Distribution, movements, and habitat use during spring, summer, and fall by mule deer in the north Salish Mountains, Montana
by Bret Jeffrey Stansberry

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Fish and Wildlife Management
Montana State University
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Abstract:
This study was conducted in the north Salish Mountains of northwest Montana during summer 1988 and spring, summer, and fall 1989 to determine deer distribution, movements, and habitat use in relation to environmental variables. Three tentative population-habitat units (PHUs), distributed in relation to winter ranges, were delineated. PHU 1 was 165.3 km^2, PHU 2 was 10.6 km^2, and PHU 3 was 13.9 km^2 . The winter range on PHU 1 was divided into 3 sub-units based on winter relocations of radio-collared deer. Deer with indistinct seasonal ranges (ISR) made up 31.5% of all radio-collared deer, deer with adjacent seasonal ranges (ASR) accounted for 16.7%, and deer with distinct seasonal ranges (DSR) comprised 51.9%. In addition to summer and winter home ranges, accessory areas were used by deer during spring and fall. Mean date of departure from winter range was earlier in 1988 than 1989 and mean date of return to winter range was later in 1988 than in 1989. All 54 radio-collared deer showed high fidelity to seasonal ranges. Summer home range size decreased significantly from 2.7 km^2in 1988 to 1.2 km^2 in 1989 possibly due to abundant precipitation and increased forage production. Lodgepole pine and mixed conifer were cover types used most heavily in spring, summer, and fall by radio-collared deer. In contrast to ISR and ASR deer, DSR deer made extensive use of sub-alpine fir cover types. Use of cover types by 5 deer occupying fall accessory areas shifted from ponderosa pine and mixed conifer to lodgepole pine and sub-alpine fir. South to west aspects were used most heavily by all deer. ISR deer used steep slopes most often, while ASR and DSR deer used moderate slopes. Comparison of plant phenology stages and deer movement indicated deer used areas as plants became green in the spring or stayed green in the fall.

DISTRIBUTION, MOVEMENTS, AND HABITAT USE DURING SPRING, SUMMER, AND FALL BY MULE DEER IN THE NORTH SALISH MOUNTAINS, MONTANA

By

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A thesis submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Fish and Wildlife Management

MONTANA STATE UNIVERSITY
Bozeman, Montana

April 1991

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APPROVAL

of a thesis submitted by

Bret Jeffrey Stansberry

This thesis has been read by each member of the thesis committee and has been found to be satisfactory regarding content, English usage, format, citations, bibliographic style, and consistency, and is ready for submission to the College of Graduate Studies.

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ACKNOWLEDGMENTS

I wish to thank Dr. R. Mackie for his guidance in directing the study and preparing the manuscript; and Drs. R. Eng, W. Gould, and H. Picton for reviewing the manuscript. Biologist C. Yde (Montana Department of Fish, Wildlife, and Parks) was very helpful in supplying equipment, accommodations, and friendly advice. S. Martin provided helpful suggestions. Additional thanks go to biologists G. Brown, L. Young, H. Nyberg, J. Cross, G. Dusek, D. Pac, and K. Hamlin. The skill of pilots K. Kinden and B. Groom in flying and the use of aerial radiotelemetry is greatly appreciated. My fellow graduate students gave helpful suggestions and many hours of vigorous debate. Finally, I wish to thank my family for their undying support throughout my education. My study was supported by Montana Department of Fish, Wildlife, and Parks; U.S. Forest Service, Kootenai National Forest; and Bonneville Power Administration.

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ABSTRACT

This study was conducted in the north Salish Mountains of northwest Montana during summer 1988 and spring, summer, and fall 1989 to determine deer distribution, movements, and habitat use in relation to environmental variables. Three tentative population-habitat units (PHUs), distributed in relation to winter ranges, were delineated. PHU 1 was 165.3 km^2, PHU 2 was 10.6 km^2, and PHU 3 was 13.9 km^2. The winter range on PHU 1 was divided into 3 sub-units based on winter relocations of radio-collared deer. Deer with indistinct seasonal ranges (ISR) made up 31.5% of all radio-collared deer, deer with adjacent seasonal ranges (ASR) accounted for 16.7%, and deer with distinct seasonal ranges (DSR) comprised 51.9%. In addition to summer and winter home ranges, accessory areas were used by deer during spring and fall. Mean date of departure from winter range was earlier in 1988 than 1989 and mean date of return to winter range was later in 1988 than in 1989. All 54 radio-collared deer showed high fidelity to seasonal ranges. Summer home range size decreased significantly from 2.7 km^2 in 1988 to 1.2 km^2 in 1989 possibly due to abundant precipitation and increased forage production. Lodgepole pine and mixed conifer were cover types used most heavily in spring, summer, and fall by radio-collared deer. In contrast to ISR and ASR deer, DSR deer made extensive use of sub-alpine fir cover types. Use of cover types by 5 deer occupying fall accessory areas shifted from ponderosa pine and mixed conifer to lodgepole pine and sub-alpine fir. South to west aspects were used most heavily by all deer. ISR deer used steep slopes most often, while ASR and DSR deer used moderate slopes. Comparison of plant phenology stages and deer movement indicated deer used areas as plants became green in the spring or stayed green in the fall.

INTRODUCTION

Recent studies in mountain and mountain-foothills habitat of southwestern Montana (Pac et al. 1991) have indicated that mule deer ecology varies widely depending on the specific habitat complexes present. Also patterns of habitat use often differ among individual deer in the same population. In northwestern Montana, mule deer occupy a variety of coniferous forest habitats managed intensively for timber production. Little is known about mule deer ecology in these habitats, especially in relation to timber and habitat management.

Although mule deer have been studied extensively in mountain-foothill environments, few studies have been conducted in coniferous forest environments similar to northwest Montana. Bailey (1960) and Fairman (1966) studied winter movement and distribution in the Rattlesnake drainage in west-central Montana. Knoche (1967) studied the ecology of the Rattlesnake winter range. Yeager (1984) studied use of cover on winter range on the Flathead Indian Reservation in west-central Montana. Simpson (1988) studied seasonal distribution in south-central British Columbia.

My study was established to provide baseline information on mule deer ecology in the north Salish Mountains. Specific objectives were to determine spring,

summer, and fall distribution and habitat use. Relationships between migration behavior and plant phenology were also established. Research was conducted during summer 1988 and spring, summer, and fall 1989.

STUDY AREA

The study area was located along the northwest flank of the Salish Mountains approximately 80.5 km northeast of Libby, in Lincoln County, Montana (Fig. 1). The area encompassed approximately 446 km^2, within the Rexford Ranger District of the Kootenai National Forest. Boundaries were Pinkham Creek on the north and east, Tenmile Creek on the south, and Lake Koocanusa on the west.

Geologically, the study area is underlain by strata from the Belt Super Group of the late Precambrian age (Johns 1970). This portion of the Salish range was created by faulting and folding during the Late Cretaceous to Early Tertiary ages and is characterized by north-northwest trending folds in the Belt sediments. The area was completely covered by the Cordilleran ice sheet except for the higher peaks. Elevations range from 744 m along the shore of Lake Koocanusa to 2,131 m at the top of McGuire mountain.

Topographically, the study area was comprised of 2 distinct zones (Fig. 2). From lake level to about 1,524 m, the area is characterized by very steep, broken terrain, including steep cliff faces and talus slopes. This terrain

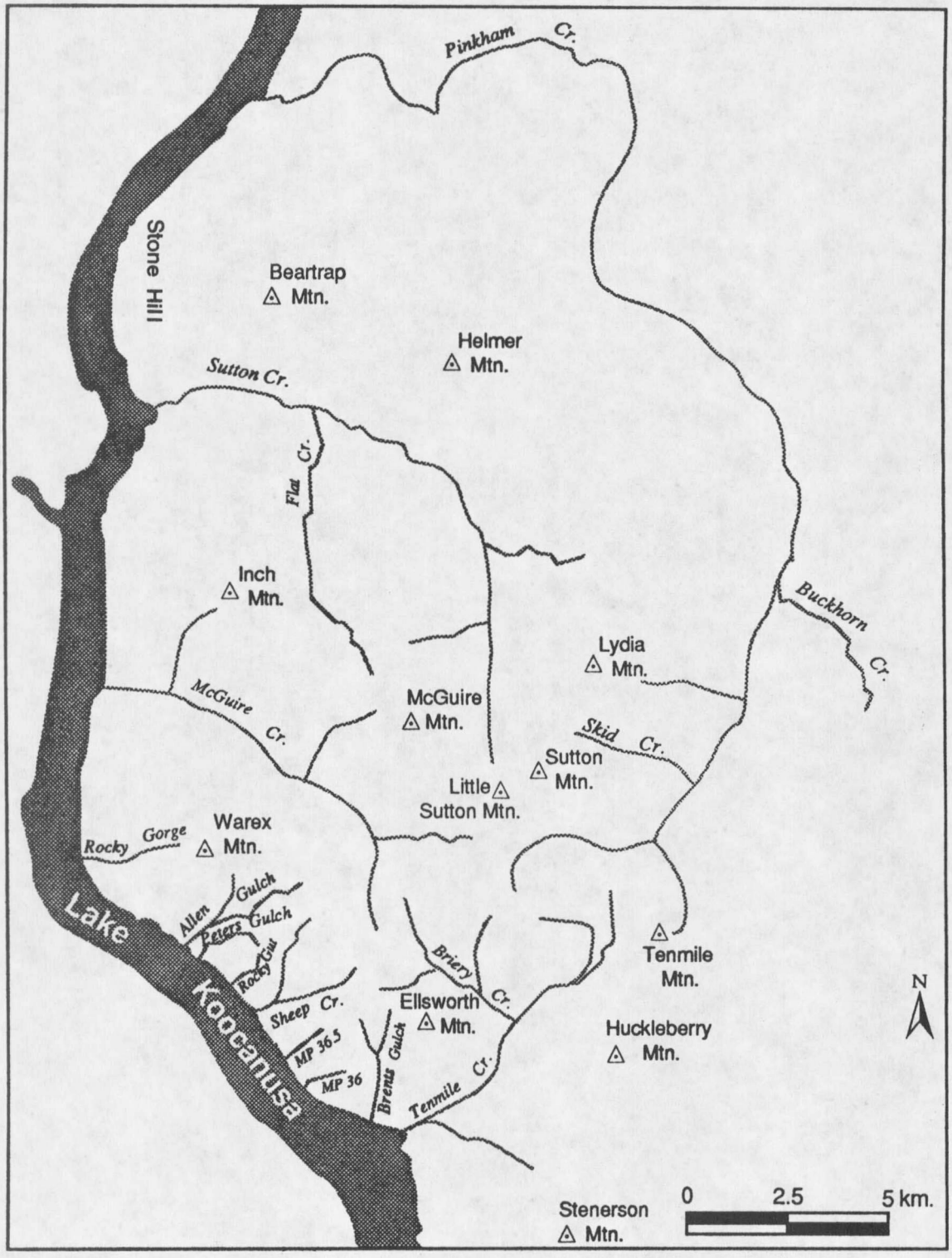


Figure 1. Map of north Salish Mountains study area showing major drainages and topographic features.

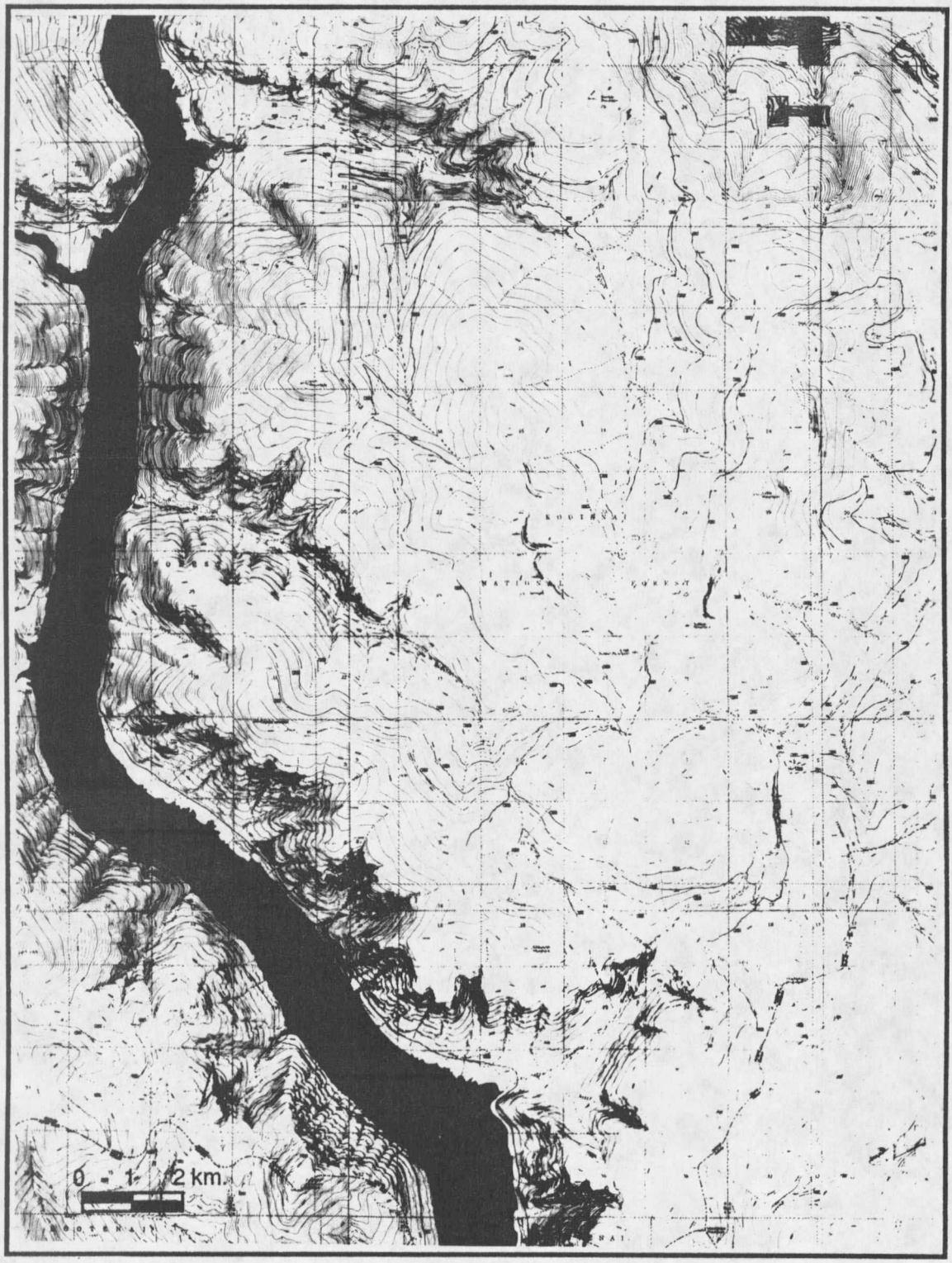


Figure 2. Contour map of north Salish Mountains study area illustrating 2 topographic zones.

provided a diversity of mesic microsites where green vegetation persisted throughout summer and often into fall. The Stone Hill area was also terraced, with some terraces being very mesic and sustaining lush vegetation much longer than adjacent areas. Above 1,524 m, in the interior of the study area, the terrain becomes less broken and steep with gentle slopes extending to ridgetops. These gentle slopes lacked topographic variation of lower areas and fewer mesic microsites occurred.

The study area lies in the path of coastal, maritime weather patterns that bring moderate temperatures and relatively abundant precipitation during all seasons. The nearest weather station at Eureka usually received less precipitation than much of the study area (National Oceanic and Atmospheric Administration 1988-89). Annual precipitation at the station ranged from 30.8 cm in 1988 to 51.9 cm in 1989 (Table 1). Total snowfall was 70.3 cm in 1988 and 83.8 cm in 1989. Annual temperature averaged about 8.1C in 1988 and 7.2C in 1989. During 1988, the annual temperature was 1.1C above the long term mean; total precipitation was 17.8 cm below mean. During 1989, annual temperature was slightly above the long term mean and precipitation was about 1 cm above normal.

Snowpack water content relative to normal at 3 Soil Conservation Service (SCS) snowcourse sites, located approximately 15.3 km southwest of the study area, is shown

Table 1. Mean monthly temperature (C), precipitation (cm), and snowfall (cm) during 1988 and 1989, Eureka Ranger Station (U.S.D.A. Soil Conservation Service).

	1988			1989		
Month	Temp.	Ppt.	Snow	Temp.	Ppt.	Snow
J	-7.4	1.68	18.0	-3.8	3.58	38.1
F	-0.3	0.89	7.1	-8.7	2.67	30.5
M	4.6	3.23	6.9	1.1	4.93	3.0
A	9.4	2.00	T[a]	9.1	3.20	0
M	13.2	4.83	0	12.8	4.85	0
J	17.9	4.55	0	17.8	1.85	0
J	19.7	1.42	0	20.4	5.54	0
A	19.3	1.07	0	17.2	11.20	0
S	13.7	2.97	0	13.1	2.36	0
O	8.2	2.24	0	7.0	3.56	0
N	2.8	2.29	1.5	2.9	5.44	1.3
D	-3.9	3.61	36.8	-3.1	2.69	10.9
Annual	8.1	30.76	70.3	7.2	51.87	83.8

[a]T = Trace

in Table 2. These sites, which are vegetatively, elevationally, and topographically similar to summer range on the study area, had much below normal snowpacks during both years, but especially in 1988. Banfield Mountain was also a Snowtel site where date when snowpack became permanent, date of melt-out, and total annual precipitation were recorded. In 1988, snowpack became permanent on November 14 and melt-out occurred May 17. During 1989, snowpack became permanent on November 4 and melt-out was June 4. Total precipitation was 73.4 cm for 1988 and 97.3 cm

for 1989 (Table 3). The total for 1989 was much closer to the long term mean than that for 1988.

Table 2. Monthly snowpack water equivalents(cm) and departures from normal(cm) on three Soil Conservation Service snowcourses near the study area, January-May, 1988 and 1989 (U.S.D.A. Soil Conservation Service).

		1988		1989	
Month	Location	SWE	Departure	SWE	Departure
Jan	Banfield[1]	27.1	-47.8	37.4	-37.4
	Bristow[2]				
	Lost Soul[3]				
Feb	Banfield	33.6	-73.6	82.6	-24.5
	Bristow				
	Lost Soul				
Mar	Banfield	69.7	-64.5	92.9	-41.3
	Bristow	34.8	-32.9	46.5	-21.3
	Lost Soul	58.7	-35.5	76.8	-17.4
Apr	Banfield	98.1	-54.8	126.4	-26.4
	Bristow	38.7	-23.2	58.1	-3.9
	Lost Soul	65.8	-35.5	93.5	-7.7
May	Banfield	72.3	-49.7	107.1	-14.8
	Bristow	0	-5.2	0	-5.2
	Lost Soul	15.5	-18.7	51.6	+17.4

[1]Elevation=1700 m

[2]Elevation=1190 m

[3]Elevation=1460 m

The study area was largely timbered and timber production was the primary land use. However, cattle were grazed on 1 allotment along Pinkham Creek. Other big game

species also occurred on the study area. Bighorn sheep (Ovis canadensis) were present along the face above the reservoir and shared winter range with mule deer. Elk (Cervus elaphus) were most highly concentrated on Stone Hill and the Skid Creek/Sutton Creek divide. Moose (Alces alces) were distributed across the entire study area. White-tailed deer (Odocoileus virginianus) were present in small numbers, mostly along riparian areas. Black bear (Ursus americanus) were distributed across the study area in low numbers.

Table 3. Monthly precipitation(cm) at the Banfield Mountain Snowtel site during 1988 and 1989 compared with the 1961-85 mean (U.S.D.A. Soil Conservation Service).

Month	1988	1989	1961-85
J	7.62	14.48	14.48
F	6.60	6.60	10.92
M	14.73	12.70	9.65
A	10.16	6.10	6.86
M	3.05	9.14	6.35
J	4.83	3.56	7.37
J	3.05	3.81	4.06
A	1.02	9.40	3.56
S	4.32	2.54	4.32
O	0.51	4.06	5.84
N	5.59	16.51	10.41
D	11.94	8.38	13.72
Total	73.41	97.28	97.54

Habitat types in the study area have been described and mapped (U.S.F.S. unpubl.) following Pfister et.al.(1977).

From this, vegetation of the area can generally be categorized within 4 broad coniferous tree cover types:

Ponderosa pine/Douglas fir type. - This type occurred along the lake shore up to an elevation of about 1,036 m. Ponderosa pine (Pinus ponderosa) was the major overstory species with Douglas fir (Pseudotsuga menziesii) below. Common shrubs included common snowberry (Symphoricarpos albus), Saskatoon serviceberry (Amelanchier alnifolia), and bearberry (Arctostaphylos uva-ursi). Bluebunch wheatgrass (Agropyron spicatum), rough fescue (Festuca scabrella), and pinegrass (Calamagrostis rubescens)were important grasses, while western yarrow (Achillea millefolium), silky lupine (Lupinus sericeus) and various asters (Aster spp.) were common forbs.

Douglas fir type. - This type occurred at elevations up to about 1,585 m, usually on north-facing slopes. Douglas fir was the major overstory species with some mixing of ponderosa pine and western larch (Larix occidentalis). Common snowberry and bearberry were dominant shrubs. Pinegrass was the predominant grass; rough fescue was less common. Western yarrow, heartleaf arnica (Arnica cordifolia), and woodrush pussytoes (Antennaria luzuloides) were common forbs throughout, while silky lupine occurred in areas with more open canopies.

Lodgepole pine type. - This type had a lower limit of approximately 1,585 m elevation, but extended to the highest

point on the study area on McGuire mountain. Lodgepole pine (Pinus contorta), the dominant species in the overstory, probably is seral, originating with large fires that occurred from 1910 to 1920. During 1940-1977, 69 additional small fires were recorded mostly on the winter range segment (Brown 1979). Western larch was numerous in the overstory of most lodgepole pine stands. Sub-alpine fir (Abies lasiocarpa) occurred as small saplings in all stands. Common shrubs were grouse whortleberry (Vaccinium scoparium), sitka alder (Alnus sinuata), and bearberry toward the lower limits of the type. Pinegrass was the most common grass. Elk sedge (Carex geyeri) was locally common. Common forbs were heartleaf arnica, mountain arnica (Arnica latifolia), and glacier lily (Erythronium grandiflorium). Silky lupine was also common in areas with open canopies.

Sub-alpine fir/Engelmann spruce type. - This type has a lower limit of 1,676 m on south-facing slopes and 1340m on north-facing slopes. Sub-alpine fir usually occurred with Engelmann spruce (Picea engelmannii), but was sometimes found in pure stands. Common shrubs were menziesia (Menziesia ferruginea), sitka alder, and grouse whortleberry. Beargrass (Xerophyllum tenax), both species of arnica, twinflower (Linnaea borealis), and queencup bead-lily (Clintonia uniflora) were common forbs. Common grasses were pinegrass and elk sedge.

In addition to the major types, small, isolated stands of western redcedar (Thuja plicata) and western hemlock (Tsuga heterophylla) occurred throughout the study area.

METHODS

Movements, Distribution, Habitat Use

Clover traps were used to capture and mark 106 mule deer on 9 different sections of winter range during 1987-1989 (Appendix Table 15). During January - May 1987, 16 deer were captured. Seven were equipped with radio collars and the others were marked with individually recognizable, 10-cm-wide vinyl neckbands. Twenty-five deer were captured during winter and spring of 1987-88. Of those, 20 were fitted with radio collars and the remainder were neckbanded. Intensified trapping effort during winter and spring 1988-89 resulted in capture of 67 deer. Thirty-two were radio-collared, 13 were neckbanded, and 22 were marked only with ear tags.

Due to the large variation in movement strategies by individual deer, standard calendar dates were not used to describe seasons. A plot of each individual's yearly home range was analyzed and seasonal home ranges were logically delineated. Home ranges described as summer ranges were often occupied during spring and fall as well; resident deer were described as having no specific seasonal ranges.

Movements, distribution, and habitat use during spring, summer, and fall were determined by aerial and ground

monitoring of radio-collared deer. Aerial monitoring was accomplished using a Piper SuperCub aircraft with a belly-mounted antenna.

Deer equipped with transmitters during winter - spring 1987 were located from the air once or twice monthly by MDFWP personnel until June of 1988. From June through mid-September 1988, I continued the relocations bi-monthly. During September 1988-March 1989, MDFWP personnel resumed aerial relocations once or twice monthly. In early spring and late fall 1989, I increased the frequency of aerial relocations to 4 times a month to intensively monitor spring and fall migration patterns and to determine transitional range areas. During summer 1989, aerial monitoring was bi-monthly as in summer 1988. Additional locations were obtained by periodically walking in on each radio-collared deer at least once each month. Some deer were visited 2-3 times per month.

Data recorded for each observation included time, Universal Transverse Mercator (UTM) coordinates, elevation, aspect, slope, habitat components, and weather conditions. Group size, composition, and activity were recorded for visual observations. For analysis, aerial and ground locations were combined for each year and season. Relocations were analyzed using the TELDAY computer program (Lonner and Burkhalter 1986) to calculate home range sizes, average activity radii (AAR), and geographic activity

centers (GAC). Analysis of variance (ANOVA) and 2-sample *t*-tests (Lund 1989) were used to compare home range sizes and AAR. Differences in mean distances travelled between seasonal ranges were also evaluated with a 2-sample *t*-test.

Habitat Analysis

Habitat types (Pfister et al.1977) were not representative of existing vegetation on portions of the study area. Because of this, vegetation cover type maps developed for the U.S. Forest Service by Big Sky Resource Analysts (unpubl.) of Kalispell were used in habitat type analyses. Those maps plotted vegetation in management compartments as stands ranging from 3 to 300 acres in size. Given the small number of observation points for each radio-collared deer and the possibility of some degree of error in locations, especially under timber canopies, I used more generalized maps that combined stands with the same predominant overstory species. Topographic measures, including slope, aspect, and elevation, used in habitat analysis were mapped from U.S.G.S. topographic maps.

Availability of cover types was determined by calculating percent occurrence of each type in areas sampled. Availability of slope, aspect, and elevation was determined by using a random sampling technique (Marcum and Loftsgaarden 1980). Observed use of cover types, slope, aspect, and elevation was the number of relocations in each

type or category. Tests for selection or avoidance of types or categories was conducted using chi-square goodness-of-fit tests following Byers et al. (1984).

Plant phenology was recorded only during the spring and summer of 1989. Sites for measurement of phenology were selected according to elevation, aspect, and habitat/cover type. An attempt was made to sample different combinations of these 3 site factors on or near the home ranges of individual deer. Location of sites and the number of times each was visited are presented in Appendix Table 16. When a site was visited, I recorded major species, average stage of phenology, and any evidence of usage by deer. Stages were: early leaf, full leaf, flower bud, full flower, seedhead, or dormant (Pac 1976).

RESULTS

Distribution, Movements, and Home Ranges

Population-Habitat Units

The deer inhabiting the study area were distributed among 3 tentative population-habitat units (PHUs) (Fig. 3). A PHU was "a rather discrete association of individual deer bonded together by traditional use of individual home ranges within a definable unit of yearlong habitat" (Pac et al. 1991). The winter range of each PHU was the nucleus of the unit. From there deer distributed themselves through migration to the boundaries of each PHU. Winter ranges for all units were very steep and topographically diverse. Summer ranges of migrants were more gentle and less varied.

PHU 1 spanned 165.3 km^2 and was used by 42 radio-collared deer. Yearlong, the unit encompassed upper McGuire Creek, upper Sutton Creek, upper Pinkham Creek, Buckhorn Creek, and all of Tenmile Creek.

The winter range for this unit extended from the south side of Tenmile Creek to just north of Rocky Gorge. The winter range in PHU 1 was subdivided into 3 sub-units based on winter home range locations of radio-collared deer (Fig. 4). The first sub-unit (1a) extended from Tenmile to Sheep

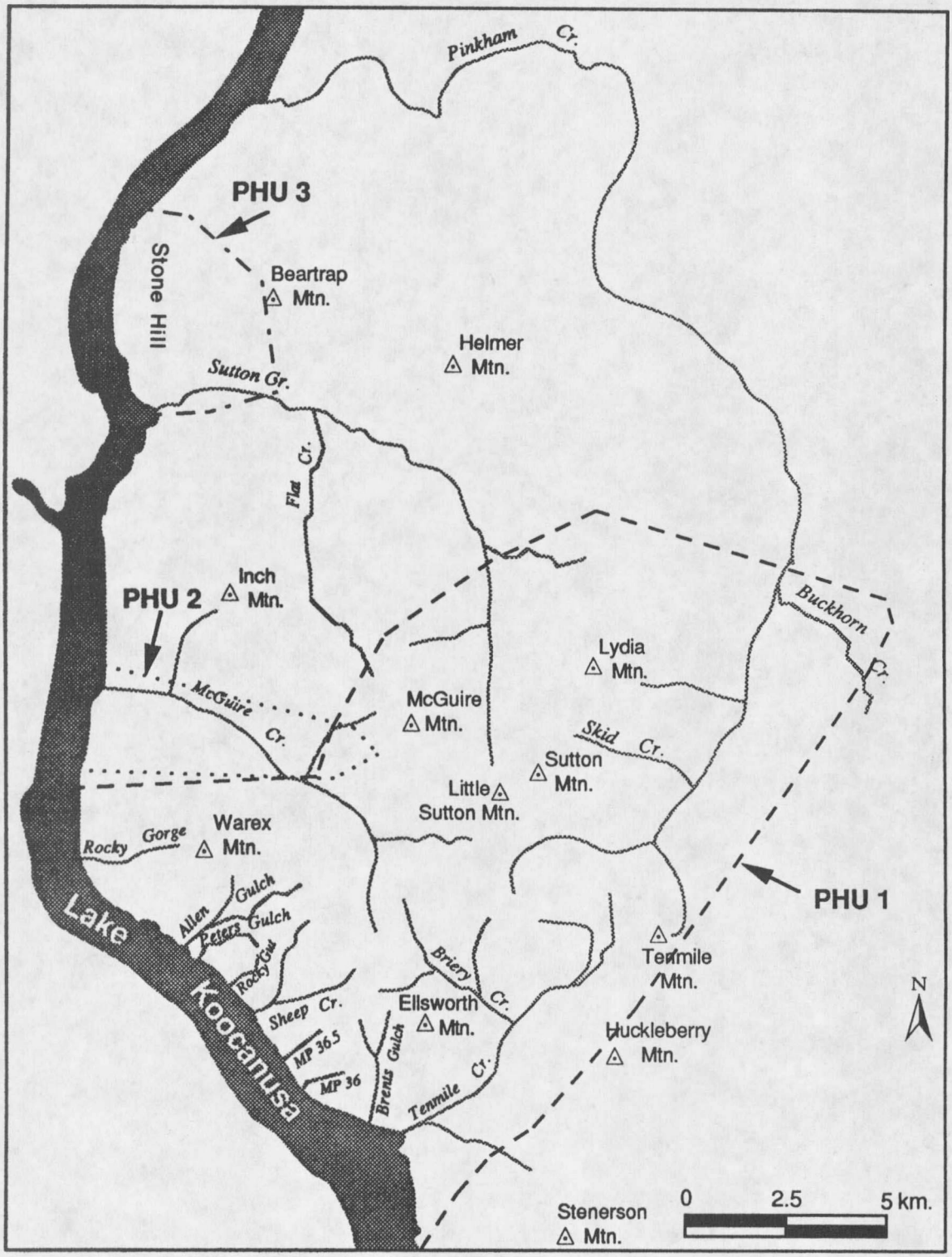


Figure 3. Map of north Salish Mountains study area showing boundaries of population-habitat units (PHUs) 1, 2, and 3.

Creeks, the second (1b) from Sheep Creek to just north of Allen Gulch, and the third (1c) from north of Allen Gulch to Rocky Gorge (Fig. 4). There were 15, 17, and 10 instrumented deer on 1a, 1b, and 1c, respectively. The entire winter range extended up to about 1,500 m elevation and was characterized by ponderosa pine, Douglas fir, and western larch interspersed with natural openings. Three helicopter logging units were situated within each of the sub-units.

When migratory deer moved off of the winter range, segmentation of the sub-units broke down (Fig. 5) as deer from different sub-units intermixed on summer ranges. Summer range was made up of several different interspersed cover types. Large, homogeneous stands of lodgepole pine, smaller stands mixed with western larch and sub-alpine/Engelmann spruce stands were most prevalent. Douglas fir was an important component on summer range adjacent to winter range. In addition to this, cutting units of varying sizes and ages were spread out over the unit in varying densities.

PHU 2 covered 10.6 km^2 and was used by 6 radio-collared deer. This unit extended along the lower half of the McGuire Creek drainage. Winter range was limited to an area about 2.3 km^2 near the mouth of the creek with the upper boundary at 914 m. Vegetation was characterized by a mixed stand of Douglas fir and Western larch. A helicopter logging unit was located on the north side of the creek. The summer range was

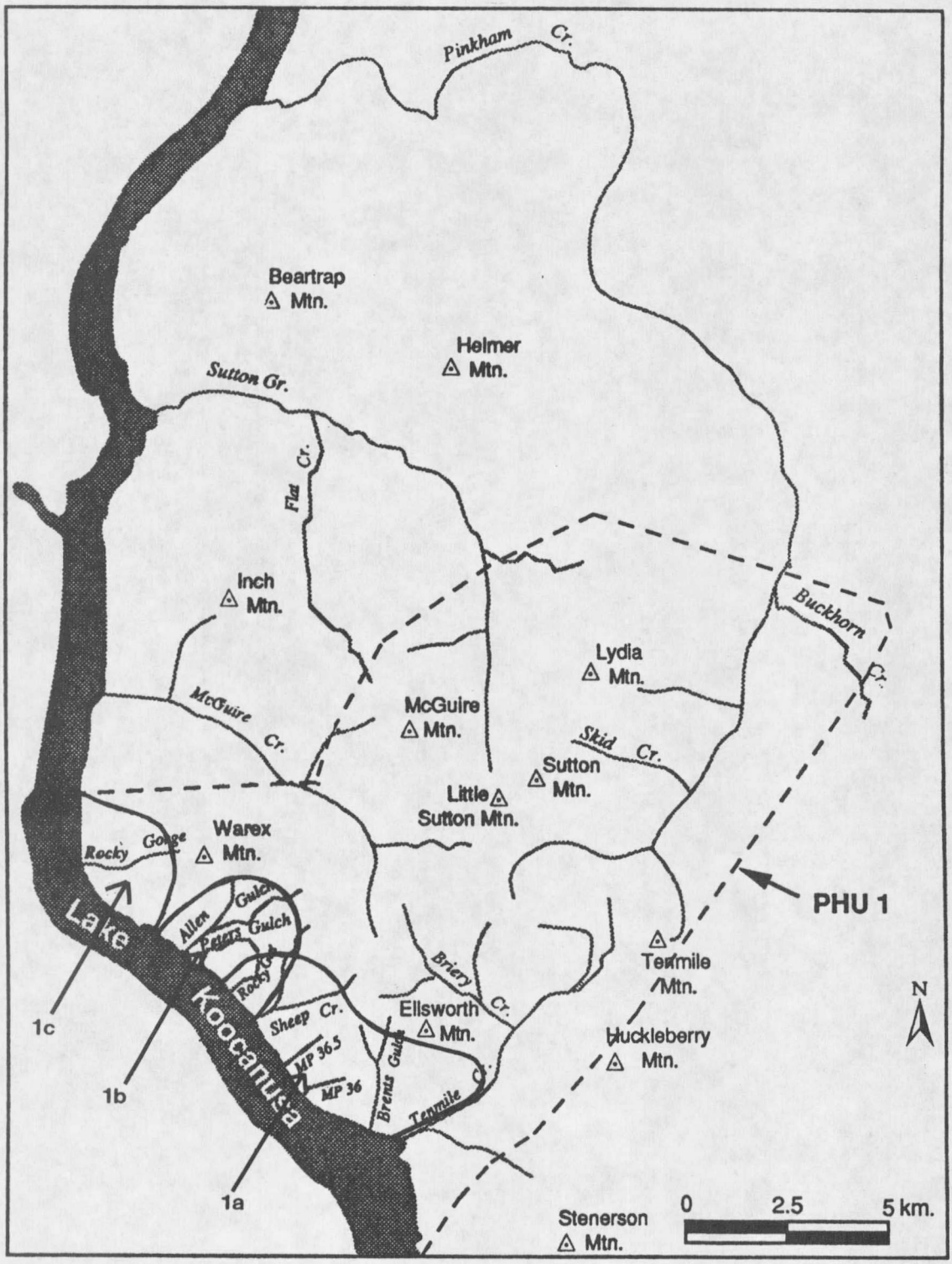


Figure 4. Winter range sub-units (1a, 1b, 1c) on population-habitat unit (PHU) 1, north Salish Mountains study area.

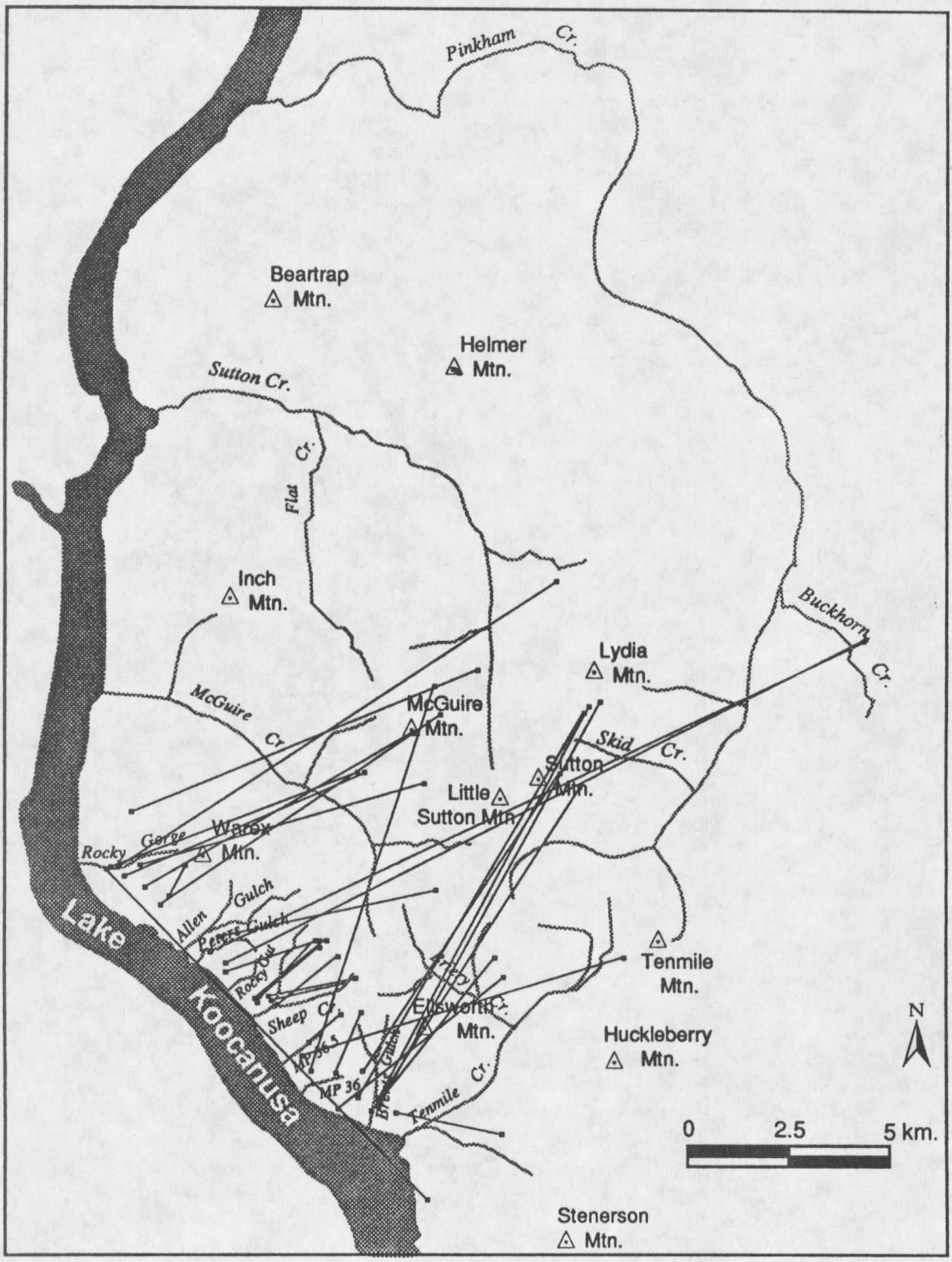


Figure 5. Winter and summer geographic activity centers (GACs) of radio-collared mule deer on population-habitat unit (PHU) 1, north Salish Mountains study area.

dominated almost exclusively by lodgepole pine through which several new cutting units were interspersed.

PHU 3 included 13.9 km^2 and the home ranges of 7 radio-collared deer. The unit was situated on Stone Hill and covered the western slope and part of the top of this landform. Because all 7 radio-collared deer used the same areas yearlong, no summer or winter range was delineated. The unit as a whole was characterized by Douglas fir and Western larch mixed with Lodgepole pine at the upper portions of the unit and Ponderosa pine at the lower portions. A relatively large portion of the unit was covered by non-forested land, consisting of either natural, grassy openings or cliffs and talus slopes.

Movements

Three different categories of deer were delineated based on distances separating seasonal ranges (Pac et al. 1991). Seasons were not delineated by standardized calendar dates. Instead, a logical separation of seasonal ranges was made from a plot of all relocations for each individual. Deer with indistinct seasonal ranges (ISR deer) occupied all or a portion of the winter range throughout the year. There was equal probability of relocating them on any portion of their home ranges during any season. Deer with adjacent seasonal ranges (ASR deer) occupied winter and summer ranges that were clearly distinguishable, but usually no more than 1.5 km from each other. ASR deer drifted back to the

winter range quite frequently. The third category, deer with distinct seasonal ranges (DSR deer), had seasonal ranges separated by at least 1.5 km (Fig. 6).

Fifty-four female deer were assigned to 1 of 3 categories based on their movements over 1 or more years (Table 4). DSR deer made up the largest component of radio-collared deer, ISR deer had the second largest percentage, and ASR deer were the smallest group. However, considerable variability occurred among PHU's. For example, PHU 1 had representatives from all movement patterns in varying numbers, while PHU 2 had only DSR deer, and PHU 3 had only ISR deer.

Table 4. Number and percentage of 54 radio-collared deer that followed indistinct seasonal range, adjacent seasonal range, and distinct seasonal range movement patterns in each population-habitat unit and among all PHUs combined, north Salish Mountains, 1988 and 1989.

PHU	ISR		ASR		DSR	
	no.	%	no.	%	no.	%
1	10	23.8	9	21.4	23	54.8
2	0	0.0	0	0.0	5	100.0
3	7	100.0	0	0.0	0	0.0
Total	17	31.5	9	16.7	28	51.9

In addition to the 3 movement categories recognized on the basis of juxtaposition of seasonal ranges, deer showed further variability in individual movement patterns by using accessory areas (Pac et al. 1991). These were areas used locally for varying periods of time in addition to the

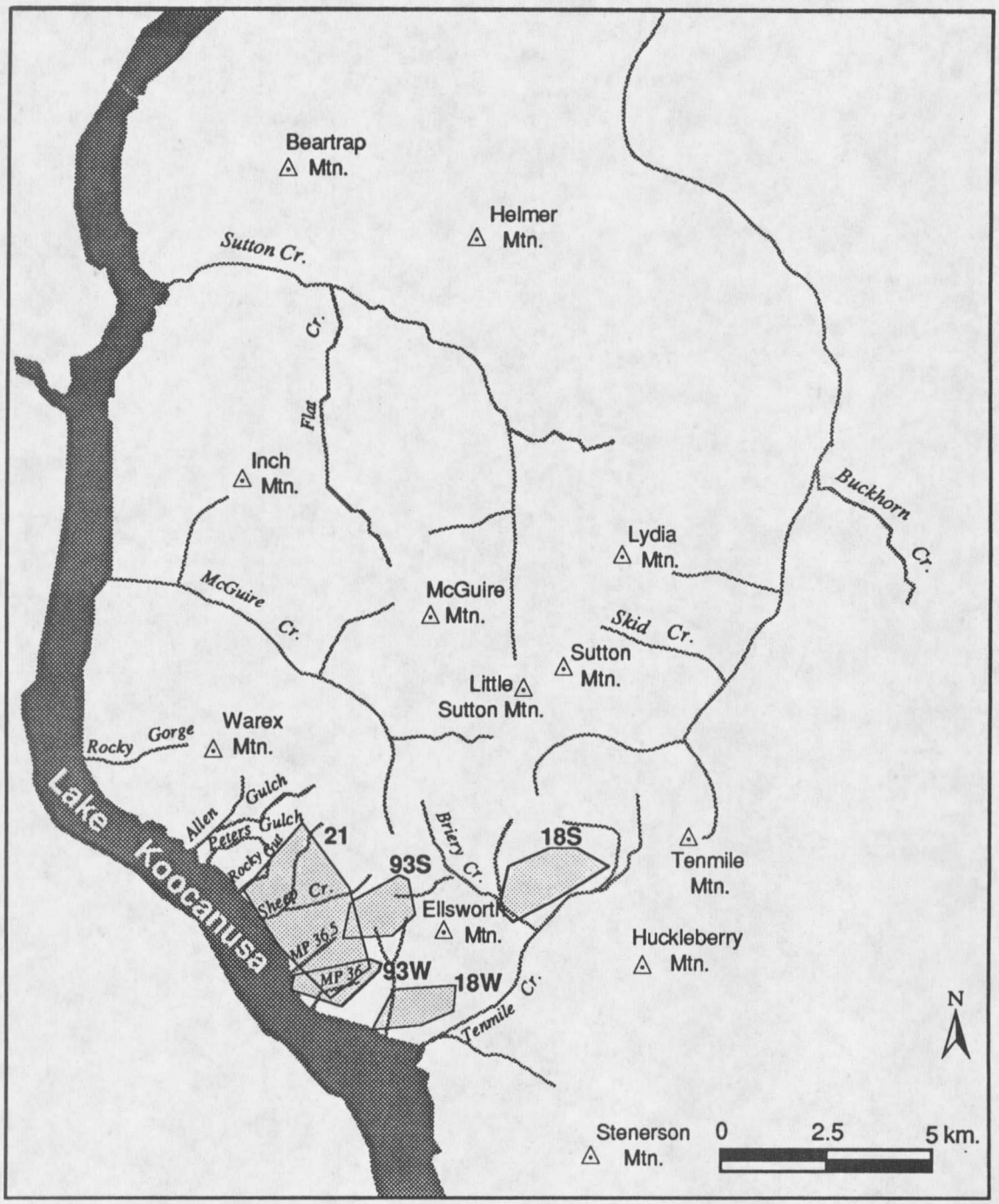


Figure 6. Examples of indistinct seasonal range (#21), adjacent seasonal range (#93), and distinct seasonal range (#18) deer on population-habitat unit 1, north Salish Mountains study area. W = winter home range and S = summer home range.

normal seasonal ranges. Distances between accessory areas and normal seasonal home ranges varied from 0.4 km to 35 km. The number of days deer spent on accessory areas ranged from 5 days to 105 days. ISR deer that used fall accessory areas spent the greatest amount of time on accessory areas. DSR deer using fall accessory areas spent the second longest time on those areas. Deer with spring and summer accessory areas usually occupied those areas for 30 days or less regardless of their movement patterns.

Spring accessory areas were used most heavily by deer occupying accessory areas (Table 5). Among movement patterns, about half or all deer used spring accessory areas (Table 6). Fall accessory areas were occupied by about a third of deer using accessory areas. About 36% of ISR deer and 27% of DSR deer used fall accessory areas. Overall, 50.0% of accessory area occupants were ISR deer, 42.3% were DSR deer, and 7.7% were ASR deer.

Table 5. Number and percentage of deer that used spring, summer, and fall accessory areas in each population-habitat unit and among all PHU's combined, north Salish Mountains, 1988 and 1989.

	Spring		Summer		Fall	
PHU	no.	%	no.	%	no.	%
1	7	38.9	2	11.1	9	50.0
2	2	100.0	0	0.0	0	0.0
3	6	100.0	0	0.0	0	0.0
Total	15	57.7	2	7.7	9	34.6

Table 6. Percentage of indistinct seasonal range, adjacent seasonal range, and distinct seasonal range deer that used spring, summer, and fall accessory areas, north Salish Mountains, 1988 and 1989.

Movement	Spring		Summer		Fall	
pattern	no.	%	no.	%	no.	%
ISR[a]	6	54.5	1	9.1	6	36.4
ASR[b]	2	100.0	0	0.0	0	0.0
DSR[c]	7	63.6	1	9.1	3	27.3

[a]-indistinct seasonal range.

[b]-adjacent seasonal range.

[c]-distinct seasonal range.

Use of accessory areas usually involved a significant change in elevation from normal seasonal ranges. In general, accessory areas were higher than winter ranges (Table 7). Summer and fall accessory areas were higher than summer home ranges, and spring accessory areas were intermediate between winter and summer home ranges. For ISR deer, spring accessory areas were lower in elevation than annual home ranges.

Movements or migrations between seasonal ranges did not appear to occur along any particular corridor. In leaving the winter range, most radio-collared animals moved east to northeast to summer range. The longest distance moved by an individual was 35 km from its summer range to a fall accessory area (deer #15, PHU 1). In contrast, several radio-collared animals in PHU 1 moved 1 km or less between

winter and adjacent summer range. The overall mean distance between seasonal ranges in PHU 1 and 2 was 6.6 km.

Table 7. Mean elevation (m) of spring, summer,and fall accessory areas; winter home ranges; and summer home ranges for each movement pattern, north Salish Mountains, 1988 and 1989.

Pattern	N	WHR[a]	Spring	Summer	Fall	SHR[b]
DSR/ASR[c]	13	1019	1324	1608	1604	1520
ISR[d]	13	1121	925	1582	1729	

[a]-Winter home range.

[b]-Summer home range.

[c]-Distinct seasonal range, adjacent seasonal range.

[d]-Indistinct seasonal range, annual home range was used in place of winter home range.

During 1988, mean date of departure of radio-collared deer from winter range was June 1. This was 7 days earlier than 1989. The mean date of return to the winter range in 1988 was November 11, about 21 days later than for 1989.

Departure dates from winter to summer range were about the same for deer following the DSR and ASR movement patterns. These were approximately June 1 in 1988 and June 6 in 1989. However the mean date of departure of ASR deer from summer range was December 11 in 1988, more than 1 month later than the mean date DSR deer left summer range. ASR deer returned to winter range at least 1 month later than DSR deer in 1989 as well.

All radio-collared deer showed high fidelity to individual seasonal ranges. Only 2 deer shifted their ranges

or changed movement patterns between years. One of these shifted her summer home range between years but occupied the same winter range. The other used the same winter range both years, but shifted from an ISR pattern in 1988 to an ASR pattern in 1989.

Home Ranges

Mean polygon home range sizes and AAR during summer for females following different movement patterns in each PHU during 1988 and 1989 are given in Table 8. They generally decreased between 1988 and 1989. Deer in PHU 2 were monitored only during 1989. All declines between years in PHU 1 and 3 were significant ($p<.05$).

Mean AAR for radio-collared deer in PHU 1 and 3 also decreased between years. Again, these decreases were significant ($p<.05$).

Mean polygon home range size and mean AAR for summer were compared between movement patterns and PHUs for both years. During 1988, only ISR deer were compared between PHU 1 and 3; no ASR deer or DSR deer were monitored in PHU 2 that year. Polygon home range size was significantly larger ($p<.05$) for ISR deer in PHU 3. There was no significant difference ($p>.05$) between AAR. During 1989, there was no significant difference ($p>.05$) between ISR deer in PHU's 1 and 3 for either measurement. Similarly, there were no significant differences ($p>.05$) between pooled measurements

for ASR and DSR deer in PHU 1 and those for DSR deer in PHU 2.

Table 8. Mean convex polygon home range sizes (PHR)(km^2) and average activiy radii (AAR)(km) for female deer following indistinct seasonal range, adjacent seasonal range, and distinct seasonal range movement patterns in population-habitat units 1, 2, and 3, north Salish Mountains, 1988-89.

	1988			1989		
PHU	N	PHR	AAR	N	PHR	AAR
1 ISR[a]	7	5.7	1.1	8	3.2	0.8
ASR	3	1.9	0.6	10	0.8	0.4
DSR	9	4.6	1.2	21	1.3	0.6
2 DSR				5	0.9	0.5
3 ISR[a]	7	8.1	1.1	7	3.3	0.8

[a] Annual home range was used rather than summer home ranges.

Winter home range sizes and AAR for females in PHUs 1 and 2 are presented in Table 9. Mean polygon home range size and mean AAR for winter in PHU 1 and 2 were not significantly different ($p>.05$).

Table 9. Convex polygon home range (PHR) size and average activity radii (AAR) of female mule deer for winter in population-habitat units (PHUs) 1 and 2, north Salish Mountains, 1988-89.

		PHR(km^2)		AAR(km)	
PHU	N	x	S.D.	x	S.D.
1	32	1.4	0.3	0.7	0.2
2	5	1.9	0.8	0.8	0.3

Differences in home range measurements associated with age were apparent. Generally, fawns and yearlings had larger home ranges than adult females. Younger females also tended

to move more sporadically throughout the summer. For example, a fawn in PHU 1, moved several kilometers at sporadic times during the summer for only a few days. As a yearling, she settled into a fairly small summer home range and stayed there the entire summer.

Habitat Use

Use of Cover Types

Relative occurrence of the 6 major cover types within PHUs is shown in Table 10. A key to abbreviations of cover types is found in Appendix Table 17. About 60% of the cover type was lodgepole pine and mixed conifer combined in PHU 1 and mixed conifer alone in PHU 2 and 3. PHU 3 also had the largest amount of non-forested cover types.

Relative use of cover types by radio-collared deer was extremely variable within and between PHUs (Table 11). Coefficients of variation (C.V.s) are included to give a measure of variation within PHUs. Lodgepole pine and mixed conifer were used about equally in PHU 1. Lodgepole pine was used most heavily in PHU 2. Mixed conifer was the most heavily used cover type in PHU 3, while non-forested types received secondary use. Variation in use of cover types was lowest for lodgepole pine in PHU 1 and 2 and mixed conifer in PHU 3.

Table 10. Percent occurrence of 6 vegetation cover types in population-habitat units 1, 2, and 3, north Salish Mountains, 1989.

PHU	NS[1]	LPP[2]	MC[3]	SAF[4]	PP[5]	NF[6]
1	15.7	27.8	30.0	20.9	3.7	1.6
2	3.4	27.1	63.3	0.0	4.9	1.4
3	9.8	5.5	59.3	0.6	9.7	15.1

[1] Non-stocked.

[2] Lodgepole pine.

[3] Mixed conifer.

[4] Sub-alpine fir.

[5] Ponderosa pine.

[6] Non-forested.

See Appendix Table 17 for further explanation.

Table 11. Mean percent use and coefficients of variation (C.V.) by female mule deer of 6 vegetation cover types in 3 population-habitat units during summer, north Salish Mountains, 1988 and 1989.

Cover type	1		2		3	
	%	C.V.[1]	%	C.V.	%	C.V.
NS[2]	14.1	96	25.0	44	4.4	133
LPP	27.2	75	65.4	12	1.0	125
MC	29.4	128	9.6	0	59.5	18
SAF	16.3	163	0.0	0	0.0	0
PP	8.5	229	0.0	0	13.5	51
NF	4.5	205	0.0	0	21.6	79

[1] C.V.=S.D.(100)/Mean.

[2] See Table 10 for definitions of abbreviations.

Use of cover types varied among deer following different movement patterns (Table 12) as well as among PHUs. For example, lodgepole pine accounted for over 50% of total use by ASR deer, but less than 10% for ISR deer. Subalpine fir types were also heavily used by DSR deer, but received use of less than 1% by ISR deer and less than 10% by ASR deer. More than 50% of total use by ISR deer occurred on mixed conifer types, while use by ASR and DSR deer was less than 25%. Variation was least for DSR and ASR deer in lodgepole pine types, and ISR deer in mixed conifer.

Table 12. Mean use of major cover types and coefficients of variation of radio-collared deer following indistinct seasonal range, adjacent seasonal range, and distinct seasonal range movement patterns during summer, north Salish Mountains, 1988 and 1989.

Cover type	ISR		ASR		DSR	
	%	C.V.	%	C.V.	%	C.V.
NS	4.9	129	15.5	87	21.8	82
LPP	7.3	137	52.3	55	33.5	66
MC	53.7	43	23.2	74	14.4	146
SAF	0.7	239	7.7	145	29.3	139
PP	17.6	65	0.0	0	0.5	529
NF	15.8	98	1.3	332	0.5	367

Differences in use of cover types between fall accessory areas and summer ranges were analyzed for 5 deer. On summer range, mixed conifer and ponderosa pine types

Table 13. Summary of chi-square analysis for selection of vegetation cover type, aspect, and slope during summer, 1988 and 1989. O = use in proportion to availability, + = use greater than expected by chance, and - = use less than expected by chance.

Environmental variable	PHU1	PHU2	PHU3
Cover types			
NS	O	+	-
LPP	O	+	-
MC	O	-	O
SAF	-		
PP	+		O
NF	+		+
Aspect			
N	-		
NE	-		
E	-		
SE	-		
S	O		
SW	+		
W	+		
NW	-		
Slope			
Level	O		
Gentle	-		
Moderate	O		
Steep	+		

received 48.1 and 21.9% of the total use, respectively. This probably occurred because the 5 deer were ISR or ASR deer with access to those types. On the fall accessory areas, lodgepole pine and sub-alpine fir received 47.6 and 21.4%,

respectively, of the total use; a clear shift in use from summer.

Patterns of use of cover types relative to their availability were analyzed on all 3 PHUs using chi-square analysis (Table 13). In PHU 1, ponderosa pine and non-forested cover types were used more than expected ($p<.01$), while in PHU 2 non-stocked and lodgepole pine were used more than expected ($p<.01$). In contrast to both PHU 1 and 2, non-stocked and lodgepole pine were used less than expected and non-forested was used more than expected ($p<.01$) in PHU 3.

Use of aspect and slope in relation to availability for PHU 1 (Table 13) indicated that north, east, northeast, southeast, and northwest exposures were used less than expected ($p<.01$). Southwest and west exposures were used more than expected ($p<.01$), and south exposures were used about in proportion to availability. Gentle slopes were used less than expected ($p<.01$) and steep slopes were used more than expected ($p<.01$). Level and moderate slopes were used in proportion to availability.

Use of Other Habitat Components

Use of aspect by ISR, ASR, and DSR deer was tabulated for PHU 1 (Fig. 7). The highest percentage of relocations for all 3 types of deer occurred on south to west aspects. This was especially true for ASR deer. Greatest relative use

occurred on south aspects in PHU 2 (Fig. 8), and on west aspects in PHU 3. When relocations were pooled for each movement pattern (Fig. 9), ISR and ASR deer appeared to use southwest aspects most heavily. DSR deer occurred most often on west aspects. In addition, DSR deer used all exposures more evenly than deer with other movement patterns.

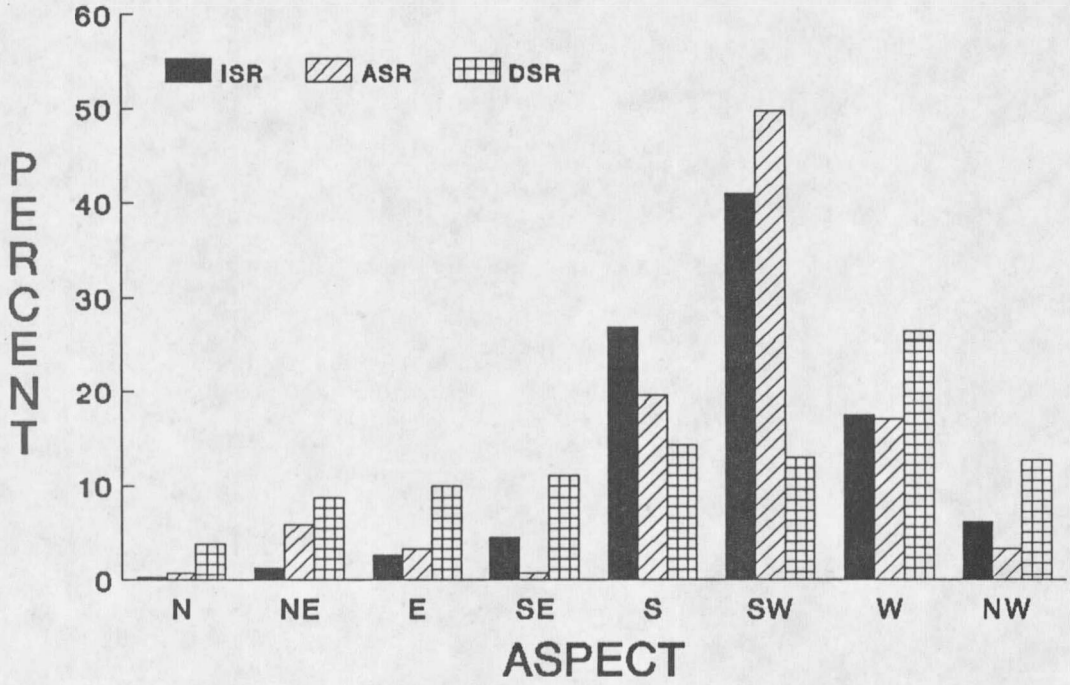


Figure 7. Percent use of aspect by radio-collared deer following indistinct seasonal range, adjacent seasonal range, and distinct seasonal range movement patterns in population-habitat unit 1.

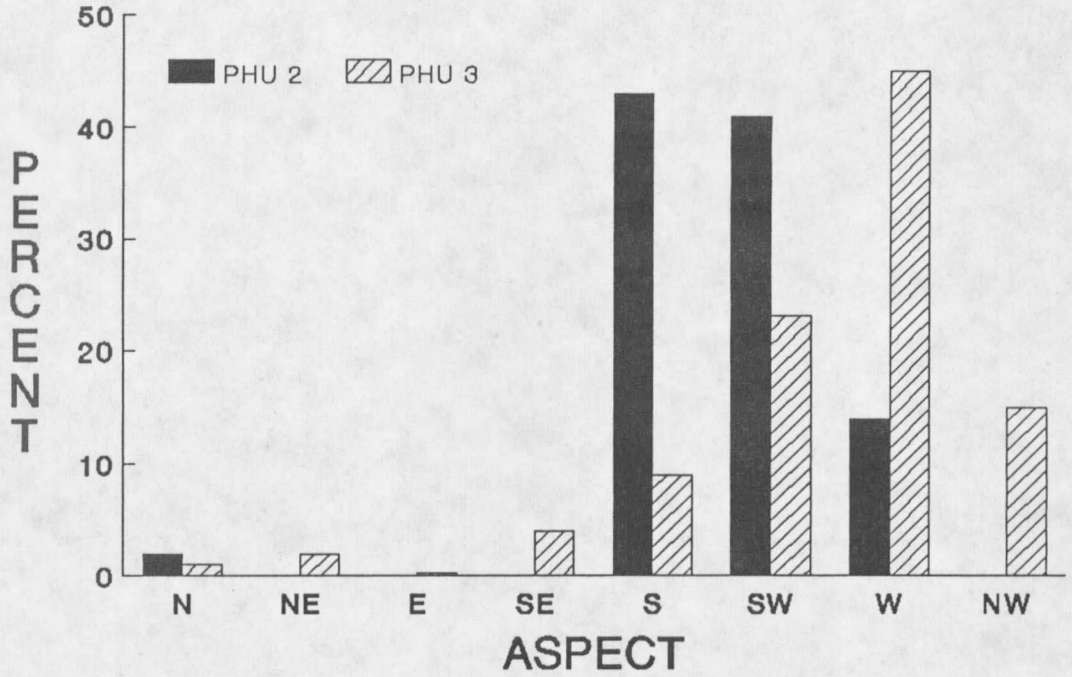


Figure 8. Percent use of aspect by radio-collared deer in population-habitat units 2 and 3.

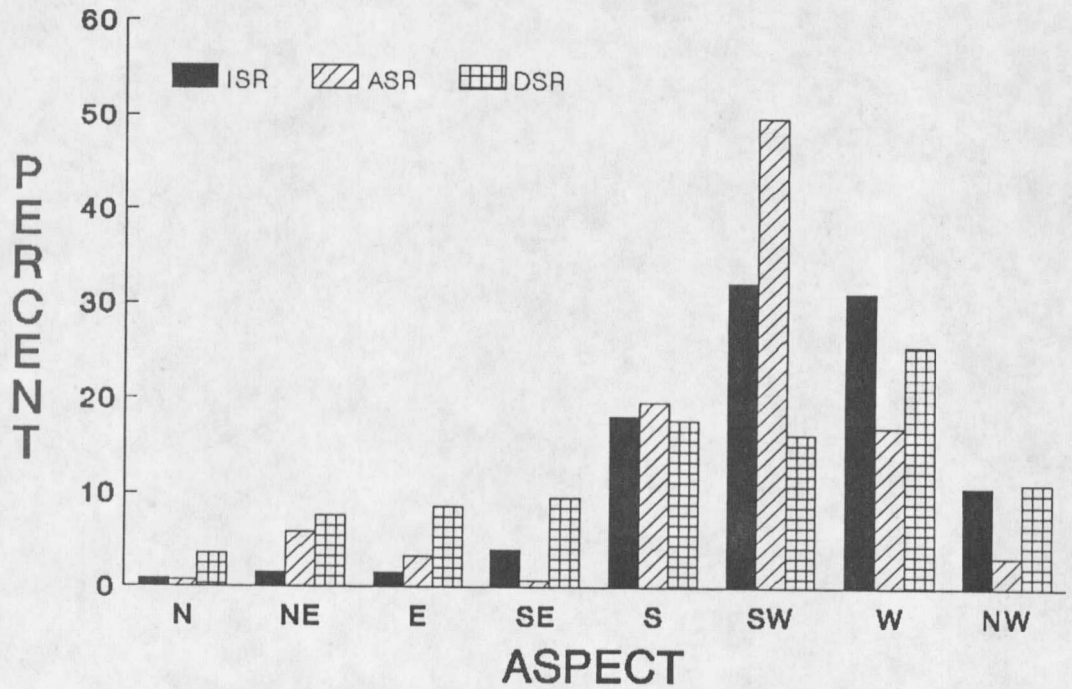


Figure 9. Percent use of aspect by radio-collared deer in each movement pattern.

Use of different slope categories was also tabulated for PHU 1 (Fig. 10). Relocations from PHU 1 indicated that ISR deer used steep slopes most often, while ASR deer and DSR deer used moderate slopes predominantly. Deer in PHU 2 used moderate slopes most heavily (Fig. 11), those in PHU 3 favored steep slopes. By pooling relocations for movement patterns (Fig. 12), about 70% of the total use by ISR deer occurred on steep slopes. Approximately 60 and 40% of the use by ASR and DSR deer, respectively, was on moderate slopes.

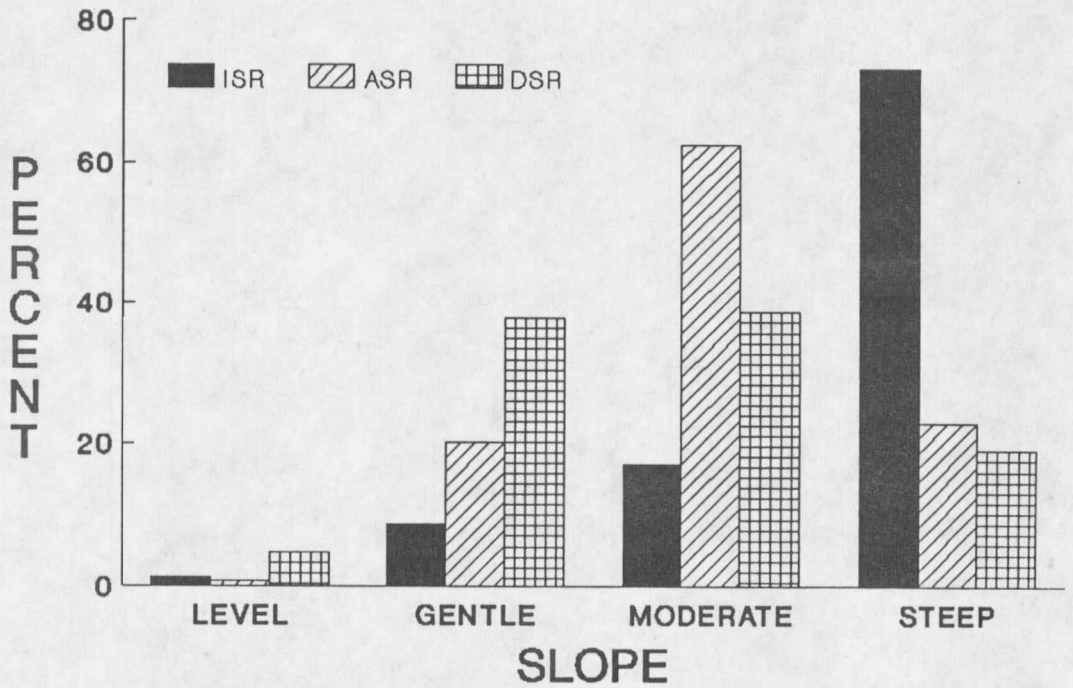


Figure 10. Percent use of slope by radio-collared deer following indistinct seasonal range, adjacent seasonal range, and distinct seasonal range movement patterns in population-habitat unit 1.

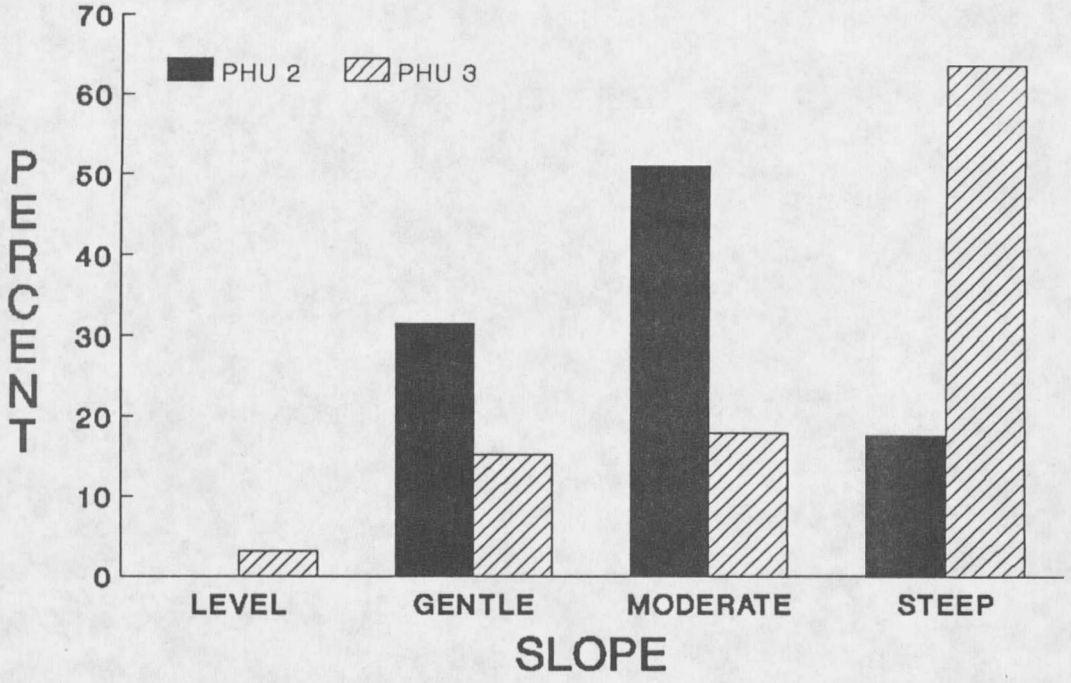


Figure 11. Percent use of slope by radio-collared deer in population-habitat units 2 and 3.



Figure 12. Percent use of slope by radio-collared deer following indistinct seasonal range, adjacent seasonal range, and distinct seasonal range movement patterns.

Mean elevations for each movement pattern within each PHU was presented in Table 14. ISR deer had the lowest mean elevations of all types. Averaging over all PHUs, ASR deer occurred at higher mean elevations than DSR deer.

Table 14. Mean elevations (m) of all summer relocations for deer following indistinct seasonal range, adjacent seasonal range, and distinct seasonal range movement patterns among population-habitat units, north Salish Mountains, 1988 and 1989. Sample size is shown in parentheses.

PHU	ISR	ASR	DSR
1	1196(10)	1699(9)	1673(23)
2			1587(5)
3	1112(7)		
All	1154(17)	1699(9)	1630(28)

Plant Phenology

Plant phenology was recorded beginning in late April when most plants were starting to green-up at all elevations. By mid May, some forbs were beginning to flower at all elevations. At that time glacier lilies and round-leaved violets were at full flower at higher elevations, while common yarrow was at full flower at lower elevations. During mid-July to early August, early flowering forbs had become dormant, and late-blooming species such as aster and lupine were at the bud stage. By the end of August, common yarrow, aster, and lupine were among the few forbs that were not yet dormant. Observations in middle to late September

indicated that most forbs and grasses were dormant or approaching dormancy.

Definite use of certain forbs was recorded at the same time phenology was recorded. Use of yarrow was observed in mid-May just at the flower bud stage. Many plants had flower buds nipped off. Use of aster was observed in mid-July when that forb was at the bud stage. As with yarrow, the flower buds were also nipped off. Observations of plants in Allen Gulch, which was burned the previous spring, indicated that phenology in late September was a month or more behind adjacent areas with many forbs being green and at the full flower stage.

DISCUSSION AND CONCLUSIONS

Distribution, Movements, and Home Ranges

Distribution and Population Organization

On winter range within each PHU, deer were distributed in small, closely-knit groups, possibly made up of maternally related individuals. These groups on winter range were the nucleus for PHUs as reported for the Bridger mountains by Pac et al. (1991). Distribution within discrete PHUs has also been reported for mule deer along the east front of the Rocky Mountains in northcentral Montana (Ihsle 1982, Pac et al. 1988).

Winter ranges for all 3 PHUs were bounded by substantial physical barriers, which forced deer to localize with very limited movements on winter range. Leopold (1951) reported limited movements caused by topographic barriers on the Jawbone winter range on the west slope of the Sierra Nevada Mountain range. Deer inhabiting the east slope of the Bridger Mountain range (Nyberg 1980) and the east slope of the Sierra Nevada Mountain range (Leopold 1951) were much more mobile and moved more freely over winter range.

The segmentation of deer on winter range in PHU 1 into 3 sub-units was very similar to sub-units described by Youmans (1979) and Pac et al. (1991). Individuals within

each sub-unit remained closely associated as they moved onto the summer range, where some intermixing with deer from other sub-units occurred.

Closely overlapping summer home ranges of deer in PHU 2 (Fig. 13) may illustrate the existence of maternally related family groups, similar to observations of Hamlin and Mackie (1989) and Pac et al. (1991). Also 2 or 3 of these deer were frequently located together.

Movements

ISR, ASR, and DSR movement patterns were similar to those described by Pac et al. (1991) for mule deer in the Bridger mountains. They also corresponded generally to resident (RES), east of the divide (EOD), and west of the divide (WOD) deer reported by Kasworm (1981), Ihsle (1982) and Pac et al. (1988). These movement patterns were probably learned by fawns from their mothers (Russell 1932, Bailey 1960, Fairman 1966, Simpson 1988, Pac et al. 1991). Migratory deer (DSR and ASR) made up 69% of the radio-collared population as compared with 89% in the Bridger mountains (Pac et al. 1991) and approximately 85% along the east front of the Rockies in north-central Montana (Kasworm 1981, Ihsle 1982). Garrot et al. (1987) reported that all radio-collared deer were migratory in northwest Colorado, while Kufeld et al. (1989) found that only 7% of radio-collared deer were migratory along the east slope of the Rocky Mountains in central Colorado.

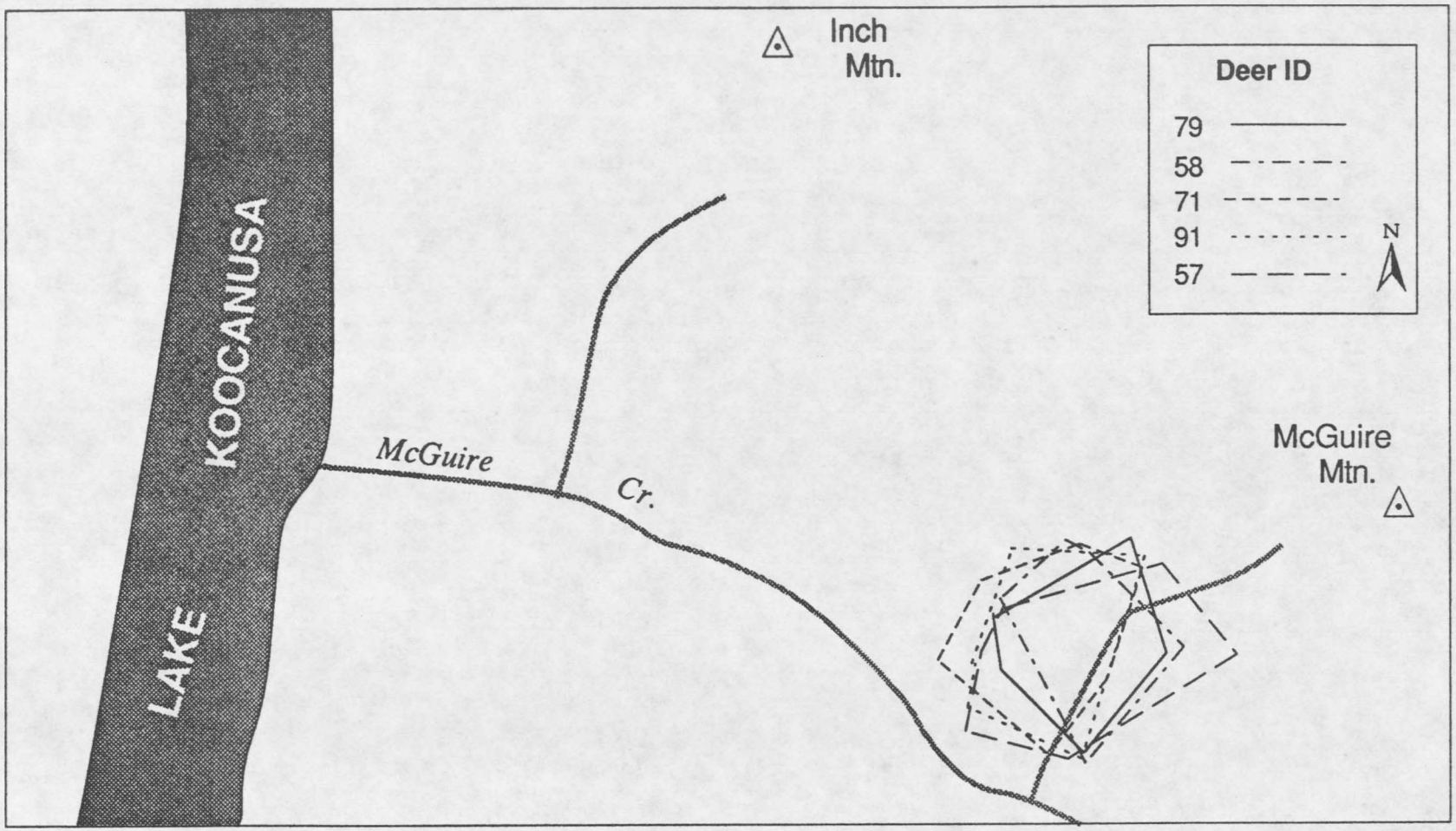


Figure 13. Summer home ranges of 5 radio-collared deer on population-habitat unit 2, 1989, north Salish Mountains.

ISR deer inhabited topographically diverse habitat with many productive microsites. The essential requirements of these deer were apparently met within these areas and no seasonal movements were necessary.

All 7 radio-collared deer in PHU 3 were ISR deer. Stone Hill may have been more diverse than any other portion of the study area. Pockets of mesic vegetation persisted on the terraced slopes throughout the summer, providing forage and hiding and thermal cover. On numerous occasions, radio-collared deer were located bedded in these pockets. In most cases, they were reluctant to leave and would do so only when disturbed from the edge of the cover patch in which they were hiding. Thus, it appeared the patches provided both good hiding and thermal cover.

Spring migration occurred on about the same dates in both 1988 and 1989. Snow melt-out on a nearby snowcourse site occurred 15 days prior to spring migration in 1988, but on approximately the same date as the melt-out in 1989. Deer may have remained on the winter range after snow melted from the higher elevations in 1988 to take advantage of succulent spring forage.

Loft et al. (1984) reported that black-tailed deer migrating the farthest distance and to the highest elevation were the last to leave the winter range. Two deer that moved the farthest distance left their winter range earlier than

other deer. However, they did not move to the highest elevation.

Fall migration did not appear to be triggered by snowfall alone. Many deer remained on summer range after significant snow fell in October, 1989. After more severe storms in November, however, most deer moved to winter ranges. Deer displaying the ASR movement pattern stayed on summer ranges a full month later than DSR deer. Because ASR deer were adjacent to their winter ranges, they could move them quickly and easily. Given this ability, ASR deer could utilize their summer range resources as long as possible, and moved onto winter range only as forced to by deepening snows.

Accessory areas were used by deer to fulfill resource deficiencies that occurred on their normal home ranges (Pac et al. 1991). Only 2 ASR deer used accessory areas. Diversity of habitat on home ranges and closeness to winter range appeared to allow ASR deer to get by without using accessory areas. ISR and DSR deer seemed to need other areas at different times of the year to fulfill habitat requirements. ISR deer used spring and fall accessory areas about equally. Because spring accessory areas of ISR deer were lower than their annual home ranges, these deer may have been moving to lower elevations to take advantage of early green-up conditions. DSR deer used spring accessory areas twice as often as fall accessory areas, implying that

the winter home ranges of these deer were not sufficient to maintain them until migration to summer ranges occurred.

Transitional ranges during spring and fall were reported by Ihsle (1982) and Pac et al. (1988) in north-central Montana. Spring and fall holding areas intermediate to summer and winter ranges have also been observed (Pac 1976, Bertram and Rempel 1977, Loft et al. 1989). These areas were used like accessory areas, providing resources that were lacking during spring or fall.

Home Ranges

Home range size is a function of the spatial arrangement of habitat components essential to an animal (Leopold 1933, Robinette 1966). Therefore, it is probable that home range sizes will vary from season to season and year to year. Both summer polygon home range size and AAR decreased significantly from 1988 to 1989. This was probably related to increased forage production as a result of higher precipitation in winter, spring, and summer of 1989. Drought conditions were prevalent throughout Montana, including the Salish mountains, in 1988. Deer undoubtedly had to be more mobile to meet their living requirements under those conditions.

Leopold et al. (1951) reported that mule deer summer ranges were more than twice the size of winter ranges. In 1988, summer home ranges on the study area were more than twice the size of winter ranges. However, in 1989, summer

ranges were about 0.5 km^2 smaller than the 1988-89 winter home ranges. Diverse topography and close interspersion of cover types on winter range during 1988 may have accounted for smaller home ranges than in summer. High forage production and quality in 1989 were probably the reason for summer ranges being smaller than winter ranges.

Average summer home range size over both years was 1.5 km^2. This was smaller than reported by Rosgaard (1981) and Nyberg (1980), but slightly larger than reported by Pac (1976) for mule deer in the Bridger mountains. Harestad (1979) and Schoen and Kirchhoff (1985) reported much smaller summer home ranges for black-tailed deer on Vancouver Island and in southeast Alaska. White (1960) reported summer home ranges averaging about 0.4 km^2 for mule deer in sub-alpine fir/spruce forest in western Montana. The summer home range size for this study was slightly smaller than that of mule deer on eastern Montana prairie (Wood 1986).

A relatively large average home range size over both years combined was due to large home ranges in 1988. Again, drought conditions resulted in poor forage production on summer range in 1988.

Habitat Use

Lodgepole pine and mixed conifer cover types dominated the landscape of the Salish Mountains study area. PHU 1 and 2 were dominated by lodgepole pine and PHU 3 was dominated

by mixed conifer. Consequently, these cover types were important to deer.

In PHU 1, deer occupied mixed conifer most often; however, ponderosa pine and non-forested cover types were preferred. The preference for ponderosa pine probably resulted from high use by ISR deer. Preference for non-forested types may have been related to the fact that ISR deer were also closely related to these types. When ISR deer were eliminated from the analysis, DSR deer made extensive use of sub-alpine fir and ASR deer used lodgepole pine quite heavily. Pac (1976) reported predominant use of sub-alpine fir cover types by long distance migrants in the Bridger Mountains.

Lodgepole pine was used most often and preferred in PHU 2; non-stocked cover types were also preferred. Schwarzkoph (1973) and Hamlin (1974) reported little or no use of lodgepole pine habitats in the Bridger Mountains. This might have been due to very few lodgepole pine stands that were present in the Bridger Mountains. All non-stocked units within the home ranges of 5 radio-collared deer were 1 year old except for one 5-10 year old clearcut on the northern tip of the unit. The latter had good forage production and a cover patch of lodgepole pine and western larch in the middle. Additional cover was provided by topographic variation.

Mixed conifer was occupied most often by deer in PHU 3. However, deer in this PHU also preferred non-forested types. Again, this appeared to result from habitat use by ISR deer which were closely associated with non-forested areas. Deer in PHU 3 were the only radio-collared deer that avoided non-stocked and lodgepole pine cover types.

Use of cover types by ISR deer was clearly different from that by both ASR and DSR deer. This occurred because ISR deer inhabited portions of the units that had completely different cover types. ASR and DSR deer were quite similar in their use patterns. Lodgepole pine was most important to both groups. Mixed conifer was second in importance to ASR deer, whereas sub-alpine fir was second in importance to DSR deer. Because of their particular movement pattern, DSR deer were more likely to encounter sub-alpine fir cover types.

Patterns of use of cover types suggested that deer probably used or could use all cover types on the study area, but the degree of use and preference depended on time, location, and the particular movement and use patterns of individuals.

Comparison of cover type use on fall accessory areas with summer home ranges of 5 deer revealed significant differences. In fall, all used lodgepole pine and sub-alpine fir types which tend to be more dense than the ponderosa pine and mixed conifer types used in summer. Because this shift occurred during hunting season, these deer may have

been selecting more secure hiding cover (Kufeld et al. 1988). This shift may have been a response to more succulent vegetation that had escaped killing frosts and was still present in the thick understory of lodgepole pine and subalpine fir cover types (Pac 1976).

Radio-collared deer preferred south, southwest, and west aspects during the summer. Thermal cover seemed to be just as adequate on these aspects as on northerly aspects. Use of aspects was more equal for DSR deer than for ASR or ISR deer. Because ASR and ISR deer were tied to the slopes from the reservoir to the ridgetops, they were much less likely to utilize northerly slopes.

Use of slope was much more variable between movement patterns. ISR deer used steep slopes (>19°=21%) very heavily reflecting their occurrence on predominantly steep slopes of winter range. DSR and ASR deer used moderate slopes (13-19°=14-21%) most heavily reflecting their occurrence on more moderate slopes on summer range. Ganskopp and Vavra (1987) reported that deer avoided slopes over 40% and seemed to favor slopes of 0-9%.

ISR deer made short, elevational migrations to the tops of ridges. DSR deer made longer migrations to the lower or mid-slopes of drainages. This difference in movement patterns may account for the lower mean elevations of summer ranges of DSR deer.

Findings suggested that distribution and movements resulted from interactions between behavior patterns of individual animals and topography/physiography, microclimate, vegetation, and land use. Behavior patterns were the specific migration routes and home ranges learned by fawns from adults.

Plant Phenology

Movements to summer range in 1989 occurred at about the same time that at least some plants were greening up at the higher elevations. Use of some early flowering forbs was observed at lower elevations before movement off winter range occurred. Spring accessory areas may have been used in response to green-up and flowering of forbs at intermediate elevations. Particular use of some forbs was observed throughout the summer as they reached the bud stage.

MANAGEMENT IMPLICATIONS

Knowledge of the distribution and habitat use of deer and their relationship to habitat structure is essential to properly assess impacts of land management activities and design effective management strategies. Timber harvesting was the major land management activity with possible significant impacts on the mule deer population on the study area.

Strong fidelity to seasonal ranges may inhibit deer from spreading to areas with suitable habitat (Garrot et al. 1987). Intensive logging of summer and fall range could result in habitat destruction or increased vulnerability to hunting and loss of some segments of the population. Timber management practices that avoid extensive clearcuts and retain interspersion of mesic hiding cover should be considered.

DSR deer were moving onto accessory areas near the winter range during hunting season. Increased deer concentration on areas with high road density from logging operations could result in over-hunting of this segment of the population in particular. Disturbance and harassment during the summer due to high road density could result in poor condition of deer going onto winter range and subsequent high mortality. Pac et al. (1988) stated that

mule deer populations along the east front of the Rockies could be impacted by increased road density and hunting pressure due to oil and gas development. By integrating knowledge of timing of deer movements and road management, impacts on the population could be reduced.

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APPENDIX

Table 15. Classification and status as of November 1989 of 106 mule deer captured during 1987-1989, north Salish Mountains.

ID #	Date	Sex	Age	Mark	Location	Status
1	5/1/85	M	3	Neckband	Rocky Gut	OK
2	1/17/87	F	4	Radio	Sheep Crk.	OK
3	1/22/87	F	5	Radio	Sheep Crk.	Dead
4	1/24/87	M	0	Neckband	Sheep Crk.	OK
5	2/4/87	F	1	Radio	Rocky Gut	D-Radio
6	2/4/87	F	3	Neckband	MP36.5[1]	OK
7	2/11/87	F	0	Neckband	MP36.5	OK
8	12/16/88	F	1	Radio[2]	Allen Gulch	OK
9	2/27/87	F	1	Neckband	Stonehill	OK
10	3/7/87	M	0	Neckband	Rocky Gut	OK
11	3/8/87	F	0	Neckband	Stonehill	OK
12	1/24/88	F	3	Radio[2]	Stonehill	OK
13	3/12/87	M	1	Neckband	Rocky Gut	OK
14	4/24/87	F	1	Radio	Rocky Gut	Dead
15	4/22/89	F	2	Radio[2]	Ten-mile	OK
16	4/28/87	F	2	Radio	MP36[3]	OK
17	5/1/87	F	3	Radio	MP36	OK
18	5/9/87	F	4	Radio	MP36	OK
19	1/12/89	F	0	Radio[2]	MP36.5	OK
20	12/10/87	F	3	Radio	Stonehill	OK
21	12/11/87	F	5	Radio	MP36.5	OK
22	1/23/88	F	0	Radio[2]	Rocky Gut	OK
23	12/14/87	F	6	Radio	Rocky Gut	Dead
24	12/16/87	F	3	Radio	Rocky Gorge	Dead
25	12/16/87	F	4	Radio	Stonehill	OK
26	12/18/87	M	0	Neckband	Stonehill	OK
27	12/18/87	F	Unk	Radio	Stonehill	OK
28	12/18/87	F	0	Neckband	Rocky Gut	OK
29	1/20/88	F	5	Radio	Sheep Crk.	OK

Table 15. (Continued).

ID #	Date	Sex	Age	Mark	Location	Status
30	1/21/88	F	0	Radio	Sheep Crk.	OK
31	1/22/88	F	0	Radio	Sheep Crk.	OK
32	1/22/88	F	0	Radio	Sheep Crk.	OK
33	1/22/88	F	0	Radio	Rocky Gorge	OK
34	1/24/88	F	3	Radio	MP36	OK
35	1/24/88	F	4	Radio	Rocky Gut	OK
36	1/24/88	F	8	Radio	Rocky Gorge	OK
37	1/24/88	F	8	Radio	Stonehill	OK
38	1/25/88	F	0	Neckband	MP36	OK
39	1/25/88	F	2	Neckband	Sheep Crk.	OK
40	1/25/88	M	0	Neckband	Rocky Gut	OK
41	2/25/88	F	5	Radio	Stonehill	OK
42	2/25/88	F	0	Radio	Stonehill	OK
43	12/4/88	F	4	Radio	Rocky Gorge	OK
44	12/5/88	M	1	Eartags[2]	Allen Gulch	OK
45	12/7/88	F	0	Radio	Allen Gulch	OK
46	12/8/88	F	5	Radio[2]	Rocky Gorge	OK
47	12/8/88	M	3	Eartags	Allen Gulch	OK
48	12/15/88	F	6	Radio	Allen Gulch	OK
49	12/15/88	F	7	Radio	Rocky Gorge	OK
50	12/15/88	F	2	Radio	Rocky Gorge	OK
51	12/16/88	M	1	Eartags	Rocky Gorge	OK
52	12/16/88	F	4	Radio	Rocky Gorge	OK
53	1/6/89	F	5	Neckband	Allen Gulch	OK
54	1/7/89	F	8	Neckband	Rocky Gorge	OK
55	1/7/89	F	6	Neckband	Allen Gulch	OK
56	1/7/89	M	0	Eartags	Allen Gulch	OK
57	1/8/89	F	7	Radio[2]	McGuire Cr.	OK
58	1/8/89	F	3	Radio	McGuire Cr.	OK
59	1/8/89	F	1	Neckband	Rocky Gorge	OK

Table 15. (Continued).

ID #	Date	Sex	Age	Mark	Location	Status
60	1/9/89	F	0	Eartags	MP36	OK
61	1/9/89	F	0	Eartags	Allen Gulch	OK
64	1/9/89	F	4	Neckband	Rocky Gorge	OK
65	1/9/89	M	0	Eartags	Rocky Gorge	OK
66	1/9/89	F	0	Neckband	Rocky Gorge	OK
67	1/9/89	M	0	Eartags	McGuire Cr.	OK
68	1/9/89	M	0	Eartags	McGuire Cr.	OK
69	1/10/89	F	0	Neckband	Rocky Gut	OK
70	1/10/89	F	0	Neckband	Ten-mile	OK
71	1/10/89	F	0	Radio	McGuire Cr.	OK
72	1/10/89	F	0	Eartags	McGuire Cr.	OK
73	1/10/89	M	2	Eartags	McGuire Cr.	OK
74	1/11/89	M	1	Eartags	MP36.5	OK
75	1/11/89	F	5	Radio	Rocky Gut	OK
76	1/11/89	M	0	Eartags	MP36	OK
77	1/11/89	F	2	Radio	Ten-mile	OK
78	1/11/89	F	1	Radio	McGuire Cr.	Dead
79	1/11/89	F	0	Radio	McGuire Cr.	OK
80	1/11/89	F	8	Eartags	McGuire Cr.	OK
81	1/12/89	F	0	Radio	Rocky Gut	OK
82	1/12/89	M	0	Eartags	Rocky Gut	OK
83	1/12/89	M	0	Eartags	Sheep Crk.	OK
84	1/12/89	F	6	Neckband	MP36	OK
85	1/12/89	F	1	Radio	Rocky Gorge	OK
86	1/12/89	M	0	Eartags	McGuire Cr.	OK
87	1/13/89	F	6	Radio	Rocky Gut	OK
88	1/13/89	M	0	Eartags	Rocky Gut	OK
89	1/13/89	F	0	Neckband	Sheep Crk.	OK
90	1/13/89	F	1	Neckband	Ten-mile	OK
91	1/13/89	F	2	Radio	McGuire Cr.	OK

Table 15. (Continued).

ID #	Date	Sex	Age	Mark	Location	Status
92	1/13/89	F	1	Radio	McGuire Cr.	OK
93	4/21/89	F	1	Radio	MP36.5	OK
94	4/21/89	F	0	Radio	Rocky Gut	OK
95	4/21/89	M	1	Eartags	Ten-mile	OK
96	4/22/89	F	7	Radio	MP36.5	OK
97	4/22/89	M	0	Eartags	Rocky Gorge	OK
98	4/23/89	M	0	Eartags	Allen Gulch	OK
99	4/23/89	F	4	Radio	Rocky Gorge	OK
100	4/23/89	F	4	Radio	Ten-mile	OK
101	4/24/89	F	0	Radio	Rocky Gut	Dead
102	4/24/89	F	2	Radio	MP36	OK
103	4/24/89	F	3	Radio	Ten-mile	OK
104	4/24/89	F	0	Radio	Rocky Gorge	OK
105	4/25/89	F	3	Radio	Rocky Gorge	OK
106	4/25/89	F	6	Neckband	Rocky Gorge	OK

[1]Mile post 36.5

[2]Recapture

[3]Mile post 36

Table 16. Phenology study sites and the number of times each was visited during April to September, 1989, north Salish Mountains.

Location	number times visited
Allen Gulch	4
Stonehill	2
East side Flat Creek	3
West side Flat Creek	4
Rocky Gorge	4
Flat Creek-McGuire Creek divide	3
Middle McGuire Creek	6
Tenmile-talus slide	2
Briery Creek	2
Skid Creek	4

Table 17. Definitions of cover type abbreviations.

Abbreviation	Meaning of abbreviation
NS	Non-stocked cutting unit
LPP	> 80% occurance of lodgepole pine
MC	> 50% occurance of Doug fir or Western larch
SAF	> 50% occurance of Sub-alpine fir or Engelman spruce
PP	> 50% occurance of Ponderosa pine
NF	Non-forested - bare rock or meadow

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