area along the Clearwater Fork and upper Moose Creek in search of prey. Wolf use in the northern and northwestern portion of the study area remains poorly studied.

Potential Effects of Mining on Wolves

1. The effects of noise, human contact, and other disturbances cause wolves to avoid portions of the study area.
2. The proposed Stampede road would likely have a negative impact on wolves using the study area and areas surrounding the Kantishna Hills. The Stampede road would cross critical wolf range, bringing various types of disturbance closer to known or suspected den and activity sites. Wolves have been regularly trapped and periodically shot in and

adjacent to the study area. Although speculative, the disappearance of the Savage wolf pack from known home range and activity sites in 1983 (J. Dalle-Molle, pers. commn. 1983) may have been the result of trapping pressure along the eastern portion of the Stampede road (Haber, pers. comm. 1983), and the Toklat pack could be similarly affected in the west. Because wolves are extremely sensitive to human disturbance, the road would likely influence use of traditional sites and alter travel routes, particularly if it followed the Clearwater Fork and/or the mainstem Toklat River.

Potential Effects of Mining on Furbearers

1. The effects of mining activity and habitat loss on furbearer populations in the Kantishna Hills are unknown. On some occasions, abandoned placer sites in Alaska and Canada were used by certain furbearer species. Beaver regularly used tailings ponds in the Yukon (Wier 1981) and in interior Alaska (J. Durst, pers. corres. 1983). Fox denning in a pile of overburden has been observed in the Yukon (Wier 1981), and lynx denning on a mined site has been observed in western Alaska (Wier 1979, cited in Wier 1981).
2. There is no evidence that subsistence trapping has seriously affected furbearer populations, although there also is no information on what effects, if any, such trapping may have had in the past.

Potential Effects of Mining on Raptors

Cliff nesting raptors may be adversely affected at nest sites by noise and other human disturbances associated with nearby mining operations. According to Newton (1978), human presence has increasingly rendered suitable habitat unattractive to raptors throughout their range, futher reducing their breeding numbers. The failure of parent birds to return to eggs or young after human interference is a serious result of such disturbances. In the Kantishna Hills, several inactive stick nests were found in drainages which had been or were being mined, and in many cases the inactive nests overlooked mining operations. No active nests were found in such situations, and the 2 active cliff nests were both in a pristine

drainage. Although the potential effects of interference vary greatly depending on the species, gryfalcons and golden eagles are particularly susceptable to disturbance. For example, use of fixed-wing aircraft near gryfalcon and golden eagle nest sites could cause nest desertions and subsequent failure of the population to produce young (Fyfe and Olendorff 1976).

RECOMMENDATIONS FOR FUTURE WORK

1. The relationship of moose to placer mining should be investigated in the Kantishna Hills, particularly since this study discovered minimal use being made of the 40-year old mined site. Because placer mining operations were very active in 1983 and may increase, moose numbers should be closely monitored in the future. For better evaluation, additional information is needed on the size of the moose population, on moose distribution relative to factors such as snowdepth and adjacent forest cover, and on availability of alternate habitat.

2. More vegetation surveys, particularly in specific streamside plots before and after mining, should be conducted to permit more accurate evaluation of habitat alteration, recovery periods, and effects of different mining techniques. Effectiveness of replacing soil overburden and revegetating with native vegetation also should be evaluated.

SUMMARY

In 1983, current and historic wildlife use and the effects of mining on wildlife habitat in the Kantishna Hills, Denali National Park, Alaska were studied between May 16 and August 28. Wildlife use was determined from available literature, interviews, and surveys of the study area. Comparative study of the effects of mining on wildlife habitat was conducted in a pair of streamside sites, one mined and one unmined.

After 40 years, habitat at the mined streamside site had not returned to conditions comparable to the unmined site in terms of moose and breeding

bird utilization. Stems of some willow species important to moose were shorter, smaller in diameter, and more widely scattered at the mined site, making them largely unusable as a source of food and cover. Moose utilization as measured by numbers of pellet groups was significantly less at the mined site than at the unmined site. Breeding birds were a quarter as abundant and species diversity was less on transects at the mined site compared to the unmined site. Small mammal trapping results were inconclusive, but other researchers have found smaller populations in mined versus unmined areas, probably because of less understory vegetation. In the Kantishna Hills, percent coverage of understory vegetation was significantly less at the mined site. Natural recovery of placer mined areas to vegetative conditions suitable for natural levels of moose, small mammal and breeding bird utilization probably requires between 70-100 years in the Kantishna Hills.

The Kantishna Hills, particularly the Clearwater watershed, provide important habitat for large mammal populations in Denali National Park. Caribou use the Kantishna Hills, particularly the southern portion, as a pre-rutting and rutting ground, and to a limited extent for wintering and calving. Migration routes cross the study area. There is evidence of greater caribou use of the Kantishna Hills when the herd was larger. Moose are particularly abundant in the Clearwater watershed, and the area density is second only to the far eastern section of Denali National Park. About 50 percent of the moose estimated to live within the range of the Toklat wolf pack are in the study area. Brown bears are common in the Kantishna Hills, which contain the only extensive alpine habitat in the northern additions and black bears are far more common than elsewhere in the old park. Wolves occasionally rendezvous and frequently travel through the study area in search of prey. Active wolf dens are located within 10-15 km of the study area. There are no recent records of Dall sheep in the Kantishna Hills.

At least 18 additional species of mammals, 85 species of birds, and one amphibian occur in the Kantishna Hills. Economically important furbearers, such as marten, are found in the Kantishna Hills but probably reach greater densities outside the study area. No endangered raptor species were observed and only two active raptor stick nests were located. There are no significant densities of waterfowl or other important game birds.

As a Biosphere Reserve, Denali National Park is representative of a functioning subarctic ecosystem. Habitat alteration in one part of the ecosystem, such as the Kantishna Hills, can have repercussions elsewhere. The large mammals in Denali National Park are a worldwide visitor attraction, generating substantial revenues for the state of Alaska.

The severe degree of habitat alteration caused by any large increase in placer mining would likely lead to a reduction in moose numbers and to predators that rely on moose such as wolves. Secondary effects associated with an increase in the human population, could result in more poaching of large animals, more human/bear conflicts and a reduction or further reductions in the number of cliff nesting raptors. The proposed Stampede Road, particularly if built along the Clearwater Fork or the mainstem Toklat River, would likely have a severe impact on movements and use patterns of wolves and caribou.

Accelerated revegetation of mined sites should be considered. Replacement of overburden and fines greatly assisted establishment of herbaceous cover in other study areas. Moose seemed most affected of all large mammals by habitat loss, and future work should include additional studies of recovery rates of vegetation, and methods to accelerate recovery of mined sites to increase moose browse supplies.

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APPENDIX 1. HISTORICAL USE OF THE KANTISHNA HILLS BY WOLVES.

Date	Observations	Source
late 1930's	Group of 22 and group of 19 near Wonder Lake.	Haber (1977)
Summer 1941	One wolf shot in Glacier/Caribou Creek area.	Dul (pers. comm. 1983)
Dec. 7, 1953	Six wolves on the Clearwater Fork. First seen on the lower Toklat, then travelled up the Clearwater Fork.	Haber (1977)
Aug. 18, 1955	Four wolves on the Clearwater Fork.	Haber (1977)
Winter 1956-57	12 wolves shot in the "Kantishna Hills area".	Dean (pers. comm. 1984)
Winter 1960	15+ wolves on North Fork Moose Creek at confluence of Glen Creek.	Arley Taylor (pers. comm. 1983)
May.-Sept. 1966-67	Four separate sightings on North Fork Moose Creek; 2 separate sightings near Busia Mountain; 4 separate sightings near the north end of Wonder Lake; kill or kill remains being utilized by wolves near Wickersham Dome and near Camp Denali.	Haber (1968)
Aug. 25, 1966	About 6 wolves near the Red Top Mine.	Haber (1977)
Oct. 1966	Five wolves on North Fork Moose Creek.	Haber (1977)
Feb. 1967	Eight wolves on the Clearwater Fork at the confluence of Moonlight Creek.	Haber (1977)
Dec. 1967	Five wolves on Moose Creek near Kantishna.	Haber (1977)
March 4, 1968	Four wolves on Moose Creek near Camp Denali feeding on moose.	Haber (1977)
Dec. 11, 1968	About 5 wolves on the Toklat River at the confluence of the Clearwater Fork.	Haber (1977)
April 1969	Six wolves on Caribou Creek.	Haber (1977)
Aug. 6, 1969	Single wolf killed adult beaver on Moose Creek at the confluence of Rainy Creek.	Haber (1977)
Jan. 9, 1970	About 10 wolves on the Toklat River at the confluence of the Clearwater Fork.	Haber (1977)
Feb. 3, 1970	About 3 wolves on the Clearwater Fork.	Haber (1977)
April 7, 1970	Five wolves on the Clearwater Fork at the confluence of Stampede Creek.	Haber (1977)

APPENDIX 1 (continued)

Date	Observations	Source
Jan. 18, 1971	Nine wolves on the Toklat River at the confluence of the Clearwater Fork.	Haber (1977)
Feb. 22, 1971	Nine wolves on the Clearwater Fork at the confluence of Stampede Creek.	Haber (1977)
March 7, 1971	Nine wolves on the Clearwater Fork at the confluence of Stampede Creek.	Haber (1977)
March 10, 1973	Thirteen wolves on the Clearwater Fork. The wolves traveled north along Myrtle Creek and the Clearwater Fork to the Toklat River.	Haber (1977)
March 19, 1973	Six wolves on Moose Creek near Kantishna feeding on kill or scavenged prey.	Haber (1977)
Oct. 15, 1973	Two wolves on Toklat River at the confluence of the Clearwater Fork; single wolf traveled north on Clearwater Fork to Moonlight Creek.	Haber (1977)
April 4, 1976	Seven wolves near the north end of Wonder Lake.	Buskirk (1976)
Winter 1976-77	Group of 5 and group of 10 in the Kantishna area.	Shank (pers. comm. 1983)
Nov. 1977	Two wolves near Busia Mountain.	McKinney (pers. comm. 1983)
July 1978	Three wolves on the Toklat River at the confluence of the Clearwater Fork.	Bundtzen (pers. comm. 1983)
July or August 1979	One wolf shot on Eureka Creek.	Looney (pers. comm. 1983)
Winter 1979-80	About 14 wolves in the Kantishna area.	Ashbrook (pers. comm. 1983)
Feb. 1980	Two wolves seen, 5 total estimated, near Myrtle Creek.	Ashbrook (pers. comm. 1983)
Aug. 1982	One dead wolf pup 3 km up Stampede Creek.	Harrison (pers. comm. 1983)
Winter 1982-83	Group of 7, including 3 young, and group of 2 in the Kantishna area.	Ashbrook (pers. comm. 1983)

Winter 1982-83	One wolf trapped on the Toklat River at the confluence of the Clearwater Fork.	Johnson (pers. comm. 1983)
March 1983	Five wolves at headwaters of North Fork Moose Creek.	Swift (pers. comm. 1983)

APPENDIX 2. BIRDS OBSERVED IN THE KANTISHNA HILLS, 1983.

For each of the 85 species, generalized statements have been made on status based on a summation of 1983 field data. For birds observed frequently, I have included only dates of early and late sightings, and nesting information if available. Phylogenetic sequence and nomenclature follows the American Ornithologists' Union (A.O.U.) check-list of North American Birds, Sixth edition (1983).

The following terminology was used in describing the status of a given species:

resident - a species present throughout the year.

migrant - a seasonal transient between wintering and breeding grounds.

breeder - a species known to breed; prefixed by "possible" if concrete breeding evidence is unavailable.

visitant - a nonbreeding species; also in fall, a species not directly in route between breeding and wintering ranges.

abundant - species occurs repeatedly in proper habitats, with available habitat heavily utilized.

common - species occurs in all or nearly all proper habitats, but some areas of presumed suitable habitat are occupied sparsely or not at all.

fairly common - species occurs in only some of the proper habitats, and large areas of presumed suitable habitat are occupied sparsely or not at all.

uncommon - species occurs regularly, but utilizes little of the available habitat.

rare - species within its normal range, occurring regularly but in very small numbers.

casual - a species beyond its normal range, but not so far that irregular observations are not likely over a period of years.

Arctic Loon (Gavia arctica)

Rare migrant and possible breeder in western section of study area. Pair with 1 large young seen on a pond between Moose Creek and upper Bear Creek on August 22; adult seen on pond between Moose Creek and lower Bear Creek on August 23.

Greater White-fronted Goose (Anser albifrons)

Fairly common fall migrant. Earliest record, 21 seen on August 5; latest record, approximately 50 seen on August 23.

Green-winged Teal (Anas crecca)

Fairly common migrant and breeder. Eight seen on lower Glen Creek on August 7; female with 4 young seen at beaver pond near Kantishna airstrip on August 8.

Northern Pintail (Anas acuta)

Rare migrant. Eight seen at confluence of Rainy Creek and Moose Creek on August 9.

American Wigeon (Anas americana)

Uncommon migrant. Two pair seen on Clearwater Fork on May 16; 1 seen between Moose Creek and upper Bear Creek on August 23.

Greater Scaup (Aythya marila)

Rare migrant and possible breeder. Seven observed between Moose Creek and upper Bear Creek on August 23.

Harlequin Duck (Histrionicus histrionicus)

Uncommon migrant and breeder. Pair seen on Caribou Creek on May 19; female with 5 young seen at confluence of Beauty Creek and Bear Creek on July 25.

Barrow's Goldeneye (Bucephala islandica)

Rare migrant. Four observed at ponds between Moose Creek and upper Bear Creek on August 23.

Common Merganser (Mergus merganser)

Fairly common migrant and breeder. Two pair seen on Clearwater Fork near mouth of Canyon Creek on May 16; 1 seen on Caribou Creek on June 15; female with 5 flightless young seen at confluence of Beauty Creek and Bearpaw Creek on July 25; female with 8 young observed at confluence of Caribou Creek and Bearpaw River on August 10; 1 seen on Rock Creek on August 25.

Bald Eagle (Haliaeetus leucocephalus)

Casual visitant. Adult seen flying low over Myrtle Creek, apparently fishing, on July 16.

Northern Harrier (Circus cyaneus)

Fairly common migrant and breeder. Earliest record, 1 seen on Clearwater Fork on May 16; 4 young seen on Moose Creek 2 km east of Camp Denali on August 7; adult and 5 young observed on Moose Creek opposite Reindeer Hill on August 8; latest record, juvenile seen on Moose Creek on August 27.

Sharp-shinned Hawk (Accipiter striatus)

Fairly common fall migrant. One seen on Rainy Creek on August 27; 3 observed on Spruce Creek on August 28.

Northern Goshawk (Accipiter gentilis)

Rare migrant and breeder. One observed carrying prey near the confluence of Moonlight Creek and Clearwater Fork on May 16. Goshawks reportedly have nested near Camp Denali in recent years.

Red-tailed Hawk (Buteo jamaicensis harlani)

Uncommon fall migrant. Four observed soaring over Moose Creek near Camp Denali on August 26.

Golden Eagle (Aquila chrysaetos)

Uncommon migrant and rare breeder. Nest containing 2 young (about nine weeks old) was located on Little Caribou Creek on August 10. Two

adults, probably from the nest on Little Caribou Creek, were seen on Little Moose Creek on July 22. A second pair of eagles was suspected of nesting in the vicinity of Moonlight Creek. One was observed on upper Moonlight Creek on May 17; 1 seen on upper Caribou Creek on May 18; 2 seen on upper Canyon Creek on July 8; 2 seen on Clearwater Fork opposite upper Moonlight Creek on July 10; 1 observed on upper Caribou Creek on July 12; 2 seen on Moonlight Creek on July 14. Berle Mercer (pers. comm. 1983) visited an active eagle nest on Moonlight Creek in the early 1970's. Prey items identified at the nest on Little Caribou Creek included 3 arctic ground squirrels.

American Kestrel (Falco sparverius)

Uncommon migrant and breeder. One seen on Caribou Creek on May 20; adult observed feeding juvenile on Glen Creek on August 7; 3 juveniles seen at Kantishna airstrip on August 8; 1 seen at Kantishna airstrip on August 26.

Merlin (Falco columbarius)

Fairly common migrant and uncommon breeder. One seen on upper Bearpaw River on July 24; adult with 3 juveniles seen on Bearpaw River on July 24; 2 juveniles observed on Moose Creek 2 km east of Camp Denali on August 7; juvenile seen between Moose Creek and upper Bear Creek on August 23; 2 juveniles seen near Kantishna airstrip on August 26; 1 juvenile observed on lower Spruce Creek on August 28.

Gryfalcon (Falco rusticolus)

Rare migrant and/or resident and breeder. Nest with 2 recently fledged young was located on Little Caribou Creek on August 10. One adult, probably from nest on Little Caribou Creek, was observed on Little Moose Creek on July 22. The following prey items were observed at the nest on Little Caribou Creek; 13 arctic ground squirrels, 1 hoary marmot, 2 ptarmigan, 1 bufflehead, 1 whimbrel, 1 surfbird.

Spruce Grouse (Dendragapus canadensis)

Rare migrant and possible breeder. One seen on Eldorado Creek on June 4.

Willow Ptarmigan (Lagopus lagopus)

Uncommon resident and breeder. Five seen along upper Moonlight Creek on May 17; 2 seen on upper Caribou Creek on May 18; 1 observed on upper Glacier Creek and 2 on Friday Creek on May 21; 1 seen on upper Canyon Creek on July 9; 1 seen on upper Little Moose Creek on July 22; 8 young seen at confluence of Moose Creek and Glen Creek on August 7; group of 8 observed on Spruce Creek on August 28.

Rock Ptarmigan (Lagopus mutus)

Uncommon resident and breeder. Three seen along upper Moonlight Creek on May 17; 3 observed along upper Caribou Creek on May 18; 1 seen on Wickersham Dome on May 20; 1 see on Alpha Ridge on June 5; 1 seen on upper Little Moose Creek on July 24; 7 young observed on upper Rainy Creek on August 27.

White-tailed Ptarmigan (Lagopus leucurus)

Rare resident and breeder. Female with 8 young seen near Kankone Peak on July 6.

Sandhill Crane (Grus canadensis)

Common fall migrant. Earliest record, 45 seen on August 23; about 400 observed flying over Moose Creek south of Reindeer Hill on August 28.

Lesser Golden-Plover (Pluvialis dominica)

Common spring migrant and uncommon breeder and fall migrant. About 25 seen on Wickersham Dome on May 20; 4 observed on Alpha Ridge on June 5; 1 seen on upper Moonlight Creek on July 20; 1 seen on upper Little Moose Creek on June 17.

Semipalmated Plover (Charadrius semipalmatus)

Rare migrant and possible breeder. One seen at confuence of Canyon Creek and Clearwater Fork on May 16; 1 seen on lower Caribou Creek on June 17.

Greater Yellowlegs (Tringa melanoleuca)

Rare migrant. One observed between Moose Creek and upper Bear Creek on August 22.

Solitary Sandpiper (Tringa solitaria)

Uncommon migrant and breeder. Two adult observed defending a territory on lower Glacier Creek on June 24; 1 seen on Moose Creek 3 km east of Camp Denali on July 6; 1 seen on Stampede Creek on August 11.

Wandering Tattler (Heteroscelus incanus)

Uncommon migrant and breeder. One seen on upper Caribou Creek on May 18; adult with 1 young seen on upper Canyon Creek on July 7; adult with 1 young seen on Clearwater Fork 6 km south of Moonlight Creek on July 11; pair observed scolding at confluence of Myrtle Creek and Clearwater Fork on July 11.

Spotted Sandpiper (Actitis macularia)

Abundant migrant and breeder. Earliest record, 2 seen on Eldorado Creek on July 4; nest with 4 eggs observed on lower Caribou Creek on June 21; latest record, 1 observed on Moose Creek on August 23.

Upland Sandpiper (Bartramia longicauda)

Fairly common migrant and breeder. Two pairs seen on Clearwater Fork about 5 km south of Moonlight Creek on July 11; 2 juveniles seen on Glen Creek on August 7.

Whimbrel (Numenius phaeopus)

Rare migrant and possible breeder. One seen giving flight song on ridge between upper Caribou Creek and upper Glacier Creek on May 20; 1 observed near mouth of Glen Creek on August 7.

Surfbird (Aphriza virgata)

Uncommon migrant and breeder. One seen on upper Caribou Creek on May 18; 2 observed in courtship flight on Alpha Ridge on June 5; adult and 1 young seen on Glacier Peak on July 4; 3 separate sightings near Spruce Peak on July 4.

Baird's Sandpiper (Calidris bairdii)

Rare migrant and possible breeder. One seen on ridge between Spruce Peak and Kankone Peak on July 5; pair observed scolding on upper Canyon Creek on July 8.

Common Snipe (Gallinago gallinago)

Uncommon migrant and breeder. One "winnowing" near Stampede airstrip on May 16; 1 "winnowing" on lower Glacier Creek on June 24; 1 observed between Moose Creek and upper Bear Creek on August 22; 1 seen on Moose Creek on August 23.

Long-tailed Jaeger (Stercorarius longicaudus)

Rare migrant. One observed on Brooker Mountain on June 5.

Mew Gull (Larus canas)

Common migrant and uncommon breeder. Earliest record, 2 seen near Stampede airstrip on May 16; adult and 2 begging young seen at confluence of Rainy Creek and Moose Creek on July 28; latest record, 3 observed near Kantishna on August 26.

Glaucous-winged Gull (Larus glaucescens) X Herring Gull (Larus argentatus) hybrid.

Rare visitant. One seen on lower Glacier Creek on June 27.

Belted Kingfisher (Ceryle alcyon)

Uncommon migrant and possible breeder. One seen on lower Caribou Creek on June 15; 1 seen on lower Glacier Creek on June 27; 1 observed on Clearwater Fork south of Moonlight Creek on July 11; 2 seen on Bearpaw

River on July 24; 1 seen on Rainy Creek on August 7; 1 seen on Stampede Creek on August 11; 1 observed near Kantishna airstrip on August 26.

Three-toed Woodpecker (Picoides tridactylus)

Rare resident and possible breeder. One observed between Moose Creek and upper Bear Creek on August 23.

Northern Flicker (Colaptes auratus auratus)

Uncommon migrant and breeder. Three young seen on Moose Creek near Kantishna on August 8.

Olive-sided Flycatcher (Contopus borealis)

Fairly common migrant and breeder. One observed on Eldorado Creek on June 4; 2 seen on lower Caribou Creek on June 18; 2 seen on lower Glacier Creek on June 25; 1 seen on Clearwater Fork on July 10; 2 young observed on Bearpaw River on July 24; 1 seen near mouth of Rainy Creek on August 7.

Western Wood-Pewee (Contopus sordidulus)

Uncommon migrant and possible breeder. One heard on lower Caribou Creek on June 15; 1 heard on lower Glacier Creek on June 24.

Alder Flycatcher (Empidonax alnorum)

Common migrant and breeder. Seven observed and/or heard on lower Caribou Creek on June 15; 5 heard on Glacier Creek on June 24; 1 seen near Kantishna airstrip on July 28; 1 heard on Moose Creek on August 8; adult seen feeding 2 young between Moose Creek and Bear Creek on August 22.

Hammond's Flycatcher (Empidonax hammondii)

Fairly common migrant and breeder. Four observed and/or heard on lower Caribou Creek on May 18; 1 observed singing on Eldorado Creek on June 4; 2 seen and/or heard on lower Glacier Creek on June 24.

Say's Phoebe (Sayornis saya)

Fairly common migrant and breeder. Pair seen bringing food to a nest on upper Canyon Creek on July 7; adult observed with 2 fledged young on upper Rock Creek on July 14; 3 fledged young seen on upper Moonlight Creek on July 20; 1 seen between Moose Creek and upper Bear Creek on August 22; 1 observed on lower Moose Creek on August 23.

Horned Lark (Eremophila alpestris)

Fairly common migrant and breeder. Three seen on Alpha Ridge on June 5; 1 seen on upper Canyon Creek on July 7; 2 seen on upper North Fork Canyon Creek on July 8; 2 seen on upper Rock Creek on July 14; 2 fledged young seen on Moonlight Creek on July 20; 3 observed on upper Rainy Creek on August 27.

Tree Swallow (Tachycineta bicolor)

Rare migrant and possible breeder. Two seen on upper Caribou Creek on May 18.

Violet-green Swallow (Tachycineta thalassina)

Common migrant and breeder. Earliest record, 3 seen at junction of Canyon Creek and Clearwater Fork on May 16; about 10 active nests observed in rock crevices on Canyon Creek on July 9; 3 active nests seen in a bank swallow colony at confluence of Moonlight Creek and Clearwater Fork and 5 active nests seen on Clearwater Fork south of Moonlight Creek on July 10; latest record, 2 seen on Bearpaw River on July 25.

Bank Swallow (Riparia riparia)

Uncommon migrant and local breeder. Colony of 30-40 active nests observed in clay-sand bank at confluence of Moonlight Creek and Clearwater Fork on July 10.

Cliff Swallow (Hirundo pyrrhonota)

Rare migrant and possible local breeder. Six seen flying around bridge

over Moose Creek near Camp Denali on July 6, but no nests located; 1 seen on lower Caribou Creek on June 17.

Gray Jay (Perisoreus canadensis)

Abundant resident and breeder. Observed throughout the study area.

Black-billed Magpie (Pica pica)

Rare resident and possible breeder. Two heard in willows on upper Stampede Creek on August 11.

Common Raven (Corvus corax)

Fairly common resident and possible breeder. One seen on Canyon Creek on May 16; 1 seen on upper Caribou Creek on May 19; 1 observed near Camp Denali on May 21; 1 seen on Eldorado Creek on June 5; 1 seen at confluence of Moonlight Creek and Clearwater Fork on July 20.

Boreal Chickadee (Parus hudsonicus)

Fairly common resident and breeder. One seen on lower Glacier Creek on June 27; 1 seen on Canyon Creek on July 9; 2 observed on Moonlight Creek and 1 adult seen feeding 2 fledged young on Clearwater Fork on July 10; 3 seen on Rock Creek on August 25; 5 observed on upper Stampede Creek on August 26; 2 seen on Spruce Creek on August 28.

American Dipper (Cinclus mexicanus)

Rare migrant and possible breeder. One seen on upper Canyon Creek on July 8; 1 seen on upper Spruce Creek on July 12.

Arctic Warbler (Phylloscopus borealis)

Common migrant and breeder. Earliest record, 5 seen and/or heard on upper Canyon Creek on July 7; 1 observed carrying insects into willows at confluence of Myrtle Creek and Clearwater Fork on July 11; latest record, adult with 3 young seen in North Fork Moose Creek on August 7.

Ruby-crowned Kinglet (Regulus calendula)

Abundant migrant and breeder. Earliest record, 2 seen near Stampede

airstrip on May 16; latest record, 2 seen on Spruce Creek on August 28.

Northern Wheatear (Oenanthe oenanthe)

Uncommon migrant and breeder. Adult seen with 2 fledged young on upper Canyon Creek on July 8; 1 juvenile observed on upper Little Moose Creek on July 24; 2 juveniles seen on upper Stampede Creek on August 11.

Townsend's Solitaire (Myadestes townsendi)

Fairly common migrant and breeder. One seen on upper Caribou Creek on May 18; 2 seen on Eldorado Creek on June 4; 3, including at least 1 fledged young, seen on upper Canyon Creek on July 8; 2 seen on upper Rock Creek on July 14; 2 observed on Moonlight Creek on July 20.

Gray-cheeked Thrush (Catharus minimus)

Abundant migrant and breeder. Earliest record, 1 heard near Red Top Mine on May 21; fledged young observed on Canyon Creek on July 9; latest record, 2 seen near Kantishna airstrip on July 26.

Swainson's Thrush (Catharus ustulatus)

Common migrant and breeder. Earliest record, 1 heard on upper Caribou Creek on May 19; latest record, 1 seen near Kantishna airstrip on August 26.

American Robin (Turdus migratorius)

Abundant migrant and breeder. Earliest record, 3 heard on Clearwater Fork on May 16; fledged young observed on Canyon Creek on July 7; about 25, including numerous juveniles, seen near Kantishna airstrip on August 8; latest record, 4 observed on Spruce Creek on August 28.

Varied Thrush (Ixoreus naevius)

Common migrant and breeder. Earliest record, 3 seen on Clearwater Fork on May 16; fledged young observed on lower Glacier Creek on June 25; latest record, 4 seen near Kantishna airstrip on August 26.

Water Pipit (Anthus spinoletta)

Abundant migrant and breeder. Earliest record, 3 seen on upper Moonlight Creek on May 18; nest with 5 eggs observed below Spruce Peak on July 4; latest record, 3 seen on upper Spruce Creek on August 28.

Bohemian Waxwing (Bombycilla garrulus)

Uncommon migrant and possible breeder. Two seen on lower Caribou Creek on June 18; 2 seen on lower Glacier Creek on June 24; 3 seen at confluence of Moonlight Creek and Clearwater Fork on July 10; 2 seen on upper Rock Creek on July 14; 2 observed on North Fork Moose Creek on August 7.

Northern Shrike (Lanius excubitor)

Uncommon migrant and breeder. One seen on Moonlight Creek on May 17; adult with 3 fledged young observed on upper Canyon Creek on July 7; 1 seen on upper Stampede Creek on August 11; 1 juvenile seen on lower Moose Creek on August 23; 1 seen on upper Rock Creek on August 25; 1 adult observed on upper Caribou Creek on August 27.

Orange-crowned Warbler (Vermivora celata)

Common migrant and fairly common breeder. Earliest record, 2 seen on Eldorado Creek on June 4; latest record, 3 seen on Spruce Creek on August 28.

Yellow-rumped Warbler (Dendroica coronata coronata)

Common migrant and breeder. Earliest record, 1 seen near Stampede airstrip on May 16; latest record, 1 observed on upper Spruce Creek on August 28.

Blackpoll Warbler (Dendroica striata)

Fairly common migrant and breeder. Two seen and heard on lower Caribou Creek on June 15; three seen and heard on lower Glacier Creek on June 24; 1 juvenile observed on Stampede Creek on August 11; 2 seen on upper Bear Creek on August 22.

Northern Waterthrush (Seiurus noveboracensis)

Common migrant and fairly common breeder. Three seen on lower Caribou Creek on June 17; 2 seen on lower Glacier Creek on June 24; 1 observed near Kantishna airstrip and 1 at confluence of Rainy Creek and Moose Creek on July 28; 3 seen on upper Bear Creek on August 23; 5 observed on upper Rock Creek on August 25; 2 observed near Kantishna airstrip on August 26.

Wilson's Warbler (Wilsonia pusilla)

Abundant migrant and breeder. Earliest record, 4 seen on upper Caribou Creek on May 18; latest record, 5 seen on upper Spruce Creek on August 28.

Western Tanager (Piranga ludoviciana)

Casual visitant. One adult male seen at Camp Denali on July 27 represents the second record for Denali National Park.

American Tree Sparrow (Spizella arborea)

Abundant migrant and breeder. Earliest record, 1 male seen near confluence of Moonlight Creek and Clearwater Fork on May 16; latest record, 3 observed on upper Spruce Creek on August 28.

Savannah Sparrow (Passerculus sandwichensis)

Common migrant and breeder. Earliest record, 1 male seen below Wickersham Dome on May 20; latest record, 1 seen on upper Rainy Creek on August 27.

Fox Sparrow (Passerella iliaca)

Common migrant and breeder. Earliest record, 1 seen near Stampede airstrip on May 16; fledged young observed on lower Glacier Creek on June 26; latest record, 2 heard near Kantishna airstrip on August 26.

Lincoln's Sparrow (Melospiza lincolnii)

Uncommon migrant and breeder. One singing on upper Caribou Creek on

May 18; pair observed defending a territory on lower Glacier Creek on June 25.

Golden-crowned Sparrow (Zonotrichia atricapilla)

Rare migrant and possible breeder. One juvenile seen between Moose Creek and lower Bear Creek on August 23.

White-crowned Sparrow (Zonotrichia leucophyrs)

Abundant migrant and breeder. Earliest record, 3 seen near Stampede airstrip on May 16; fledged young observed on lower Caribou Creek on June 19; latest record, 5 seen on Spruce Creek on August 28.

Dark-eyed Junco (Junco hyemalis hyemalis)

Abundant migrant and breeder. Earliest record, several seen on Clearwater Fork on May 16; latest record, 3 seen on alpine tundra on upper Spruce Creek on August 28.

Lapland Longspur (Calcarius lapponicus)

Uncommon migrant and rare breeder. Pair observed on Alpha Ridge on June 5; about 15 seen on upper Rainy Creek on August 27; 5 observed on upper Spruce Creek on August 28.

Snow Bunting (Plectrophenax nivalis)

Rare migrant and possible breeder. One seen on upper Canyon Creek on July 5; 1 seen on upper North Fork Canyon Creek on July 8.

Rusty Blackbird (Euphagus carolinus)

Uncommon migrant. Eight seen between Moose Creek and upper Bear Creek on August 22; 1 observed between Moose Creek and lower Bear Creek on August 23; 1 seen near Kantishna airstrip on August 26.

Rosy Finch (Leucosticte arctoa)

Uncommon migrant and breeder. One seen near Kankone Peak on July 5; 2 seen on upper Canyon Creek on July 8; 1 juvenile seen near Spruce Peak on July 12; 2 seen near Spruce Peak on July 25.

White-winged Crossbill (Loxia leucoptera)

Fairly common migrant and possible breeder. Four singing on lower Glacier Creek on June 30; 10 observed on upper Bear Creek and 1 on Moose Creek on August 22; 7 seen between Moose Creek and lower Bear Creek on August 23.

Common Redpoll (Carduelis flammea)

Abundant migrant and breeder. Earliest record, 7 seen near Stampede airstrip on May 16; latest record, 5 observed on Spruce Creek on August 28.

APPENDIX 3. RAPTOR NESTS IN THE KANTISHNA HILLS, 1983.

General Location	Description of Nest Site	Status of Nest/Species
Little Caribou Creek	Stick nest about 9 m below the top of a 24 m rock outcrop. The nest was on the south side of the drainage 100 m outside the study area at an elevation of about 970 m.	Active/Golden Eagle
Little Caribou Creek	Stick nest about 6 m below the top of a 21 m rock outcrop. The nest was on the north side of the drainage about 1 km outside the study area at an elevation of about 920 m.	Active/Gryfalcon
Moonlight Creek	Stick nest.	Inactive
Moonlight Creek	Stick nest.	Inactive
Between Crevice and Caribou Creeks	Stick nest. A single eagle flew from the nest area.	Inactive
Glen Creek	Stick nest. A single eagle flew from the nest area.	Inactive
Glen Creek	Stick nest.	Inactive
Rainy Creek	Stick nest.	Inactive
Caribou Creek	Stick nest.	Inactive
Caribou Creek	Stick nest.	Inactive
Caribou Creek	Stick nest.	Inactive
Caribou Creek	Rock outcrop with white excrement. No stick nest located. A large falcon seen flying in the area on Sept. 1983 (Van Horn, pers. comm. 1983).	Inactive

APPENDIX 3 (continued)

General Location	Description of Nest Site	Status of Nest/Species
Rock Creek	Stick nest.	Inactive
Rock Creek	Rock outcrop stained white with excrement. No stick nest located. A large falcon seen flying in the area on April 1, 1983 (Van Horn, pers. comm. 1983).	Inactive
Eldorado Creek, Iron Dome	Stick nest. Reported in 1982 but not located in 1983.	Undetermined
Eldorado Creek	Rock outcrop stained white with excrement. No stick nest located.	Inactive
Eldorado Creek	Stick nest. Located in 1981 but not checked in 1983.	Undetermined

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environment and cultural value of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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