ALASKA DEPARTMENT OF FISH AND GAME

JUNEAU, ALASKA

STATE OF ALASKA
Bill Sheffield, Governor

DEPARTMENT OF FISH AND GAME
Don W. Collinsworth, Commissioner

DIVISION OF GAME
W. Lewis Pamplin, Jr., Director

WINTER HABITAT UTILIZATION BY MOOSE AND MOUNTAIN GOATS IN THE CHILKAT VALLEY

by
Kris J. Hundertmark
Wayne L. Eberhardt
and
Ronald E. Ball

Final Report
A Contribution to The Haines-Klukwan
Cooperative Resource Study

Funded by Legislative Appropriation

(Printed August 1983)

CONTENTS

INTRODUCTION

This study was undertaken to evaluate habitat use by moose (*Alces alces*) and mountain goats (*Oreamnos americanus*) in the State timber sale area at Haines, Alaska and make recommendations to minimize the impacts of logging on these species. Major impacts on wildlife populations resulting from timber harvest in the Haines area will be in the form of habitat alteration, roading, and increased human disturbance. The major area of impact consists of approximately 86,000 acres located primarily in the Chilkat, Klehini, and Kelsall river valleys.

The adoption of the Haines-Skagway Land Use Plan (Alaska Dept. of Natural Resources, 1979), and subsequently the Haines timber contract in August 1979, allowed for the harvest of 10.2 million board feet of spruce and hemlock saw logs annually over a period of 15 years, with a provision for a 10-year extension negotiable. An unspecified amount of cottonwood and pulpwood may be cut in addition to the saw logs. Moose and mountain goats are known to rely on mature coniferous forests for forage and cover during severe winters and, to a lesser extent, during other seasons (Peek et al. 1976, Hebert and Turnbull 1977, Fox 1981, Doerr et al. 1980, Schoen and Kirchoff 1982, Brusnyk and Gilbert 1983). Therefore, these species will be effected adversely by indiscriminate resource development.

PART I. MOOSE

STUDY AREA

The study area was located in the northern portion of Lynn Canal in southeastern Alaska, bounded by the U.S.-Canada border to the west and north, Anchor Point to the south of Haines, and the Takshanuk Mountains to the east. Specific areas were surveyed for moose and included portions of the Chilkat, Klehini, Tsirku, Kelsall, and Takhin river valleys. The lower Chilkat river valley, including the Takhin and Kicking Horse river valleys, was selected for intensive study (Fig. 1). The study area supported a large number of moose and contained several tracts of timber available for harvest, and was adjacent to an area, Chilkat Lake, subject to extensive timber harvest in the near future.

The topography of the study area is typical of the coastal mountain region of southeastern Alaska, and consists of adjoining mountain valleys characterized by glacial features. The river valleys are narrow, deep, and U-shaped as a result of glacial action. The rivers are shallow, meandering, and silt-laden, and often terminate in large alluvial fans of gravel, boulders, and silt. Murphy Flats and the Takhin delta are large flat expanses formed by sediment deposition from the Kicking Horse, Takhin, and Chilkat rivers, and by isostatic rebounding of the Chilkat delta following glacial retreat. The resultant scarring and deposition produces a wide variety of seral vegetative associations.

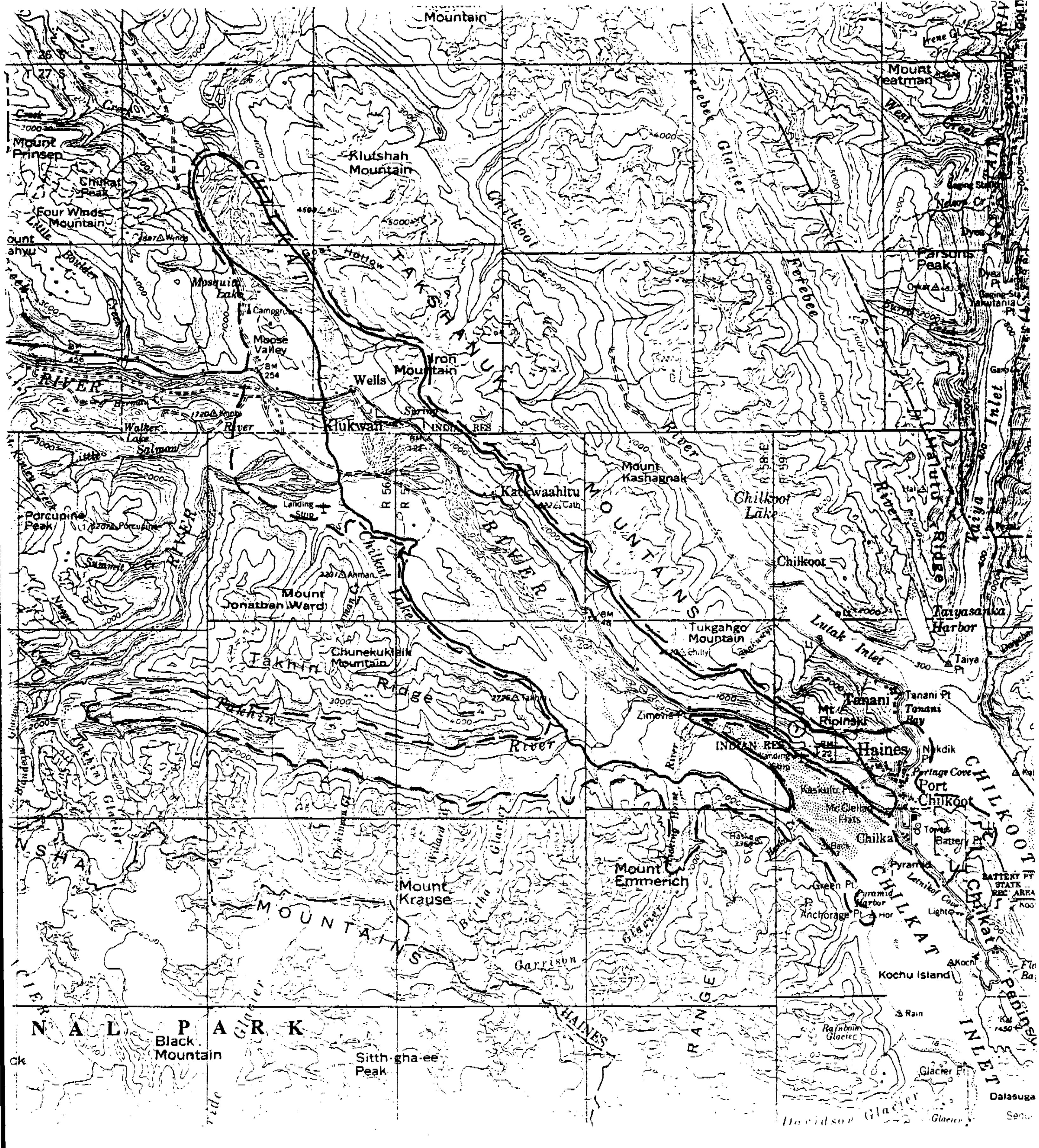

Fig. 1. Summer range (broken line) and winter range (solid line) of radio-instrumented moose, Chilkat Valley, Alaska, November 1981-April 1983.

The vegetation on upland slopes of the study area was characterized by Sitka spruce-western hemlock (Picea sitchensis-Tsuga heterophylla) forest with a hardwood component of black cottonwood (Populus trichocarpa) and paper birch (Betula papyrifera), the abundance of which varied depending upon site quality. Drier slopes supported stands of lodgepole pine (Pinus contorta) mixed among hardwoods, interspersed with small heath (Cassiope spp.) meadows. Mountain hemlock (Tsuga mertensiana) was found at higher elevations.

Lowland valleys were supported by a wide variety of vegetative associations, ranging from pioneer communities of willow (Salix spp.) and alder (Alnus spp.) on gravel bars to young stands of climax spruce-hemlock forest. Other vegetative types included mature stands of cottonwood and thick stands of alder and willow (non-stocked areas), interspersed with river channels, sloughs, ponds, marshes, and gravel bars.

METHODS AND MATERIALS

Twenty adult moose (4 males, 16 females) were immobilized in October 1981 using helicopter-aided darting techniques (described for immobilization of mountain goats by Schoen and Kirchhoff 1982) (Appendix A). A mixture of etorphine (M-99) and xylazine hydrochloride (Rompun) was used as an immobilizing agent. The drugs were injected via 10cc darts fired from a Palmer Cap-Chur gun. Diprenorphine was administered by hand as an antagonist. Each immobilized moose was fitted with a radio-instrumented collar (Telonics, Mesa, AZ) and a numbered, colored ear tag.

From November 1981 through April 1982, and during the same period in 1982-83, aerial relocations of radio-instrumented moose were obtained approximately twice monthly. One relocation flight was conducted in June 1982 and one in August 1982. Poor weather precluded flights in February 1982.

Until April 1982, aerial relocation flights were conducted in a Helio-Courier aircraft after which flights were conducted with a Bellanca Citabria 150. For all flights the aircraft was equipped with a Telonics TR-2 scanner/receiver with a directional antenna mounted under each wing.

An aerial survey was conducted on 2-3 February 1982, using the Helio-Courier, and on 20 March 1983 using the Citabria to determine the distribution and abundance of moose on their winter range. No attempt was made to determine sex of adults. Calves were recorded separately when observed. Each location was recorded on a topographic map.

Relocations of radio-instrumented moose were recorded on 1:63,360 U.S.G.S. topographic maps. Whenever possible, radio-instrumented moose were identified visually. Specific habitat types as well as topographic characteristics were recorded at each moose relocation including slope, aspect, and elevation. Overstory canopy cover was estimated to the nearest 10% from the air or obtained from Department of Natural Resources (DNR) habitat type maps (1966) along with net Scribner volume. When appropriate, estimates of percent snow cover and snow type were recorded (Appendix B).

For statistical testing, the specific habitat types used by moose were placed into 5 general habitat categories (coniferous, deciduous, mixed conifer/hardwoods, cut areas, and open areas) and 2 topographic categories (uplands and valley bottoms). Coniferous types were defined as areas with a dominant coniferous overstory. Deciduous types were hardwood-dominated stands, and alder and willow thickets (non-stocked areas). Mixed conifer/hardwood stands contained codominant coniferous and deciduous species in the overstory. Cut areas were any areas logged in the last 25 years. Open areas were frozen lakes and rivers as well as gravel bars. In general, open areas had no browse available above the ice. Relationships between habitat use and availability were tested by a Chi-square procedure developed by Marcum and Loftsgaarden (1980).

In 1982, ground surveys were conducted in accessible timbered areas to determine winter utilization by moose. Observations, including habitat type, topography, and vegetative characteristics were recorded in addition to the presence of tracks, droppings and sightings of moose and other wildlife. On-ground radio tracking was used as a means of relocating specific animals and obtaining habitat use information through direct observation. Data recorded on-site included: beds, browse utilization, habitat type, and characteristics of the overstory and understory vegetation. Information obtained during these surveys was used to develop procedures for intensive habitat sampling.

In February and March 1983, habitat utilization by moose in the lower Chilkat Valley was sampled in a manner independent of aerial relocations. Randomly placed transects consisting of consecutive 10x20-m plots were traversed in valley bottoms and on upland slopes in areas known to contain high concentrations of moose. Habitat type, number of fresh moose tracks, number of feeding sites (freshly trampled areas surrounding a plant browsed recently), species of plants browsed recently, number of moose beds, and snow depth to the nearest 10 cm were recorded at each plot.

In April and May 1983, after snow melted, sampling was conducted to determine distribution and abundance of browse plants, as well as extent of browsing. Browse species were identified in the previous sampling period and consisted of willow, red osier dogwood (*Cornus stolonifera*), mountain maple (*Acer glabrum*), high-bush cranberry (*Viburnum edule*), black cottonwood saplings, birch, mountain ash (*Sorbus* spp.), crabapple (*Malus* spp.) and blueberry (*Vaccinium* spp.).

In each distinct habitat type a maximum of 100 sample points were distributed at 10-m intervals along randomly placed transects. Abundance of browse species (number of stems/ha) was determined with the point-centered quarter technique (Pieper 1978), wherein the distance from a central point to the nearest browse plant in each of 4 quadrants was measured, and the abundance of browse plants was determined as a function of the mean distance. For each plant encountered with this technique, species identity, height class (less than 1 m, 1-3 m, greater than 3 m), and browse condition (less than 34% of available browse utilized, 34-67%, greater than 67%) were recorded. Estimates of abundance of individual species were computed by multiplying the estimate of total browse abundance by the proportion of stems encountered for any given species.

Harvest statistics for moose in Game Management Unit (GMU) 1D (Haines-Skagway area) were reviewed to determine the proportion of the total sport harvest comprised of moose taken from the study area.

RESULTS AND DISCUSSION

Seasonal Range and Movements

Based upon data from this study and published information (LeResche and Hinman 1973), winter range in the Chilkat Valley overlapped summer range and consisted of the lowlands bordering the Chilkat River and adjacent areas of upland slopes, particularly those with southerly (SE, S, SW) exposures. Summer range consisted of the winter range and the upper reaches of side valleys.

Radio-instrumented moose utilized the Chilkat River lowlands below the Kelsall River, particularly that section below Wells Bridge and the adjacent upland slopes (Fig. 1). In summer, moose continued to utilize that portion of the Chilkat River below Wells Bridge and also utilized the Takhin and Kicking Horse valleys, and the Chilkat Peninsula.

For those moose occupying "winter range" throughout the year, movement to their wintering area was defined as a marked reduction in movements related to winter weather conditions. Those moose occupying summer-only range moved to winter range through specific corridors. Moose occupying summer range in the Takhin Valley were limited in their movements because of the narrowness of the valley floor and therefore used well-defined, traditional trails. Upon reaching the lowlands of the Chilkat

River, moose dispersed into the Takhin-Murphy Flats area or up the Chilkat Valley either through the Chilkat Lake area or along the west bank of the Chilkat River.

During this study, movement to winter range occurred during mid-December through January. Moose summering in the Takhin and Kicking Horse valleys likely were forced from summer range by accumulated snow. These valleys are narrow and deep, and peaks to the south and west effectively block sunlight from the valley floors during winter. Thus, autumn snowfalls that may have melted in more exposed sites likely accumulated in these side valleys.

Important concentration areas for radio-instrumented moose on winter range were the Takhin River delta (12 of 39 [31%] winter ranges were classified as occupying this area), the upland slopes above the Haines Highway between 6 mile and 19 mile (21%), the large vegetated islands in the Chilkat River between 10 and 19 mile of the Haines Highway (18%), the south slopes of Mt. Ripinski between Yandustuki and Haines (13%), and the Kicking Horse-Murphy Flats area (8%).

Habitat Selection

Moose exhibited seasonal differences in habitat use (Table 1). In summer, moose preferred habitats with a canopy. Twenty-one of 39 locations (54%) during June and August 1982 were in coniferous

Table 1. Numbers of moose relocations in different habitat types by month, Chilkat Valley, Alaska.

Habitat	Nov. '81	Dec. '81	Jan. '82	Mar. '82	Apr. '82	June '82	Aug. '82	Nov. '82	Dec. '82	Jan. '83	Feb. '83	Mar. '83	Apr. '83	Total
swamp alder	1	4	4	2	0	0	0	2	0	3	0	1	4	21
swamp willow	0	7	6	1	0	0	0	0	5	5	4	0	0	28
open swamp	0	0	0	1	0	0	0	3	0	1	0	0	0	5
marsh	0	0	0	0	1	0	0	0	0	0	0	0	3	4
non-stocked/alder	0	9	6	8	1	1	1	0	0	4	2	2	6	40
non-stocked/BCW/alder	9	0	8	9	0	0	3	5	4	7	9	8	8	70
non-stocked/willow	0	12	2	6	0	1	1	11	2	0	0	0	0	35
spruce/hemlock	3	4	2	7	2	6	8	1	0	6	2	2	3	46
spruce-BCW	3	5	2	2	1	1	0	0	1	2	0	3	2	22
spruce	2	5	2	1	0	1	2	3	2	2	6	8	3	37
black cottonwood (BCW)	0	7	2	9	8	7	3	5	0	1	0	0	0	42
hemlock	0	0	1	0	0	0	0	1	0	0	0	0	0	2
hardwood	0	0	0	3	0	0	0	0	0	2	1	3	0	9
lodgepole pine	0	0	0	0	0	0	0	0	0	0	2	6	0	8
coniferous CC	0	1	5	3	1	0	0	2	1	0	0	0	0	13
deciduous CC	0	0	0	0	0	0	0	2	0	0	0	0	0	2
partial cut	0	0	0	0	0	0	0	2	2	0	0	0	0	4
mixed hardwood-conifer	2	1	1	4	5	3	0	1	0	3	8	4	7	39
mixed conifer	0	0	0	1	0	0	0	0	0	0	1	0	1	3
gravel-slough	0	2	0	0	0	0	0	0	2	1	3	1	1	10
subalpine	0	0	0	0	0	0	1	0	0	0	0	0	0	1
Total	20	57	41	57	19	20	19	38	19	37	38	38	38	441

stands, primarily spruce-dominated. In addition, 10 locations (26%) were in black cottonwood stands. The remaining locations (20%) were in non-stocked areas and one in subalpine.

The high proportion of relocations in habitats with an overstory canopy possibly was due to moose attempting to escape from heat; relocation flights were conducted at mid-day when solar radiation was most intense. Kelsall and Telfer (1974) reported that moose were limited in their southern distribution by the inadequacy of southern habitats to provide thermal cover when temperatures exceeded 27°C for extended periods. Belovsky (1981) also believed that cover was important to moose during summer to relieve accumulated body heat. Additionally, these habitat types likely were used by moose for feeding.

In autumn (November and December), 74 of 134 locations (55%) were in swamp or non-stocked areas. Thirty-five (26%) were in coniferous stands, and the remaining locations (19%) were in hardwood or clearcut areas. Winter (January through April) habitat use was concentrated in swamp and non-stocked areas (122 of 268 locations, 46%), and coniferous stands (102 locations, 38%).

Use of habitat while on winter range differed between years (Table 2). In 1981-82, a relatively snow-free winter, deciduous areas were used in greater proportion than availability would dictate based on a random distribution. Coniferous, mixed

Table 2. Distribution of moose relocations while on winter range and 995 randomly located points among 5 general habitat categories, Chilkat Valley, southeast Alaska.

Year	General Habitat Type	No. of Observations	Availability	Relative Preference (P <0.01)[a]
1982 (n=20 moose)	coniferous	16	221	0
	deciduous	54	238	+
	open	13	374	-
	mixed	11	108	0
	cut	7	54	0
	Total	101	995	
1983 (n=19 moose)	coniferous	39	221	0[b]
	deciduous	42	238	0[c]
	open	23	374	-[d]
	mixed	30	108	+[b]
	cut	0	54	-[c]
	Total	134	995	

[a] "+" indicates use greater than availability, "-" indicates use less than availability, "0" indicates use not different than availability.

[b] Use was significantly (P < 0.05) greater in 1983 than in 1982.

[c] Use was significantly (P < 0.05) less in 1983 than in 1982.

[d] Use was not significantly different between years.

hardwood/conifer, and cut areas were used in proportion to their availability, and open areas were avoided ($P < 0.01$). In 1982-83, a winter characterized by relatively deep snow, mixed hardwood/conifer stands were used in greater proportion than available, coniferous and deciduous stands were used as available, and cut and open areas were used less than available ($P < 0.01$). Coniferous and mixed hardwood/conifer stands were selected in greater proportions and deciduous and cut stands were used significantly less often than in 1981-82 ($P < 0.05$). Seasonal (Phillips et al. 1973, Irwin 1974, Peek et al. 1976) and annual (Peterson 1977) differences in use of habitats with an overstory canopy were reported for moose populations in other areas.

The increased use of coniferous and mixed stands coincided with increased use of upland habitat in 1982-83. In general, use of uplands between December and April 1982 was 36%; use of uplands during the same months in 1982-83 was 49%, a significant ($P = 0.02$) increase from the previous year.

Seemingly, the increased use of upland habitat in winter 1982-83 was related to the increased snowfall of that year. Monthly mean elevation of moose relocations did not vary significantly in 1981-82 (Fig. 2). However, mean elevations in 1982-83 increased after a period of heavy snow in January.

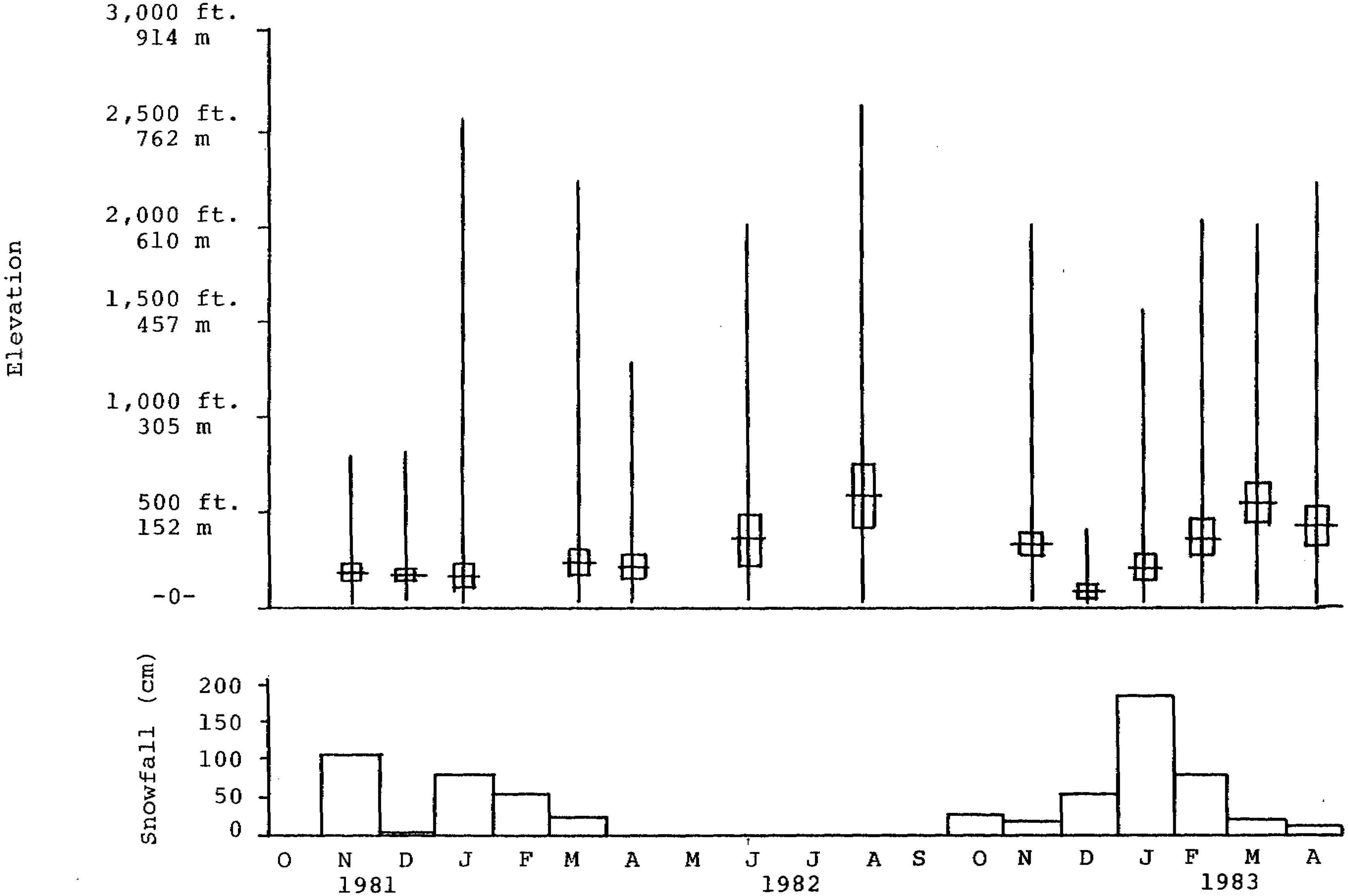

Fig. 2. Monthly mean elevations (horizontal lines) ± SE (boxes) and ranges (vertical lines) of moose relocations, Chilkat Valley, Alaska. Lower graph shows monthly snowfall measured at Haines, in the Southeast corner of the study area.

While on the uplands, moose apparently selected habitats with the least potential to accumulate snow. From December through April, 51% of all relocations above 500 ft. (152.4 m) were in stands with 75% or greater coniferous canopy compared to 11% below 500 ft. (Table 3). Also, 57% of relocations above 500 ft. were on slopes of 26° or greater (Table 4).

Selection for aspect differed significantly from expected (P < 0.001) for winter and non-winter seasons (Table 5); additionally, selection for aspect differed between years. In winter southerly aspects and flat areas were preferred, while on summer range only flats were preferred.

Upland habitats above the Haines Highway had significantly less snow than those in the valley (t = -2.92, d.f. = 492, P = 0.004). Snow depths differed among habitat types in the valleys (F = 44.99, d.f. = 4, 1586, P < 0.001). Open areas had significantly less snow than all other habitats (P < 0.05). No significant differences existed among the 4 other types. Snow depths among habitat types on uplands also differed significantly (F = 47.07, d.f. = 3, 354, P < 0.001). Deciduous and mixed stands had less snow than coniferous stands, and cut areas had the greatest snow depths of all types (Table 6).

Presumably, deciduous and mixed stands had less snow than coniferous stands because they usually were at higher elevations and on steeper slopes. However, information concerning upland

Table 3. Numbers of relocations of radio-instrumented moose classified by percent coniferous canopy coverage and elevation, from December 1981 through April 1982 and December 1982 through April 1983, Chilkat Valley, Alaska.

Percent Canopy Coverage	Elevation 0-31m 0-100'	32-152m 101-500'	153-305m 501-1,000'	306-457m 1,001-1,500'	458-610m 1,501-2,000'	> 610m > 2,000'	Total
0-25	179	48	6	5	0	4	242
26-50	4	3	1	1	0	2	11
51-75	10	15	3	2	1	1	32
76-100	16	16	12	5	7	3	59
Total	209	82	22	13	8	10	344

Table 4. Numbers of relocations of radio-instrumented moose in various ranges of coniferous canopy coverage and slopes from December 1981 through April 1982 and December 1982 through April 1983, Chilkat Valley, Alaska.

	Elevation						
Degrees Slope	0-31m 0-100'	32-152m 101-500'	153-305m 501-1,000'	306-457m 1,001-1,500'	458-610m 1,501-2,000'	> 610m > 2,000'	Total
flat	205	30	0	0	0	0	235
6-15	2	27	3	1	2	1	36
16-25	2	16	7	2	3	4	34
26-35	0	9	11	5	0	3	28
> 35	0	0	1	5	3	2	11
Total	209	82	22	13	8	10	344

Table 5. Distributions of relocations of radio-instrumented moose and 497 randomly-located points according to aspect and season, November 1981 through April 1983, Chilkat Valley, Alaska.

Season	Aspect	No. of Relocations	No. of Random Points	Relative Preference ($P < 0.05$)[a]
winter	flat	121	246	0
	SE-SW	79	101	+
	W-NW	0	35	-
	N-E	11	115	-
	Total	211	497	
summer	flat	148	246	+[b]
	SE-SW	49	101	0[c]
	W-NW	3	35	-[b]
	N-E	43	115	0[d]
	Total	243	497	

[a] "0" indicates use not different from availability, "+" indicates use greater than availability, "-" indicates use less than availability.

[b] Not different from winter use ($P > 0.01$).

[c] Used less than in winter ($P < 0.01$).

[d] Used more than in winter ($P < 0.01$).

Table 6. Mean snow depths (expressed in cm) in general habitat types classified by topographic type for moose winter range, Chilkat Valley, Alaska. Means within a topographic type that share a common superscript are not significantly different at $\alpha = 0.05$.

	Open	Cut	Coniferous	Deciduous	Mixed	Total
valleys	46.9[a]	58.2[b]	61.7[b]	65.8[b]	67.3[b]	59.6
uplands	----	82.1[c]	52.0[d]	39.7[e]	41.4[e]	54.4

habitats should be regarded as tentative because intensive sampling was not conducted at elevations above 500 ft. or on steep slopes.

Of all moose tracks encountered, 98% were in snow depths of 80 cm or less (Fig. 3). This relationship corresponds well with other reports of critical snow depths for moose (Kelsall and Prescott 1971, Coady 1974). Most tracks (71%) were located in snow depths between 20 and 60 cm, whereas only 56% of plots were located at these depths. The relatively low proportion of tracks in the 0-20 cm class likely was due to the hydric nature of habitats with these snow depths. Rivers and marshes were subject to accumulation of snow only after surface water froze, and all open habitat was exposed to wind which caused scouring and drifting of snow. These habitats likely were used as transportation corridors and as a refuge from deep snow. However, the larger expanses of open areas (e.g. Tsirku Delta and Chilkat River below Zimovia Point) were not used, possibly because of the absence of feeding or escape cover nearby. Moose were only observed once in any open area more than a few hundred meters wide, and this observation consisted of a cow and calf traveling across the frozen Chilkat River at a fast pace. All other observations of moose in open areas were on frozen sloughs and narrow river channels, or on the edges of wider areas with cover nearby.

Track counts (Table 7) were highest in riparian areas, willow bottoms (non-stocked willow) along the Takhin River, and upland

Table 7. Mean numbers of moose tracks, feeding sites, and bedding sites per plot in different vegetative types, Chilkat Valley, Alaska.

Vegetative Type	N	Tracks/ Plot	Feeding Sites/ Plot	Bedding Sites Plot
swamp/alder	91	.86	.26	.38
swamp/willow	12	.50	.42	.08
marsh	158	.70	.07	.01
riparian	184	2.26	.88	.08
non-stocked/alder	321	.90	.50	.12
non-stocked/BCW-alder	87	.28	.01	0
non-stocked/willow	49	2.10	1.18	.14
spruce-hemlock	124	.04	0	0
spruce-black cottonwood	122	.11	0.02	0
spruce	130	.22	0.03	.03
black cottonwood	314	.70	0.20	.08
hemlock	8	0	0	0
hardwood	34	.44	0.09	0
lodgepole pine	6	2.00	0.83	0
coniferous clearcutting	37	.54	0.30	0
deciduous clearcutting	71	.39	0.37	.01
mixed hardwood-conifer	152	.49	0.19	.02
gravel, sandbar, slough	49	.63	0.14	.04

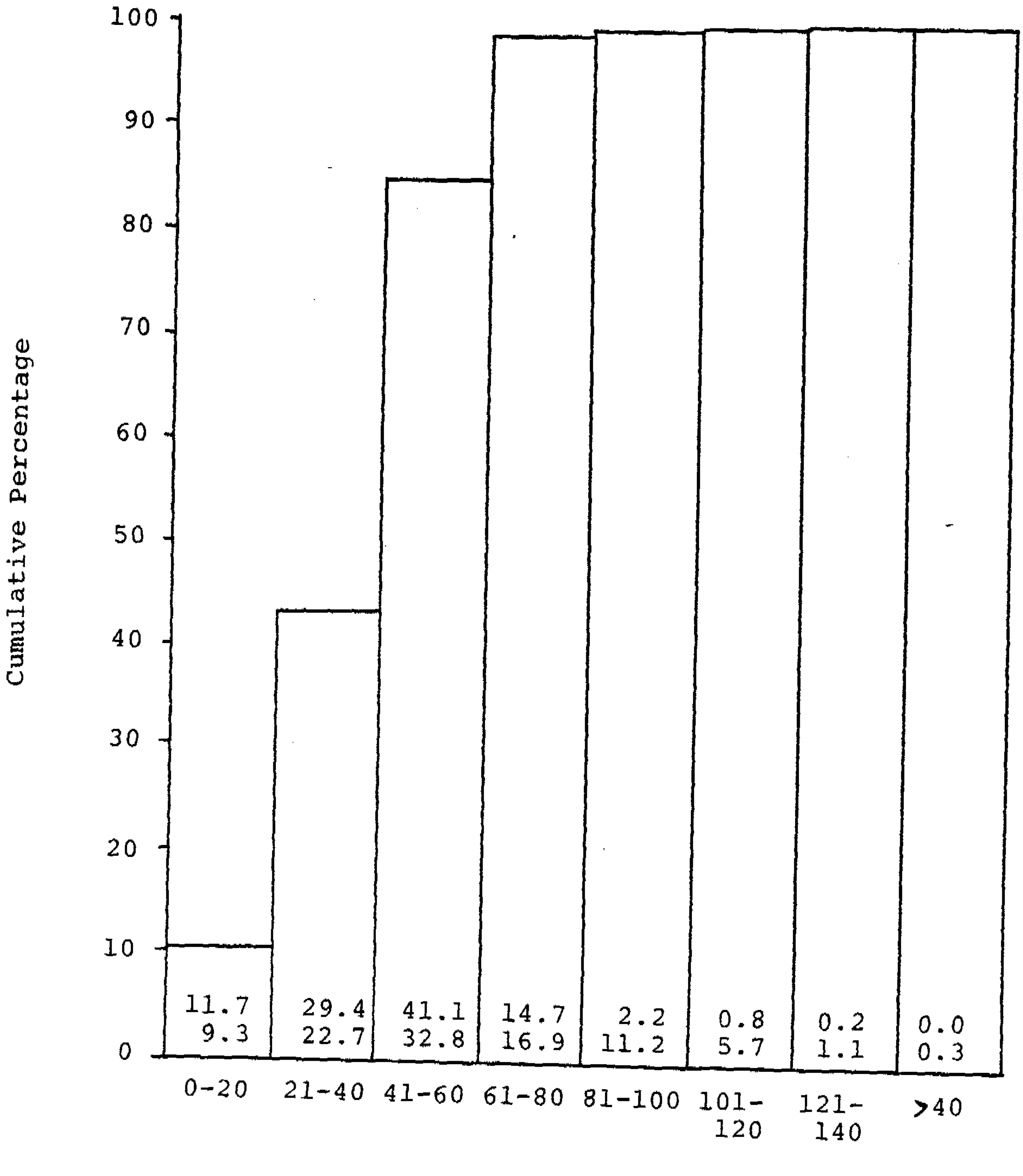

Fig. 3. Cumulative percentages of moose tracks encountered in different depths of snow, Chilkat Valley, 1983. Upper numbers in columns are percentages of tracks at those depths, and lower numbers are percentages of plots at those depths.

stands of lodgepole pine; however, the latter type is based on a small sample and should be interpreted with caution. Other habitats with high track densities were non-stocked alder, swamp willow, black cottonwood, and open areas. Areas of low track density were spruce-dominated stands, and non-stocked black cottonwood/alder. Feeding sites were most abundant in willow bottoms, riparian areas, and lodgepole pine stands, and were least abundant in coniferous stands and black cottonwood/alder areas. Moose beds were most commonly encountered in deciduous areas on the valley floor (Table 6).

Among habitats, feeding and bedding sites were correlated with abundance of tracks ($\underline{P} < 0.01$). Abundance of tracks, feeding sites, and bedding sites correlated with browse density ($\underline{P} < 0.01$). Browse species most strongly correlated with habitat use were willow and dogwood (Table 8).

Browse Composition and Utilization

Browsing pressure was greatest on willow and dogwood (Table 9), with 52% and 35% of their stems having moderate or heavy browsing, respectively. When only living individuals were considered, 59% of willow stems and 40% of dogwood were browsed moderately or more. The mean for all browse plants in the moderate and heavy classes was 27% (29% of living stems).

Table 8. Correlation coefficients (r_s) between indices of habitat use and forage density, Chilkat Valley, Alaska, 1983. All coefficients are significant at $\alpha = 0.01$.

	Tracks/ Plot	Feeding Sites/ Plot	Bedding Sites/ Plot	Density of Dogwood and Willow	Density of All Other Browse Species
tracks/plot	---	0.85	0.95	0.95	0.79
feeding sites/ plot		----	0.61	0.97	0.76
bedding sites/ plot			----	0.92	0.78

Table 9. Percentages of plant species in browse classes, Chilkat Valley, Alaska, 1983.

Species	Light	Moderate	Heavy	Dead or Dying	N
dogwood	52.3	20.0	14.6	13.1	2152
willow	35.6	26.9	25.0	12.4	683
high-bush cranberry	88.5	7.0	1.5	3.0	1510
birch	72.4	13.5	6.7	7.3	178
mt. maple	79.4	11.1	3.1	6.2	287
black cottonwood	73.5	20.3	2.5	3.8	79
blueberry	75.4	22.8	1.8	0	57
mt. ash	77.4	13.1	6.0	3.6	84
other	86.0	6.5	5.4	2.2	93

Abundance of browse species was greatest in clearcuts and riparian areas (Table 10). Spruce-hemlock and spruce-black cottonwood stands also ranked highly, but the most abundant species in these stands was highbush cranberry, of which 89% was browsed lightly or not at all (Table 9). Abundance of preferred browse, willow and dogwood, was highest in clearcuts, riparian, and non-stocked areas.

Browsing pressure on plants during winter was related somewhat to the height classes available. Potential browse less than 1 m in height (height class 1) likely was buried under snow during most of the winter and therefore was unavailable. Browse greater than 3 m in height (height class 3) was available in various degrees depending upon the volume of branches within reach of moose, and the thickness of the bole, which determined the amount of bark and cambium available. Browse between 1-3 m (height class 2) was the optimum height for moose (Peek et al. 1976).

Although dogwood was the most abundant browse species, and highly preferred, most stems (69%) encountered were in height class 1 (Table 11), and therefore were unavailable under deep snow. In comparison, 21% of willow stems were in height class 1 and 56% were in height class 2.

Amount of browsing observed within the different height classes corresponded to availability. Dogwood and willow had less than 40% of their height class 1 plants browsed moderately or heavily

Table 10. Estimated number of stems/ha for moose browse in the Chilkat Valley, Alaska. Estimates for individual species were derived from proportions of stems encountered relative to the total, and therefore are approximate.

	Dogwood	Willow	Viburnum	Birch	Mt. Maple	Mt. Ash	Black Cottonwood	Vaccinium	Other	Total	(SE)
coniferous CC	8123	534	438	779	480	0	288	0	21	10675	(3071)
riparian	6182	1417	1398	0	0	38	347	0	0	9381	(2019)
BCW	2541	67	2441	0	388	111	0	0	0	5548	(1549)
non-stocked BCW-alder	2587	299	1834	10	35	0	214	0	0	4985	(1363)
spruce-hemlock	311	12	1699	12	311	324	12	0	433	3113	(1144)
non-stocked willow	1237	1101	45	0	0	0	0	0	0	2383	(1118)
hardwood	1289	42	178	276	518	12	26	0	0	2343	(650)
deciduous CC	873	925	79	102	6	27	58	0	6	2079	(612)
spruce	318	20	833	6	152	44	0	97	103	1566	(294)
non-stocked alder	682	549	302	0	0	3	3	3	3	1542	(432)
spruce-BCW	300	4	1036	0	0	27	27	0	0	1395	(485)
mixed hardwood-conifer	39	170	138	142	73	17	0	0	3	582	(168)

Table 11. Numbers of browse plants encountered in different height classes, Chilkat Valley, Alaska, 1983.

	≤ 1m	1-3m	≥ 3m
dogwood	1487	634	31
willow	143	383	157
high-bush cranberry	853	650	7
birch	28	68	82
mt. maple	125	127	35
black cottonwood	29	37	13
blueberry	44	13	0
mt. ash	58	24	2
other	82	10	1

(Fig. 4). In height class 2, dogwood had approximately 45% of plants browsed moderately or heavily, and willow had over 70%. In height class 3 dogwood had nearly 90% of stems browsed moderately or more, but willow had only slightly more than 50%. The difference in browsing pressure of plants greater than 3 m probably was related to the differences in growth form between dogwood and willow. Red osier dogwood resembles a tall shrub or small tree when mature and plants greater than 3 m tall are still susceptible to being bent by moose to reach upper branches. Also, dogwood of this height consistently had branches below the 3 m level. Conversely, many species of willow, particularly those found on upland habitat in Haines, attain moderate height when mature and produce stout boles that moose could not bend. Therefore, only low-hanging branches, bark and cambium were available to moose. Many willows in height class 3 had much bark stripped by moose in winter, which likely explains the high proportion (22%) of dead or dying willows in this class.

Population Composition and Harvest

Aerial surveys conducted as part of this study and as part of routine departmental survey and inventory procedures indicated that the Chilkat Valley moose population was relatively stable over recent years (Table 12). Numbers of moose observed fluctuated greatly, but this likely represented variation in observers, flight conditions, and habitat use by moose more so than actual fluctuations in the population. During the most

Table 12. Recent aerial survey data for the Chilkat Valley moose population.

Date	# Bulls	Cows w/0	Cows w/1	Cows w/2	Adults w/0	Adults w/1	Adults w/2	Total Adults	Lone Calves	Total Calves	Total Moose	Calf % in Herd
1/28/81	--	--	--	-	61	13	3[a]	77	0	20	97	20.6
2/23/81	--	--	--	-	139	30	4	173	0	38	211	18.0
2/2-3/82	--	--	--	-	118	28	3	149	0	34	183	18.6
11/30-12/1/82	34	70	40	5	---	--	-	149	1	51	200	25.5
3/20/83	--	--	--	-	52	15	2	69	0	19	88	22.0

[a] Includes one cow with triplets.

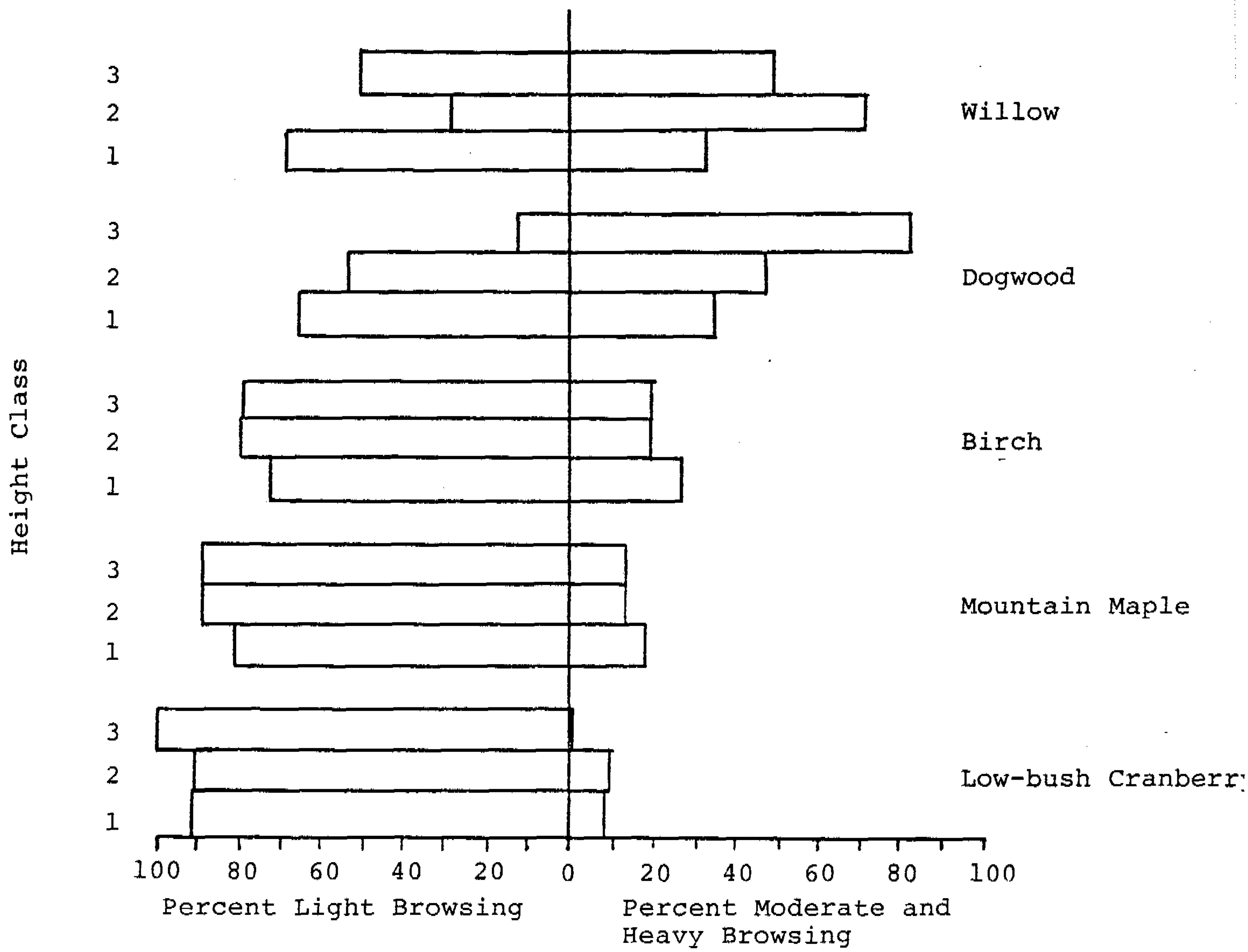

Fig. 4. Distribution of browse pressure by height class (1 = less than 1 m, 2 = 1-3 m, 3 = greater than 3 m) for the 5 most abundant browse species on the study area, Chilkat Valley, Alaska, 1983.

intensive survey, conducted by helicopter on 30 November and 1 December 1982, 200 moose were observed, 9 of which had collars (from a total of 19), yielding a population estimate of 422 moose (90% CI [Seber 1982]:196-648).

Productivity of the population was good; percentages of calves in the herd varied from 18.0-~~34.2~~ 25.5 (Table 12). The high proportion of calves in 1982-83 (25.5% of the population in late autumn) followed a winter in which snowfall was moderate to low and was evenly distributed throughout the winter. Good calf production in years following mild winters also was reported by Peterson (1977).

Coady (1974), Franzmann and Arneson (1976), Sigman (1977), and Doerr et al. (1980) reported high calf mortality in winters with deep snow. However, calf survival in relation to adult survival was excellent in the severe 1983 winter in Haines. Calves comprised 25.5% of the herd in fall 1982 and 22.0% of the herd in late winter 1983 (Table 12).

A mean of 38 (range 25-55) moose were harvested annually in GMU 1D for the period 1975-82, when a bulls-only harvest was permitted (Table 13). Of all moose taken from known localities, the mean annual harvest from the study area was 11 (29% of 1D total). Often hunters did not indicate specifically the location of their moose kill. If moose in the unspecified category were added to those known to have been killed on the study area, an

Table 13. Locations of reported moose kills in the lower Chilkat Valley, Alaska, 1975-82.

Year	Lower Chilkat River	Chilkat Lake	Takhin River	Murphy Flats	Klukwan	Haines Hwy. to Wells	Kicking Horse River	Total Known Taken from Study Area	Additional Moose Possibly Taken From Study Area	Total 1D Kill	% 1D Moose Known To Be Killed On Study Area	% Possible
1975	1	0	3	1	0	0	0	5	10	26	19	38
1976	4	2	7	0	0	4	0	17	8	55	31	45
1977	1	0	2	1	0	2	0	6	15	31	19	68
1978	1	1	4	0	0	6	0	12	11	45	27	51
1979	3	3	5	0	0	1	1	13	10	39	33	59
1980	1	0	4	0	0	4	1	10	24	48	21	50
1981	1	0	6	0	0	2	2	11	18	33	33	55
1982	4	1	3	0	0	2	0	10	14	25	40	56
Mean	2.00	0.88	4.25	0.25	0	2.63	0.50	10.50	37.75	13.75	27.88	52.75

additional 14 moose possibly were taken for a mean maximum possible of 25 (66%). Therefore, the actual mean percentages of moose taken from the study area is between 29% and 66% of the total GMU 1D harvest, a substantial amount.

CONCLUSIONS, MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

Moose range in the Chilkat River drainage was divided into 2 seasonal categories: summer (normally mid-April through mid-December) and winter. Although winter and summer ranges for moose in the Chilkat Valley overlapped extensively, moose utilized different habitats seasonally within the range. In mid-summer the high use of habitats with an overstory likely reflected the intolerance of moose to high temperatures. Moose also may have been feeding on succulent forbs in these areas, as reported for moose from the Kenai Peninsula (LeResche and Davis 1973). However, daily timing of flights may have influenced observed habitat use trends. Peek et al. (1982) reported that moose use more open communities during cooler times of the day. Movement in autumn to clearcuttings and non-stocked areas likely was associated with the seasonal switch from forage to browse (Peek 1974). In winter moose likely utilized riparian and non-stocked areas for feeding and adjacent coniferous stands for thermal and escape cover. Clearcuttings were utilized in the low-snow winter, but not in the deep-snow winter. Moose also utilized steep, southerly slopes with coniferous stands, and frozen river channels to escape from deep snow. Use of coniferous stands by moose during deep snow conditions also was reported by Telfer (1970), Van Ballenberghe and Peek (1971), Peek et al. (1976), Doerr et al. (1980), and Brusnyk and Gilbert (1983).

Moose track distribution was related to depth of snow and to abundance of preferred browse. Preferred browse was most abundant in clearcuttings, non-stocked and riparian areas. However, the availability of browse was determined by the height distribution of plants and snow depth. This relationship likely was responsible for the movement of moose to steep, southerly slopes and to frozen, braided river channels interspersed with riparian zones during periods of deep snow.

Habitat use as derived from aerial relocations differed from estimates derived from track counts. The high proportion of relocations in coniferous stands and the low number of tracks in such stands indicates a highly discriminative pattern of selection by moose. We believe that moose do not use all sections of coniferous stands equally, at least during severe weather. We propose that moose selected coniferous stands that offered thermal cover and shelter from snow and also were adjacent to feeding areas. Thus, areas of coniferous stands that are relatively far from feeding areas received relatively little use in winter, while areas with a dense conifer-dense browse edge received intensive use. This relationship may be different in other seasons when forage, in the form of understory vegetation, is available throughout coniferous stands.

Considering the high relative survival of moose calves during the winter of 1983 and the stable productivity of the Chilkat Valley population we conclude that the habitat, at the present time, is capable of sustaining the existing population even during periods of deep snow. However, a disproportionately low number of young willows (< 1 m) on the study area may indicate declining numbers of this forage plant due to transition from hydric to mesic sites resulting from isostatic rebounding and silt deposition on river deltas. Our data were not collected specifically to assess the age distribution of browse species, therefore this statement is somewhat tenuous. However, it indicates an area that deserves further study.

Clearcuttings have been reported widely as being beneficial to moose populations (Bergerud and Manuel 1968, Markgren 1974, Ahlen 1975, Peek et al. 1976, Doerr et al. 1980) because they provide browse during autumn and low-snow winters. The abundance of preferred browse found in recent clearcuttings in this study and in Thomas Bay, Alaska (Doerr et al. 1980) supports this statement. However, these areas become essentially unusable during periods of deep snow.

Also, the duration of availability of moose browse in second-growth stands in Haines is unknown. Alaback (1982) reported that canopy closure in regrowth stands of spruce-hemlock in southeast Alaska eliminated browse for as much as 80% of rotation age. Peek et al. (1976) and Doerr et al. (1980) concluded that regrowth stands were not beneficial to moose unless intensively managed. Also, removal of coniferous stands reduces the availability of feeding/thermal cover on summer ranges.

Brusnyk and Gilbert (1983) reported that in winter moose used strips of timber adjacent to feeding areas more intensively than they used extensive tracts of timber, and that a dense conifer-dense browse edge was an important component of moose winter habitat. Thomas et al. (1979) reported that stands of cover for deer and elk should be between 183 m (600 ft.) and 366 m (1,200 ft.) wide. Because moose in the Chilkat Valley utilize coniferous habitat extensively in summer and winter for feeding and cover we believe that tracts of uncut timber are extremely important to moose. Therefore, we recommend that existing stands of timber within high-density moose areas be retained and that timber surrounding feeding, breeding and movement areas be retained at a minimum width of 1,000 ft. (305 m).

Because of the dense concentrations of moose on the Takhin River and Murphy Flats area, and the restricted movement corridor between these areas, we recommend that development, particularly roading and logging, in these areas be avoided. Rolley and Kieth (1980) reported that moose avoided roaded areas. Also, logging roads built in the vicinity of moose concentration areas should have public access restricted to minimize harassment of the moose population. Ritchie (1978) and Peek et al. (1982) expressed concern over increased "extra-legal" losses of moose due to increased human access and decreased escape cover.

PART II. MOUNTAIN GOAT

STUDY AREA

The Kelsall Valley (Fig. 5) was selected as the site for intensive study of mountain goats because this area supported a relatively large population of goats (60+) and a large portion of the valley is scheduled for timber harvest. The Kelsall River originates in Canada and flows southeasterly to its confluence with the Chilkat River in the U.S. The river descends approximately 800 ft. from the U.S.-Canada border to its terminus, a distance of approximately 10 miles. The northeastern side of the valley rises sharply (approximate mean slope of 35°), with uppermost cliffs vertical or nearly so. This side is intersected with deep ravines and high-elevation valleys. The southwest side of the valley is less steeply inclined and contains no major valleys. Peaks on both sides of the valley rise to approximately 6,000 ft. Valley bottoms, and slopes up to 2,000 ft. are forested with commercial-quality Sitka spruce and western hemlock. A brush zone extends to approximately 3,500 ft., above which were alpine areas.

Fig. 5. Mountain goat study area in the Kelsall Valley, Alaska.

METHODS AND MATERIALS

During October 1981, 5 mountain goats (3 females, 2 males) were captured in the Kelsall Valley. During August 1982, 6 additional goats (3 females, 3 males) were captured in the Kelsall Valley and 2 goats (1 female, 1 male) were captured in the Rosaunt Creek drainage, in the southern portion of the study area (Appendix C). Helicopter-aided darting techniques were used to capture the goats (Schoen and Kirchhoff 1982). Etorphine (M-99) was used as an immobilizing agent and was fired from a Palmer Cap-Chur gun in 8cc darts which injected the drug. Diprenorphine (M50-50) was administered by hand as an antagonist. Each goat was fitted with a mortality-sensing radio-instrumented collar (Telonics, Mesa, AZ) and a numbered, colored plastic ear tag. Streamers of red nylon webbing were attached to collars to aid in identification of collared animals. Standard body measurements, hair samples for mineral analyses, blood samples, and fecal pellets were obtained when possible. Age was determined by counting horn annuli.

Eight aerial relocation flights, at approximately monthly intervals, were conducted between November 1981 and June 1982. Ten flights were conducted between November 1982 and April 1983. The first 8 flights were conducted in a Helio-Courier aircraft; the remainder were conducted in a Bellanca Citabria 150. Both aircraft were equipped with a Telonics TR-2 scanner/receiver connected to 2 wing-mounted Yagi directional antenna.

Radio-instrumented goats were identified visually whenever possible to aid in precise determination of habitat use. Locations within the U.S. were recorded on 1:63,360 USGS topographic maps; locations within Canada were recorded on 1:50,000 Canadian topographic maps during the first winter and, during the second winter, on enlargements of 1:250,000 USGS maps that approximated the 1:63,360 scale (1:63,360 topographic maps of Canada were not available). Topographic characteristics of slope, aspect, elevation, and terrain (smooth or broken) were recorded for each goat relocation (Appendix B).

Habitat classification followed Schoen (1979) and included: subalpine, rocky outcrop - cliff face, permanent ice/snow field, brush above timberline, deciduous brush (slide or avalanche zone), and spruce/hemlock forest. In habitats with an overstory, canopy coverage was estimated to the nearest 10% from the air or obtained from DNR forest type maps (1966). Net Scribner volume was obtained from DNR timber type maps. When present, estimates of percent snow cover, and snow type (hardness) were recorded.

During spring 1982, designated timber harvest units were surveyed on foot to assess use by goats based primarily on occurrence of fecal pellets and trails. A previously cut unit adjacent to known goat summer range also was searched. Intensive habitat sampling was planned for spring 1983, but was precluded because of deep snow.

Harvest statistics for mountain goats in GMU 1D were analyzed to determine the proportion of the total harvest comprised of goats taken from the study area.

RESULTS AND DISCUSSION

Twelve of 13 instrumented mountain goats were relocated 149 times; 143 of the relocations (96%) were considered precise enough to include in analysis. The five goats captured in 1981 were relocated 93 times (mean 16.6, range 10-18) and 7 of the 8 goats captured in 1982 were relocated 66 times (mean 9.4, range 6-10). One goat, a male captured in the Rosaunt Creek drainage in 1982, was never relocated after capture. We believe this animal died or its radio failed immediately after capture. Three of the remaining 12 goats (25%) died during the 1982-83 winter. Two goats were relocated at the bases of avalanche chutes on 23 January and 4 March and the cause of death of the third goat was undetermined. The third mortality was relocated by radio on 9 April 1983 but was not located visually. This individual was relocated in the same area on the two previous flights but never observed because of the craggy features of the cliffs. On the 9 April flight a mortality signal was received and the goat was assumed to be dead. However, during this study 2 radios on living goats malfunctioned and transmitted mortality signals; therefore this mortality could not be confirmed. High over-winter mortality, primarily due to avalanches, has been documented for goat populations in Idaho (Brandborg 1955 cited by Wigal and Coggins 1982), Montana (Chadwick 1977), and British Columbia (MacGregor 1977).

Seasonal Habitat Utilization

Goats were relocated in a greater variety of habitats and range of elevations in November than in any other month. One of 26 relocations (4%) was in coniferous forest, 2 (8%) were on brushy slopes, 8 (31%) were in alpine tundra, 1 (4%) was on permanent ice/snow, and 14 (54%) were in cliffs. Elevations of relocations varied between 2,000-5,400 ft.

Widely dispersed habitat use in November may have been associated with the rut, which peaks during this month (Wigal and Coggins 1982). Males have been reported to travel extensively during this time (Schoen and Kirchhoff 1982). Also, goats may have used lower slopes to avoid accumulated snow at higher elevations. Instrumented goats in this study were observed at lower elevations during November 1981 and 1982 than in any other month except April 1982.

During winter (December through March) 7 of 97 goat relocations (7%) were on brushy slopes, 4 (4%) were in alpine tundra, and 86 (89%) were in cliffs. Elevations varied from 2,400-5,700 ft. In April, goats were relocated in similar habitats in each year, but use between years differed. All relocations in 1981 were in coniferous forest and all 1982 relocations were in cliffs. Elevations varied from 1,500-5,700 ft. All (5) relocations in June were in cliffs between 3,800-4,500 ft.

No instrumented goats were relocated in clearcuts or on slopes above clearcuts. Also, observations of non-instrumented goats in or above clearcuts were uncommon but these goats were abundant in areas used by instrumented goats. Avoidance of clearcuts by mountain goats also was observed by Chadwick (1973) and Rideout (1974).

Southerly (SE, S, SW) exposures predominated in relocations in all months. Ninety-six percent of all relocations were on southerly aspects and 2% each were on W-NW and N-E aspects. Preference for southerly aspects was reported for other goat populations in southeastern Alaska (Fox 1977, Schoen and Kirchhoff 1982, Fox et al. undated) and elsewhere (Chadwick 1977, Smith 1977). Schoen and Kirchhoff (1982) reported high use of northerly aspects by goats in summer, which they speculated were characterized by cooler microenvironments. Rideout (1977) also observed summer use of northerly aspects by goats in Montana. He stated that northerly aspects supported more lush vegetation because they held more snow in winter and thus had more favorable soil moisture regimes during the growing season. Our data are limited (5 relocations in June 1982), but goats were relocated only on southerly aspects in summer. Also, aerial surveys along other ridges in the Haines area in spring 1983 revealed relatively little use of northerly aspects by goats (B. Dinneford, pers. comm.), a trend observed by Chadwick (1973) in Montana.

Habitat Utilization Between Years

Differences in habitat utilization between the winters of 1981-82 and 1982-83 seemingly were related to snowfall. Snowfall recorded at Canada Customs, Pleasant Camp, B.C. (12 mi. southwest of the study area) was 437.6 cm from October 1981 through April 1982 (51% of the 1957-1973 mean) compared with 1057.0 cm for the same period in 1982-83 (124% of the mean). Monthly snowfall was higher in 1982-83 than in 1981-82 for 5 of 7 months (Fig. 6).

Monthly mean elevations of relocations were significantly higher during the 1982-83 winter than in the 1981-82 winter. Mean, maximum, and minimum elevations recorded in all months in 1982-83 were higher than those for the corresponding months in 1981-82 (Fig. 6).

Differences between years in utilization of habitat were significant for December, January, and April (Fisher's Exact Test, $P < 0.01$). No differences were evident in November. Data for March did not conform to assumptions of Chi-square analysis (Zar 1974) and observations in February and June were recorded in 1982 only; therefore no tests were possible. In all months in

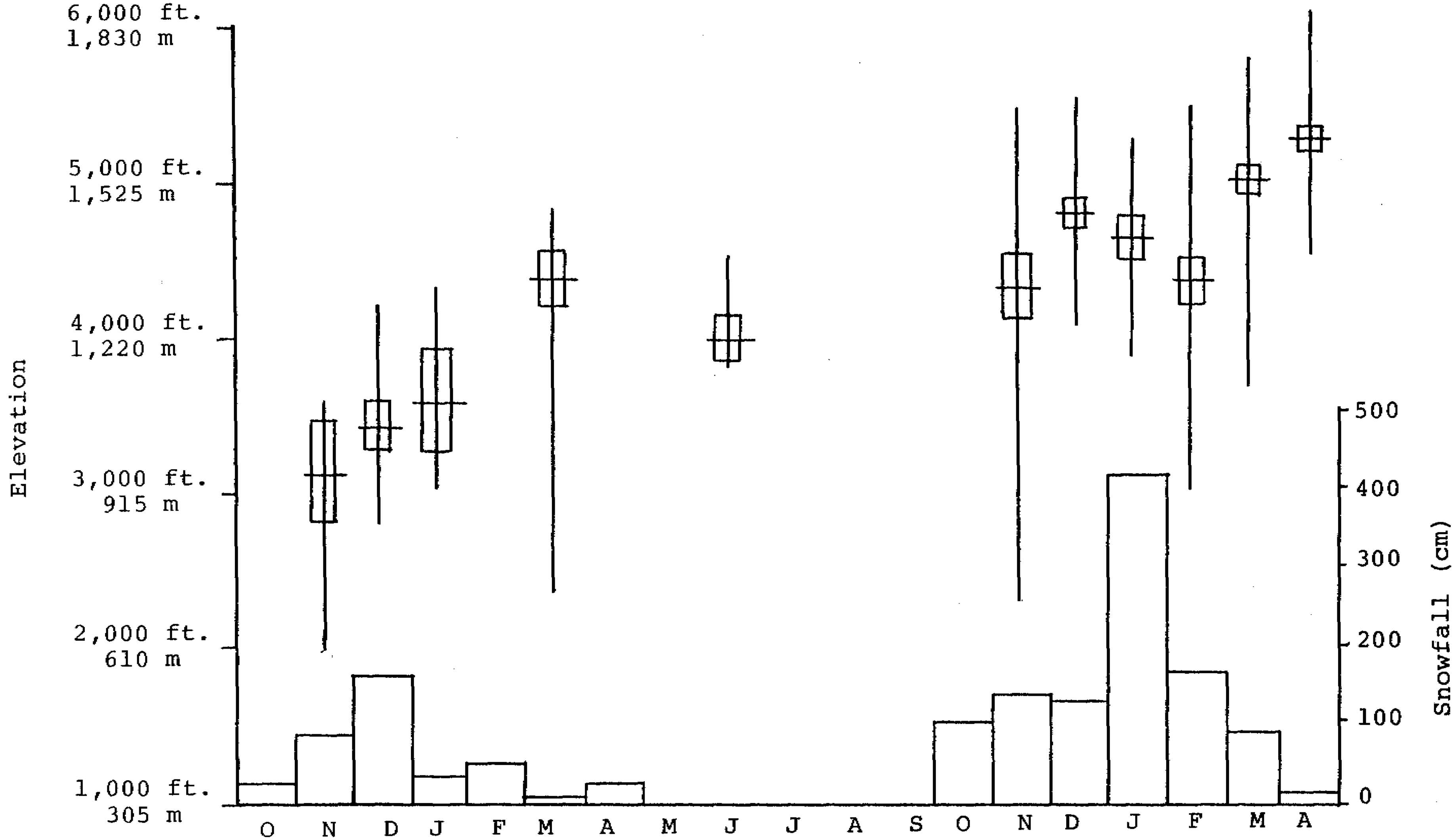

Fig. 6. Monthly mean elevations (horizontal lines) + SE (boxes) and ranges (vertical lines) of mountain goat relocations, Kelsall Valley, Alaska. Monthly snowfall also is displayed.

which differences were evident use of cliffs was proportionately greater in 1982-83 than in 1981-82 (Table 14).

Ninety-three of 105 relocations (89%) from November 1982 through April 1983 were in cliffs, compared with 17 of 33 (52%) for the same period in 1981-82. Non-cliff use was spread throughout the 1981-82 winter. The only month during which goats were not relocated in cliffs was April 1982, when all instrumented goats were relocated in coniferous forest. Snow had melted considerably by this time and estimates of snow cover in the immediate vicinities of relocated goats varied from 70-100%. Goats possibly were utilizing forage exposed by the melting snow and/or conifer foliage, which was reported to be a primary food item of goats in winter in Montana and Alberta (Saunders 1955, Kerr 1965 cited by Wigal and Coggins 1982, Smith 1976).

All instrumented goats moved back to cliffs in June 1982. This movement possibly was related to receding snow at higher elevations and the corresponding "green-up" of vegetation, and also may have been related to the need for escape cover during parturition. However, Lentfer (1955) and Saunders (1955) observed parturient goats in timbered areas in Montana. Other authors reported a preference by goats for high-elevation, grassy slopes and cliffs in summer (Saunders 1955, Hebert and Turnbull 1977, Schoen and Kirchhoff 1982).

Table 14. Distribution of mountain goat relocations between cliffs and other habitat types, Kelsall Valley, Alaska. Results of tests of significance are reported where between-year comparisons are possible.

Month	Year	Habitat: Cliffs	Habitat: All Other Types	Test Result[1]
January	1982	1	3	not significant $P > 0.05$
	1983	11	0	
February	1983	19	2	no test possible
March	1982	8	1	no test possible[2]
	1983	30	0	
April	1982	0	5	habitat use differed between years $P < 0.01$
	1983	10	0	
June	1982	5	0	no test possible
November	1981	3	2	not significant $P > 0.05$
	1982	11	11	
December	1981	5	5	habitat use differed between years $P < 0.01$
	1982	12	1	

[1] Fisher's Exact Test (Zar 1974).

[2] Sample size is too large for Fisher's Exact Test and data do not conform to assumptions for Chi-square analysis (Zar 1974:66).

The response of mountain goats in the Kelsall Valley to deep snow in the 1982-83 winter was to utilize steep southerly cliffs, likely because of their snow-shedding characteristics. Affinity to windswept cliffs and ridges by goats in winter was reported by Lentfer (1955), Fox (1981), Chadwick (1973), and Hebert and Turnbull (1977). However, use of forested areas and/or lower elevations (in comparison with summer range) also has been reported for over-wintering goats (Rideout 1977, Smith 1977, Schoen and Kirchhoff 1982). When goats were observed in forested habitats in winter they usually were associated with broken, steep terrain (Schoen and Kirchhoff 1982, Fox et al. undated). Kuck (1977), Fox (1981), and Schoen and Kirchhoff (1982) believed that escape cover (i.e. cliffs) was the primary factor influencing selection of winter habitat by goats. It is intuitively reasonable to assume that if steep, broken terrain existed within forested areas goats would utilize such habitat in winter because of increased forage availability and thermal cover. In the Kelsall Valley there is not sufficient steep habitat within timbered areas to warrant goat use of these areas, therefore goats utilized cliffs above timberline. However, such areas exist elsewhere within the Haines State Forest.

Population Composition and Harvest

Aerial surveys of specific mountain ranges within the State Forest in 1982 and 1983 (B. Dinneford *in litt.*) indicate moderate production in resident goat populations (Table 15). The ratio of

Table 15. Game Management Unit 1D aerial survey data, 1982-83.

Area	Date	Adults	Kids	Total	Kids/ 100 Adults	% Kids	Count Time (Minutes)
SW Ferebee Ridge drainages	8-16-82	13	9	22	69.2	40.9	65
NE Chilkoot Ridge drainages	8-16-82	20	5	25	25.0	20.0	218
SW Chilkoot Ridge drainages	8-16-82	9	--	0	----	----	35
Subtotal		42	14	56	33.3	25.0	318
Takhin Ridge	6-23-83	23	8	31	34.8	25.8	64
Tsirku/Klehini Ridge	6-23-83	44	15	59	34.1	25.4	120
Subtotal		67	23	90	34.3	25.6	284
Total		109	37	146	33.9	25.3	602

33.9 kids:100 adults is similar to estimates of production reported for managed populations in Alberta (30.0:100, Hall 1977) and southeast Alaska (34.6:100, Ballard 1977).

Hunter success rates varied greatly since 1975, when a one-goat bag limit was imposed (Table 16). Mean success rate from 1975-81 was 33.5%, somewhat less than mean success rates reported for other areas on the southeast Alaska mainland (41.4% in GMU 1A and 44.1% in GMU 1C).

Reliable methods for estimating mountain goat densities from aerial surveys do not exist (Ballard 1977); therefore, no estimate of mountain goat numbers within the State Forest is possible at this time. Consequently, it is difficult to assess the impact of current hunting pressure on the goat population. However, relatively low hunter success rates may indicate low numbers of goats in areas accessible to hunters.

CONCLUSIONS, MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

Mountain goats utilized coniferous forests, brushy slopes, alpine tundra, permanent ice/snow, and cliffs at some time during this study. No instrumented goats were relocated in clearcuts or on adjacent slopes. Cliffs were the primary habitat type utilized, and they were used in all months except in April 1982 when snow cover was patchy under the overstory canopy. Cliffs were

Table 16. Historical GMU 1D goat harvest, 1975-1982.

Year	Male	Female	Unknown	Total	Number Hunters	Percent Success
1975	21	12	1	34	77	52.2
1976	8	9	0	17	65	45.5
1977	15	9	1	25	69	26.1
1978	7	10	0	17	52	36.2
1979	14	8	0	22	40	55.0
1980	11	10	9	30	103	29.1
1981	24	19	0	43	127	33.9
1982	13	11	1	25	103	24.3

utilized most intensively during the deep-snow winter of 1982-83, during which goats utilized slopes at higher elevations than during the previous winter. Goats did not utilize forested habitat in winter, likely because steep, broken terrain (escape cover) was not available within forested areas. Forested habitat was utilized most heavily in spring after the low-snow winter and this use likely corresponded with decreasing snow cover and increasing forage availability under the canopy.

Considering the data presented in this report and the observations of others we conclude that logging in the Kelsall Valley is unlikely to eliminate critical mountain goat winter habitat. Even if escape cover were present within the coniferous stands the slopes likely would be too steep to permit timber harvesting. However, we believe that logging will have drastic adverse impacts on the mountain goats in the valley. Logging would result in loss of habitat utilized during rut, pre-parturition and possibly parturition periods. The most severe impacts of logging, however, will be in the form of disturbance and increased hunting pressure.

Reports from other areas indicate that goats may be adversely affected by logging, mining, and associated road construction (Brandborg 1955 cited by Smith 1973, Chadwick 1973, Rideout 1974, Hebert and Turnbull 1977). Detrimental effects were in the form of excessive noise, continuous close human presence, disturbance of goat movement corridors, replacement of habitat that was used occasionally (timber) with habitat used rarely if at all (clearcuts), and increased hunter access via new roads. Mountain goat populations have relatively low recruitment rates compared with other big game species and the potential for high density-independent winter mortality is great. Therefore, mountain goat populations do not respond to intense hunting pressure as may other game species, and are affected adversely by increases in hunting pressure (Kuck 1977, Hebert and Turnbull 1977). Brandborg (1955 cited by Smith 1973), Kuck (1977), and Hebert and Turnbull (1977) have reported substantial declines in mountain goat populations after hunter access was improved by logging and/or mining roads.

We believe that if the Kelsall Valley and other high-concentration goat areas are logged, resident goat populations will decline, and possibly be eliminated. Increased hunter access via logging roads will result in increased legal and illegal harvest. Because hunter success is relatively low within the State Forest, we foresee substantial increases in hunting pressure in areas with improved access. Resultant population declines would be unacceptable from a management standpoint.

Our recommendations for minimizing the impacts of logging on mountain goats within the State Forest are:

- Defer timber harvest on the eastern slopes of the Kelsall Valley.

- Future timber sales within the State Forest should be evaluated in terms of their impacts on resident goat populations. Timber harvests should be deferred in areas of high goat concentrations.

- If logging-goat conflicts are unavoidable, a windfirm buffer strip of timber not less than 0.5 mi. (0.3 km) wide should border goat concentration areas, as identified by the Department of Fish and Game. This follows a similar recommendation made by Schoen and Kirchhoff (1982) for goat populations in Berners Bay, Alaska.

- In areas where access roads are built to facilitate timber harvest, administrative closure of these roads to recreational vehicular traffic should be invoked.

- In areas of possible logging-goat conflicts, the affected goat populations should be monitored closely by the Department of Fish and Game to determine actual impacts of disturbance and access.

- If goat populations are declining, conservative hunting regulations should be adopted, including decreased season lengths and/or bag limits, registration permit hunts, or specific area closures.

ACKNOWLEDGEMENTS

Invaluable field assistance was provided by Chiska Derr, Dave Dreyer, and Gordon Woods. Chris Smith and Rod Flynn assisted with capture of goats. Tom June, Livingston Copters, made capture operations easier with his skillful piloting. LAB Flying Service and Wings of Alaska provided pilots and aircraft for fixed-wing surveys; particular credit goes to Doug Lane (WOA), survey pilot extraordinnaire. Ray Staska provided logistical support. Mike Thomas assisted with data analysis and Matt Kirchhoff wrote a computer program used for use-vs.-availability analysis. Earlier versions of this manuscript were reviewed by Rod Flynn, John Matthews, Don McKnight, John Schoen, and Mike Thomas. Bruce Dinneford provided useful insight concerning goat distributions and management recommendations. Dara Miller typed the manuscript. To all these persons we express our gratitude.

LITERATURE CITED

Ahlen, I. 1975. Winter habitats of moose and deer in relation to land use in Scandanavia. Viltrevy 9:45-191.

Alaback, P. B. 1982. Dynamics of understory biomass in Sitka spruce-western hemlock forests of southeast Alaska. Ecology 63:1932-1948.

Alaska Dept. of Natural Resources. 1979. Haines-Skagway area land use plan. Vol. III. Planning and Classification Section, Alaska Dpet. of Natural Resources, Anchorage. 162pp.

Ballard, W. 1977. Status and management of the mountain goat in Alaska. Pp. 15-23 <u>in</u> W. Samuel and W. G. MacGregor (eds.) Proc. First Int. Mountain Goat Symp. Kalispell, MT.

Belovsky, G. 1981. Optimal activity times and habitat choice of moose. Oecologia 48:22-30.

Bergerud, A. T. and F. Manuel. 1968. Moose damage to balsam fir-white birch forests in central Newfoundland. J. Wildl. Manage. 32:729-746.

Brandborg, S. M. 1955. Life history and management of the mountain goats of Idaho. Idaho Dept. Fish and Game Wildl. Bull. 2. 142pp.

Brusnyk, L. M. and F. F. Gilbert. 1983. Use of shoreline timber reserves by moose. J. Wildl. Manage. 47:673-685

Chadwick, D. A. 1973. Mountain goat ecology-logging relationships in the Bunker Creek drainage of western Montana. Montana Fish and Game Dept. P-R Proj. Rep. N-120-R-3, 4. 262pp.

Chadwick, D. H. 1977. The influence of mountain goat social relationships on population size and distribution. Pp. 74-91 in W. Samuel and W. G. MacGregor (eds.). Proc. First Int. Mountain Goat Symp. Kalispell, MT.

Coady, J. W. 1974. Influence of snow on behavior of moose. Naturaliste Can. 101:307-323.

Doerr, J. G., E. L. Young, Jr., and A. W. Franzmann. 1980. Ecological and physiological aspects of a moose population in Thomas Bay, southeast Alaska. Proc. N. Amer. Moose Workshop. 16:203-237.

Fox, J. L., K. J. Raedeke and C. A. Smith. Undated. Mountain goat ecology on Cleveland Peninsula, Alaska 1980-1982. Final Rept. Coop. Agreement No. PNW-81-0017. Pacific NW For. Range Exp. Sta., Forestry Sci. Lab., Juneau, AK. 41pp.

Fox, J. 1981. Site selection by mountain goats wintering in forest habitat. Final Rept. Coop. Agreement No. 153 between USDA Forest Service (Pac. NW For. and Range Exp. Sta.) and College of Forest Resources, Univ. of Washington. 55pp.

Franzmann, A. W. and P. D. Arneson. 1976. Marrow fat in Alaskan moose femurs in relation to mortality factors. J. Wildl. Manage. 40:336-339.

Hall, W. K. 1977. Status and management of the Rocky Mountain goat, *Oreamnos americanus*, in the Province of Alberta. Pp. 8-14 *in* W. Samuel and W. G. MacGregor (eds.) Proc. First Int. Mountain Goat Symp. Kalispell, MT.

Hebert, D. and W. Turnbull. 1977. A description of southern interior and coastal mountain goat ecotypes in British Columbia. Pp. 126-146 *in* W. Samuel and W. MacGregor (eds.). Proc. First Int. Mountain Goat Symp. Kalispell, MT.

Irwin, L. L. 1974. Relationships between deer and moose on a burn in northeastern Minnesota. M.S. thesis. Univ. of Idaho. Moscow. 51pp.

Kelsall, J. P. and W. Prescott. 1971. Moose and deer behavior in snow in Fundy National Park, New Brunswick. Can. Wildl. Serv. Rep. 15. 25pp.

Kelsall, J. P. and E. S. Telfer. 1974. Biogeography of moose with particular reference to western North America. Naturaliste can. 101:117-130.

Kerr, R. G. 1965. The ecology of mountain goats in west central Alberta. Unpubl. M.S. thesis, Univ. Alberta, Edmonton. 96pp.

Kuck, L. 1977. The impacts of hunting on Idaho's Pashimeroi mountain goat herd. Pp. 114-125 in W. Samuel and W. G. MacGregor (eds.) Proc. First Int. Mountain Goat Symp. Kalispell, MT.

Lentfer, J. W. 1955. A two-year study of the Rocky Mountain goat in the Crazy Mountains, Montana. J. Wildl. Manage. 19:417-429.

LeResche, R. E. and J. L. Davis. 1973. Importance of non-browse foods to moose on the Kenai Peninsula, Alaska. J. Wildl. Manage. 37:279-287

LeResche, R. E., and R. A. Hinman (eds.). 1973. Alaska's wildlife and habitat. Alaska Dept. of Fish and Game, Juneau. 144pp. + maps.

MacGregor, W. G. 1977. Status of mountain goats in British Columbia. Pp. 24-28 in W. Samuel and W. G. MacGregor (eds.) Proc. First Int. Mountain Goat Symp. Kalispell, MT.

Marcum, C. L. and D. O. Loftsgaarden. 1980. A nonmapping technique for studying habitat preferences. J. Wildl. Manage. 44:963-968.

Markgren, G. 1974. The moose in Fennoscandia. Naturaliste Can. 101:185-194.

Peek, J. M. 1974. A review of moose food habits studies in North America. Naturaliste Can. 101:195-215.

Peek, J. M., D. L. Urich, and R. J. Mackie. 1976. Moose habitat selection and relationships to forest management in northeastern Minnesota. Wildl. Monogr. 48:1-65.

Peek, J. M., M. D. Scott, L. J. Nelson, D. J. Pierce and L. L. Irwin. 1982. Role of cover in habitat management for big game in northwestern United States. Trans. N. Amer. Wildl. Nat. Res. Conf. 47:363-373.

Peterson, R. O. 1977. Wolf ecology and prey relationships on Isle Royale. Monogr. Ser. No. 11. U.S. Nat. Park Serv., Wash., D.C. 210pp.

Phillips, R. L., W. E. Berg and D. B. Siuiff. 1973. Moose movement patterns and range use in northwestern Minnesota. J. Wildl. Manage. 37:266-278.

Pieper, R. D. 1978. Measurement techniques for herbaceous and shrubby vegetation. New Mexico State Univ. Bookstore Inc. Las Cruces. (revised) 148pp.

Rideout, C. 1974. A radio telemetry study of the ecology and behavior of the Rocky Mountain goat in western Montana. Unpubl. Ph.D. diss., Univ. Kansas, Lawrance. 146pp.

Rideout, C. B. 1977. Mountain goat home ranges in the Sapphire Mountains of Montana. Pp. 201-211 in W. Samuel and W. G. MacGregor (eds.) Proc. First Int. Mountain Goat Symp. Kalispell, MT.

Ritchie, B. W. 1978. Ecology of moose in Fremont County, Idaho. Wildl. Bull. No. 7. Idaho Dept. Fish and Game, Boise. 33pp.

Rolley, R. E. and L. B. Kieth. 1980. Moose popualtion dynamics and habitat use at Rochester, Alberta. Can Field.-Nat. 94:9-18.

Saunders, Jr., J. K. 1955. Food habits and range use of the Rocky Mountain goat in the Crazy Mountains, Montana. J. Wildl. Manage. 19:429-437.

Schoen, J. 1979. Winter habitat use by mountain goats. Alaska Dept. Fish and Game. P-R Prog. Rept. W-21-1. 13pp.

Schoen, J. W. and M. D. Kirchoff. 1982. Habitat use by mountain goats in southeast Alaska. Final Rept. Fed. Aid. Wildl. Restor. Proj. W-17-10, W-17-11, W-21-1, W-21-2, Job 12.4R. Alaska Dept. of Fish and Game, Juneau. 67pp.

Seber, G. A. F. 1982. The estimation of animal abundance. Second ed. MacMillan, New York. 654pp.

Sigman, M. 1977. A hypothesis concerning the nature and importance of the overwinter cow-calf bond in moose. Proc. N. Amer. Moose Conf. 13:71-90.

Smith, B. L. 1976. Ecology of Rock Mountain goats in the B. Herroot Mountains, Montana. Unpubl. Ph.D. diss., Univ. Montana, Bozeman. 203pp.

Smith, B. L. 1977. Influence of snow conditions on winter distribution, habitat use, and group size of mountain goats. Pp. 174-189 in W. Samuel and W. G. MacGregor (eds.) Proc. First Int. Mountain Goat Symp. Kalispell, MT.

Smith, C. A. 1983. Habitat use by mountain goats in southeastern Alaska. Prog. Rept. Alaska Dept. Fish and Game. P-R Proj. W-22-1, Juneau, AK.

Telfer, E. S. 1970. Winter habitat selection by moose and white-tailed deer. J. Wildl. Manage. 34:553-559.

Thomas, J. W., H. Black, Jr., R. J. Scheryinger, and R. J. Pederson. 1979. Deer and elk. Pp. 104-127 in J. W. Thomas (ed.), Wildlife habitats in managed forests: the Blue Mountains of Oregon and Washington. USDA For. Serv. Agric. Handbook No. 553.

Van Ballenberghe, V. and J. M. Peek. 1971. Radio telemetry studies of moose in northeastern Minnesota. J. Wildl. Manage. 35:63-71.

Wigal, R. A. and V. L. Coggins. 1982. Mountain goat. Pp. 1009-1020 in J. A. Chapman and G. A. Feldhammer (eds.) Wild mammals of North America. Johns Hopkins Univ. Press, Baltimore.

Zar, J. H. 1974. Biostatistical analysis. Prentice-Hall. Englewood Cliffs, N.J. 620pp.

APPENDIX A. Age, sex, and location of capture for radio-instrumented moose, Chilkat Valley, Alaska.

Moose No.	Capture Date 1981	Location of Capture	Age	Sex	Calf No.
1	10/27	Murphy Flats	--	M	-
2	10/27	Murphy Flats	--	F	-
3	10/28	Murphy Flats	5	F	1
4	10/28	Murphy Flats	4	M	-
5	10/28	Takhin River	2	F	1
6	10/28	Takhin River	10	F	1
7	10/28	Takhin River	--	F	1
8	10/28	Murphy Flats	--	F	-
9	10/28	Murphy Flats	7	F	1
10[a]	10/28	Takhin River	2	M	-
11	10/28	Takhin River	--	F	1
12	10/29	Murphy Flats	10	F	-
13	10/29	Murphy Flats	--	F	-
14	10/29	Murphy Flats	--	F	2
15	10/29	Takhin River	--	F	-
16	10/29	Takhin River	--	M	-
17	10/29	Takhin River	--	F	-
18	10/29	Takhin River	--	F	-
19	10/29	Chilkat River	2	F	-
20	10/30	Takhin River	--	F	-

[a] This moose was killed by a hunter in September 1982.

APPENDIX B. Moose, mountain goat telemetry data codes.

Animal	Survey Type	Observer	Clouds	Precipitation
1=goat	1=aerial	1=Wayne	% Cover	1=no rain
2=moose	2=ground	2=Gordie		2=intermittant rain
		3=Ron		3=steady rain
		4=Other		4=snow

Wind Direction	Wind Velocity
Degs magnetic	MPH
0, Variable=111	

Habitat

1 series=Swamp
10=swamp/alder
11=swamp/willow
12=swamp/open
13=marsh   14=stream edge/marsh edge

2 series=Non-stocked
20=NS/alder
21=NS Black Cottonwood/alder
22=NS/willow

3 series=Forested
30=Spruce/Hemlock
31=Spruce/BCW
32=Spruce
33=BCW
34=Hemlock
35=Hardwood
36=Lodgepole Pine

4 series=Alpine Terrain
40=Subalpine
41=Brush above timberline
42=Deciduous brush (slide, avalanche)
43=Alpine tundra
44=Rocky outcrop, cliff face
45=Permanent ice, snowfield

5 series=Cut Areas
50=Early clearcut (0-15 years)
51=Mid Clearcut, deciduous (16-30 years)
52=Mid Clearcut, coniferous (16-30 years)
53=Partial cut

6 series=Other Types
60=Mixed conifer
61=Mixed HW/conifer
62=Gravel, sandbar, slough
63=Other

Canopy	Terrain	Snow Cover (%) and Depth (in.)	Snow Type
% Cover	1=smooth	In general vicinity of animal	0=no snow
	2=broken		1=soft
			2=hardpack
			3=crust

Accuracy

1=Location within 25 acres-habitat certain
2=Location within 25 acres-habitat uncertain
3=Location within 100 acres-habitat uncertain

Animal Location (from map)

First three values are the X (EW) coordinate
Last three values are the Y (NS) coordinate

Aspect (from map)

01=Flat	04=E	07=SW	10=Ridgetip
02=N	05=SE	08=W	
03=NE	06=S	09=NW	

Slope

degrees	# contour lines/grid
1-15	1-2
16-30	3-5
31-45	6-9
46+	10+

Group Size

# of individuals observed in each group

APPENDIX C. Age, sex, and location of capture for radio-instrumented mountain goats, Kelsall Valley, Alaska.

Goat No.	Capture Date	Location of Capture	Age	Sex	No. of Kids
1	10/7/81	Kelsall River	4	M	-
2	10/7/81	Kelsall River	1	F	0
3	10/8/81	Kelsall River	4	M	-
4	10/8/81	Kelsall River	3	F	0
5	10/9/81	Kelsall River	7	F	1
6	8/82	Kelsall River	5+	F	1
7	8/82	Kelsall River	6	M	-
8	8/82	Rosaunt Creek	5+	F	1
9	8/82	Kelsall River	5+	M	-
10[a]	8/82	Rosaunt Creek	5+	M	-
11	8/82	Kelsall River	4	M	-
12	8/82	Kelsall River	7	F	0
13	8/82	Kelsall River	-	M	-

[a] This goat was never relocated.