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Peace River Site C Hydroelectric Development
Environmental Assessment
Consumptive Wildlife Resources

by

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EXECUTIVE SUMMARY

New wildlife studies for the Peace Site C hydro electric project were commissioned to document changes which had occurred since the last review in 1981. The project area was defined as the valley of the Peace River in B.C. and surrounding lands which may be important to wide-ranging wildlife species which use the proposed reservoir area (flood zone) only seasonally. Biophysical habitat mapping done by the Ministry of Environment was used as the basis for measuring project impacts on the land base. Existing harvest and census information available from MOE was reviewed and used to assess changes since 1981. Aerial censuses were completed to estimate winter populations of ungulates and beavers. Tracking surveys were used to document relative abundance and habitat use of furbearers. Mule deer, moose and elk were captured to determine seasonal movements and habitat use of radio-collared animals.

The beaver population, estimated at 380, was about double the size noted in 1976. This was apparently due to more stable water levels and increases in riparian habitat after construction of the WAC Bennett dam upstream on the Peace. Nine other furbearers were more abundant on north slopes and plateau areas, but all occurred in the flood zone. Mink and otter were seen along the river but few tracks were found in the areas sampled. Marten and weasel were moderately abundant and coyotes were abundant in riparian habitat below the proposed flood line.

Data from mule deer collared by MOE showed that deer east of Ft. St. John were non-migratory, while about 64% were migratory in the project area. Seven of 11 collared mule deer moved from 25 to 110 km from the Peace River in summer and returned each winter. Tracking of 14 moose for 2-3 months showed that moose spent 30-40% of that period in the flood zone and often moved to

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the plateau and other drainages. Four elk collared in summer rarely used the flood zone but did cross the Peace and tributaries. Mule deer and elk concentrated on south aspect river breaks where snow depths were minimal. Moose used all habitats in winter since maximum snow depths of 50 cm were not sufficient to restrict their movements. We estimated 2533 mule deer and 307 moose within the reservoir area and adjacent slopes based on stratified random block counts. The mean density for mule deer ($14/km^2$) was 5 times the average since 1965 and about triple the density noted in other parts of the Peace region in 1991. The high numbers probably resulted from the concentration of both migratory and resident deer in the area in winter. White-tailed deer have generally occurred at a ratio of 5 per 100 mule deer based on counts since 1965. The ratio we noted of 4.6 to 100 suggests that their numbers have increased at the same rate as mule deer. The total elk count (257) was similar to recent estimates. Some elk were found at several new locations even though much of the area was not surveyed using the random block count method. Block counts underestimate the abundance of animals distributed in clumps unless the survey blocks are very large. Elk have expanded their range and appear to be increasing slowly in numbers. Moose numbers were similar to previous long term estimates, however, 7 out of 13 collared animals which used the reservoir area in winter were on the plateau outside the censused area during our survey. The actual number of different moose using the reservoir area in winter may, therefore, be double the number we counted.

Most of the flood zone was mapped as spruce-poplar floodplain (SP). Some deer and elk did use the flood zone but maximum snow depths probably exceed their tolerance limits for some months every winter. The valley bottom habitats had the greatest value to moose in winter and were the year round home of many furbearers, especially coyotes and beaver. Spruce forests along the river and on north facing slopes had the greatest densities of furbearers and may also provide snow shelter for moose in extreme winters. The flood zone is also a potentially important reproductive habitat for deer, moose and elk, however, limited data are available to assess the relative importance.

Habitat mapping was completed for 5 map sheets in the area surrounding the proposed reservoir (3,847 km^2). Lands in the reservoir comprised 1.9% (72.5 km^2) of the total area. Habitats on south aspect breaks, including aspen rose crests (ARc), aspen saskatoon forests (AS), shrubland (SW) and cultivated fields (CF) were essential elements of deer and elk winter range. All habitats were used by moose in winter 1990-91, however, river breaks (AS, BD, PC) and spruce-poplar floodplains (SP) would be more important in deep snow years. North aspect breaks (BD) and floodplains (SP) were most important to furbearers based on results of tracking surveys.

Habitat losses were assessed based on the total area which would be flooded and the availability of similar habitats nearby. Spruce-poplar floodplains (SP) accounted for the greatest area lost in a single habitat unit (4263 ha). This was also a significant portion (39.3%) of the total available in the mapped area. Saskatoon-wheatgrass (SA) had the second highest percent loss (4.3%) although only 251 ha would be flooded. Most other habitats suffered less than a 2% loss although the actual areas lost were more extensive (399-642 ha).

Key habitats were identified based on survey information and literature review. Densities were estimated from census surveys and literature review. Actual numbers of animals lost were calculated based on the areal extent of habitat losses and estimated animal densities in key habitats. Estimated losses due to flooding were 214 mule deer, 8 elk, 96 moose, 347 beaver, 12 lynx, 2 fisher, 15 marten, 3 weasel, 10 coyote and 10,194 red squirrels. Mink and otter occurred in the area but the information available was not sufficient to estimate losses.

Better survey techniques are needed for water associated species. Other species, including wolf and wolverine, occurred rarely in the project area and losses would probably be minor.

River islands and riparian flats in the spruce-poplar floodplain habitat unit were potentially important reproductive habitats for deer, moose and elk. Recently obtained data has shown that moose and deer are using the area for calving/fawning and some collared elk may also calve there. Since flooding will remove a large portion of that habitat and little is available in surrounding areas, impacts on ungulate reproduction could be significant. More information on the extent of calving/ fawning in the proposed reservoir and key habitat characteristics is required to assess impacts and identify mitigation opportunities. The significance of river crossings to ungulates in the Peace valley should also be assessed since access to habitats may be affected by ice formation on the new reservoir. Information on habitat use patterns of white-tailed deer is needed to identify important habitats and potential effects of flooding.

Additional information which may alter the assessment of losses includes:

1. better definition of the importance of river islands for reproduction in the deer, elk and moose populations,

2. defining the annual movements of the collared moose and elk and their annual use of the flood zone,

3. determining the extent of crossings of the flood zone by deer, elk and moose particularly in winter.

4. defining the habitat use and movement patterns of white-tailed deer in the Peace valley.

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INTRODUCTION

B.C. Hydro previously applied for an energy project certificate for the Peace Site C Project in 1981. Impacts of the project on wildlife were assessed based on studies from 1976 to 1977. Significant changes in wildlife populations have occurred since that time. A review of existing information was completed to assess the magnitude of changes and trends since 1981 (Blood 1991). Biophysical mapping, recently completed by the Ministry of Environment, has also permitted a better inventory of lands and wildlife capabilities within the region and the project area (Lea and Lacelle 1989). Information on annual ranges and time spent in the reservoir area was deemed essential in order to assess the effects of flooding on wide-ranging species such as mule deer, elk and moose.

Objectives

New field studies were commissioned primarily to update the inventory information for hunted and trapped wildlife species. Defining the habitats used and times of occupancy of the reservoir area by wide-ranging deer, moose and elk was a key component of field studies. More detailed habitat use information was also required to assess the relative importance of biophysical map units to each species.

Study Area

The core study area included the floodplain, side slopes and terraces of the Peace River from the Peace Canyon Dam to 1 km below the Site C dam site and the area traversed by two 500 kV transmission lines joining Site C to Peace Canyon Dam. In addition to the proposed reservoir, construction site and transmission right-of-way, areas used by wide-ranging wildlife species which may be affected by the proposed development were included. The preliminary study area includes map sheets 94A2, 94A3, 94A4, 94A5 and 94A6. These map sheets include all of MOE Management Units 7-32, 7-34 and 7-35 and parts of MU's 7-33, 7-43, 7-44, 7-45 and 7-46 (Figure 1). Final definition of the actual study area was dependent on the results of wildlife movement studies.

Habitat Units

Standardized biophysical mapping of the Lower Halfway (1:50,000 map sheets 94A3, 94A4, 94A5 and 94A6) was completed by the Ministry of Environment in 1989 (Lea and Lacelle 1989). Earlier mapping of the Pine-Moberly area (94A2, 94A3 and 94A4) by Thompson and Harcombe (1979) was updated in 1990 by MOE to be compatible with the Halfway mapping.

For our purposes, habitat units were subdivided into 3 topographical areas relevant to the Site C project:

1. valley bottoms of the Peace River and tributaries including riparian floodplains, islands and adjacent forested benches and fields below the flood elevation;

2. valley slopes, benches and breaks adjacent to the proposed reservoir;

3. plateau land at the top of the river breaks including, wetlands, rolling forest land and agricultural fields.

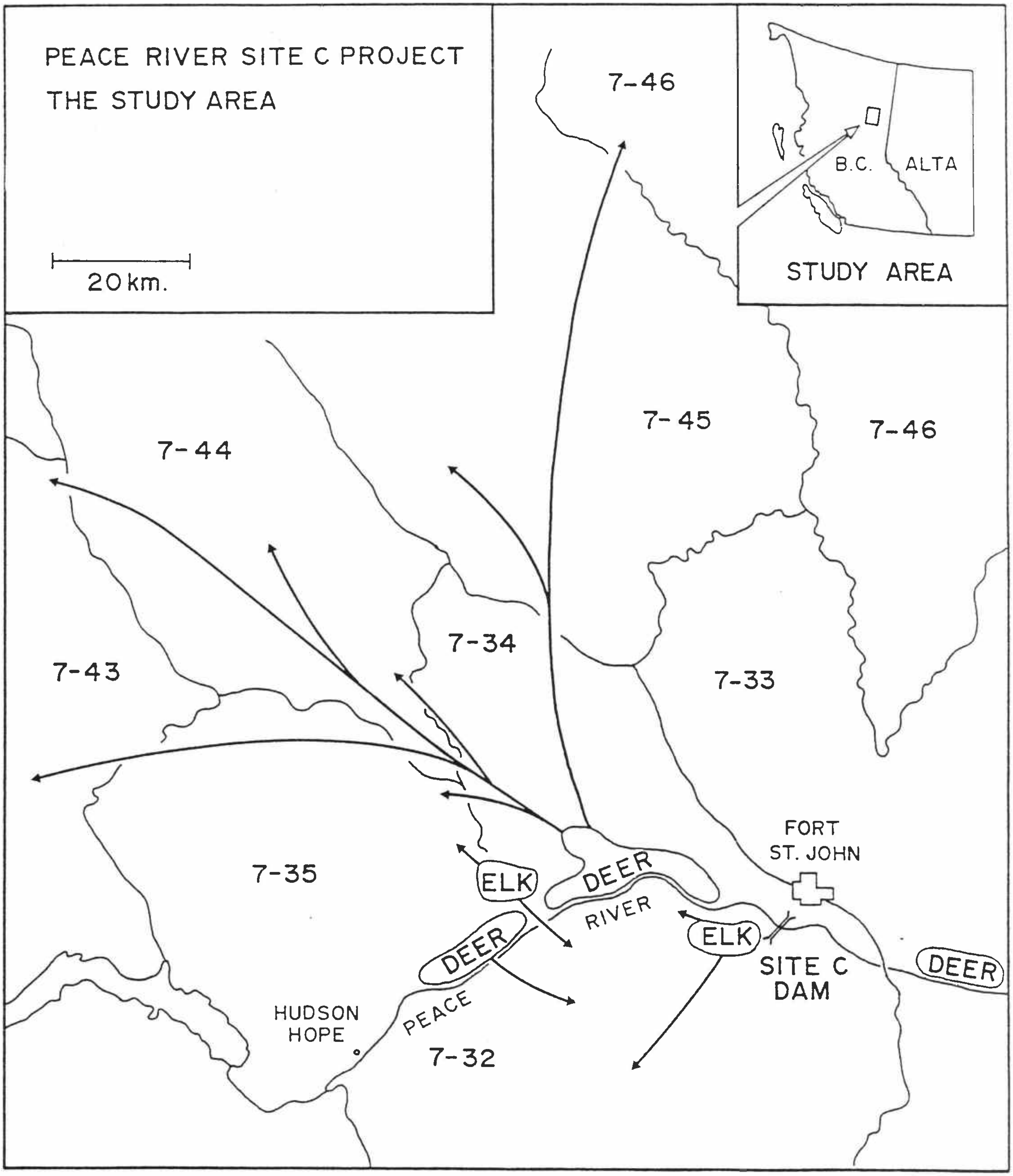

Figure 1. The study area showing wildlife management units used by deer and elk which winter in the Site C project area along the Peace River.

The majority of the Peace River valley bottom was mapped as white spruce-balsam poplar floodplain (SP). Gravel bars (GB) also accounted for a small portion of the area.

Trembling aspen-prickly rose on crests and ridges (ARc, ARr), aspen-saskatoon (AS) and saskatoon-slender wheatgrass (SW) were most common on south facing river breaks.

Paper birch-red osier dogwood (BD) was predominant on north aspect breaks.

Plateau lands were dominated by the aspen-rose (AR) and balsam poplar-highbush cranberry (PC) habitat units. White spruce-bunchberry (SB), black spruce upland (BS) and wetlands (BP, SS, WI, WB) were widely distributed but less common.

Cultivated fields (CF), an important habitat unit for ungulates, occur north of the Peace in all 3 topographic areas.

Acknowledgements

Ministry of Environment staff in Fort St. John, particularly Rob Woods and Brian Churchill, provided telemetry data from previous mule deer studies, technical assistance and equipment needed to initiate the wildlife studies. Rod Backmeyer assisted with capture and was responsible for collecting and recording most of the telemetry data. Bill Reno collected much of the tracking data and Diane Culling, Kathy Kovacs, Johan Stroman and Brian Mitchell assisted with aerial surveys, data analysis and report preparation. Don Blood compiled existing wildlife data and assisted with some field surveys. Stan Hirst and Glen Singleton co-ordinated the project on behalf of B.C. Hydro. Glen Singleton and Bob Bradley reviewed an earlier draft of this report and provided useful comments to improve the content and clarity of the information.

METHODS

Beaver were inventoried by flying the Peace River valley using a helicopter and searching riparian habitats for lodges and other signs of activity. Active lodges were identified by the presence of food caches. All lodges were plotted on 1:50,000 scale maps. Boat surveys were completed in accessible areas to check for missed colonies. Some lodges which appeared inactive or had no food cache were resurveyed later.

Other furbearers were inventoried by counting tracks in the snow in each habitat type along measured transect lines. Some transects were completed on foot and others by snowmobile. Track counts were best completed 2 to 3 days after fresh snowfalls. Sufficient time must elapse to allow tracks to accumulate but tracks should not be so dense that individual trails cannot be distinguished. The time period during which tracks accumulated was determined by recording the days since a fresh snow covered all tracks. On some transects which were surveyed more than once, tracks were marked as they were tallied so tracks already counted could be recognized on successive surveys. Track counts for each species were recorded as no./km/day/habitat. Expected counts were calculated based on the proportion of sampling in each habitat.

Movements, seasonal ranges and habitats used by mule deer, moose and elk were assessed by relocating radio-collared animals at regular intervals using telemetry equipment. Mule deer radio location data collected by MOE from 1987 to 1990 was reviewed and analysed. Those deer with ranges close to the Site C project area were incorporated into the B.C. Hydro telemetry program. Additional radio transmitters were attached to deer, elk and moose at various locations in and around the reservoir area from July 1990 to March 1991. Collared animals were located 4-6 times each month using light aircraft. Some animals, which were in areas accessible by road, were located from the ground during consecutive day and night periods to document nocturnal movements and habitat use. All radio locations were plotted on 1:50,000 scale habitat maps. Information recorded in computer files included date, hour, map UTM grid, location accuracy, aspect, elevation, slope, habitat unit, seral stage, tree cover, topographic position, activity; group size and classification; and distance from habitation, roads, cultivated fields and the proposed flood elevation line.

Data relevant to interpretations of wildlife distribution and movements, such as snow depth and temperature, were available from the permanent weather station at Ft. St. John airport. We also collected snow depth data during ground locations and established snow stations at representative sites along the Peace in January.

Total counts of deer, moose and elk in the reservoir area and adjacent slopes were completed using intensive helicopter searches. Groups were counted, classified (where possible) and recorded by one observer behind the pilot. The forward observer (navigator) was responsible for plotting group locations on maps and identifying block boundaries. The pilot was responsible for systematically searching the entire block. All personnel, including a third observer behind the navigator, searched for animals. Twenty-nine survey blocks from 2 to 15 km^2 were defined within the project area and each was rated high, moderate or low for expected numbers of deer or moose based on capability mapping. Counts in randomly selected blocks were used to estimate ungulate numbers in the blocks not surveyed. The number of animals missed was estimated based on the sightability of collared animals during radio location flights and the proportion of collared animals in the survey area which were seen during the helicopter survey.

WILDLIFE POPULATIONS and HABITATS

Beaver Surveys

A complete count of beaver lodges, dams and food caches within the reservoir area was completed by helicopter on October 11, 1990. The Peace mainstem from the Halfway River to Wilder Creek was surveyed by boat on October 12 and 13. It was possible to locate some bank dens not visible from the air during the boat survey, but none had food caches and most appeared inactive. Seventy-five active lodges and 27 inactive lodges were located during the October surveys.

Inactive lodges were re-checked during telemetry flights and by boat in November. Some lodges previously thought active were abandoned and other inactive lodges were occupied with food caches nearby. The corrected count included 76 active and 26 inactive lodges in the reservoir area (Figure 2). Discussions with a local trapper indicated that most lodges contained 2 adults and 3 to 5 young (B. Reno - personal communication). A few had 4 large beaver, presumably adults and yearlings or 2 year olds, plus young. One previous aerial survey in 1976 located 45 areas with beaver activity (Blood 1979). From additional ground surveys in summer 1977, 30 to 40 active colonies were estimated in the reservoir area. Blood (1979) used 5 beaver per colony to estimate total numbers at 150-200 animals. Using the same figure, the current number is approximately 380, or about double the 1976 population.

Most lodges were found in areas with islands, side channels and extensive shrubby riparian habitat. Thurber (1979) indicated that the lack of spring floods along the Peace since construction of the Bennett dam has increased gravel deposition and island formation. Pioneering vegetation on expanding islands and more stable water levels both enhance the area for beavers and likely account for the increased population.

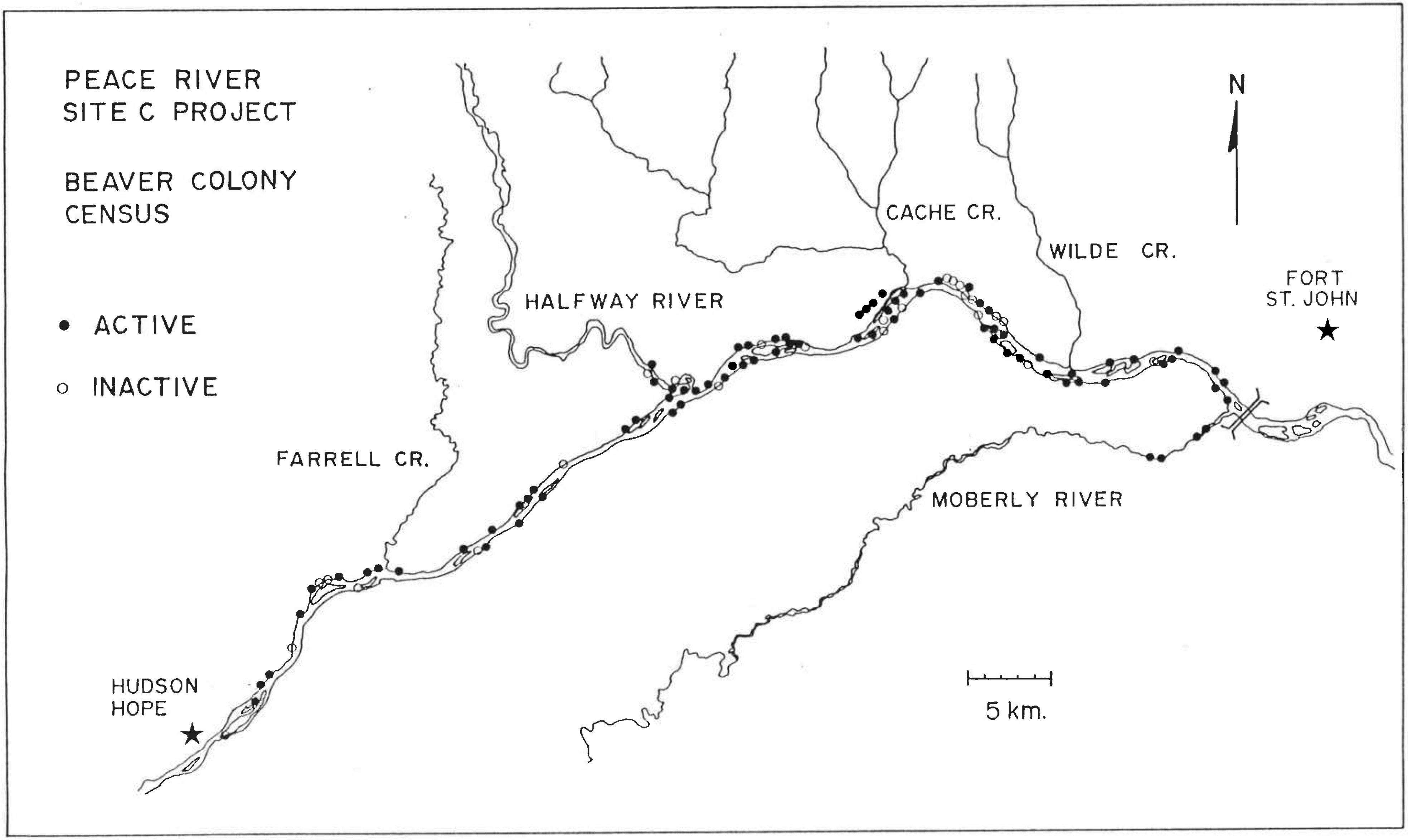

Figure 2. Locations of beaver colonies within the study area.

Furbearer Track Counts

Track counts provided comparative data to estimate relative use among habitats in the same geographic area but did not provide population estimates. Low temperatures were thought to reduce the above ground activity of many small mammals. Squirrels were extremely common in virtually every forested habitat and tracks were so numerous during mild weather that accurate counts were not possible and probably unnecessary.

Track counts were compared between habitats and topographical areas. Expected numbers were calculated by apportioning the total count for each species according to the sampling intensity in each habitat. Tracks of coyotes, marten, weasel and fisher were the most commonly encountered in the study area, excluding squirrels. Tracks of some species notably wolves, foxes, wolverine, mink and lynx were rarely encountered. Tracks of otter and mink were seen in the area but the sampling was mainly in upland habitats, not along river banks where otter and mink were expected to be most active. Numbers of tracks in floodplain habitat (SP) was greater than expected for coyotes (Table 1). All species did occur in the floodplain but generally at lower density than observed in adjacent upland habitats. South breaks had zero track counts for all species except coyotes. North aspect breaks (BD) had consistently greater than expected counts for all species except wolves and mink. Many tracks counted on the plateau were not classified by specific habitats but all were within AR, SB or SS types (Table 1). Large areas of aspen forest must be traversed to sample small amounts of riparian and spruce forested areas. These counts were not useful for comparing plateau habitats but were used to assess the relative importance of lower elevation units based on tracks counted per kilometer.

Table 1. Observed and expected* numbers of furbearer tracks in different habitat types.

Hab-	Sample	wolf		coyote		fox		wolverine		fisher		marten		weasel		mink		lynx	
itat	km day	obs	exp	obs	exp	obs	exp	obs	exp	obs	exp	obs	exp	obs	exp	obs	exp	obs	exp
Peace River valley																			
SP	71.4	7	5	125	57	2	3	0	2	2	9	20	42	11	25	0	3	2	7
South aspect breaks																			
AS	11.4	0	1	22	9	0	0	0	0	0	1	0	7	0	4	0	0	0	1
CF	12.0	0	1	15	10	0	0	0	0	0	2	0	7	0	4	0	0	0	1
SW	2.8	0	0	7	2	0	0	0	0	0	0	0	2	0	1	0	0	0	0
subtot	26.2	0	2	44	21	0	0	0	0	0	3	0	16	0	9	0	0	0	2
North aspect breaks																			
BD	118.6	3	7	83	96	8	4	11	4	18	16	92	70	42	42	0	5	17	13
Plateau																			
AR	128.0	8	9	17	103	0	6	1	5	1	16	14	75	10	46	0	6	0	12
SB	38.6	0	2	0	31	0	1	0	1	6	5	32	23	0	14	0	2	0	4
SS	52.0	0	3	0	42	0	2	0	2	2	7	0	31	24	19	9	2	7	5
All	"	10		81		6		2		27		99		68		9		17	
sbtot	218.6	18	13	98	176	6	8	3	7	36	29	145	130	102	79	18	9	24	21
TOTAL	434.8	28	28	350	350	16	16	14	14	56	56	257	257	155	155	18	18	43	43

* Expected numbers were calculated by apportioning total counts according to the km days of sampling in each habitat.

Seasonal Movements and Ranges of Mule Deer

Long-term information was only available for 23 mule deer collared by MOE from 1987 to 1989 (Appendix I). Collared mule deer were categorized as resident or migratory. Resident deer remained within the same area year round. Migratory deer moved long distances in spring and fall travelling between distinct summer and winter ranges. Nine mule deer collared in the lower Beaton River were resident (Figure 3). The tenth deer was never relocated. Of 12 deer collared in lower Cache Creek, only 4 were resident, 7 were migratory and 1 died shortly after capture. Migration distances ranged from 25 to 110 km (Figure 3). Spring migrations occurred from mid- to late May (Table 2). Fall migrations were less well defined due to infrequent locations, but appeared to occur from late September to early November (Table 2). Migratory deer occupied the winter range for 6-7 months each year. Generally the frequency of location before July 1991 was not sufficient to accurately determine range sizes, particularly for widely distributed migratory deer which required flights to obtain summer locations. Most summer range sizes were estimated from only 3 to 8 locations collected over 2-3 years. Recognizing the limitations of the small sample sizes, seasonal ranges of migratory deer appeared similar in size to annual ranges of resident deer, ranging from 2 to 13 km^2 based on minimum covex polygons (Figure 4 and Appendices II, III, IV).

Five of the 18 deer collared in the Cache Creek to Farrell Creek area, included the reservoir in their home ranges. All collared deer close to the proposed reservoir were located once each week from the air and, when accessible, twice each week from the ground. Two yearling males collared in summer 1990 had larger than expected ranges (50 and 115 km^2, Figure 3) based on 7 months of tracking. Such movements are typical of sub-adult animals and future tracking may determine if they resulted from migratory movements or random wanderings prior to establishing a resident home range. One used the river islands extensively in

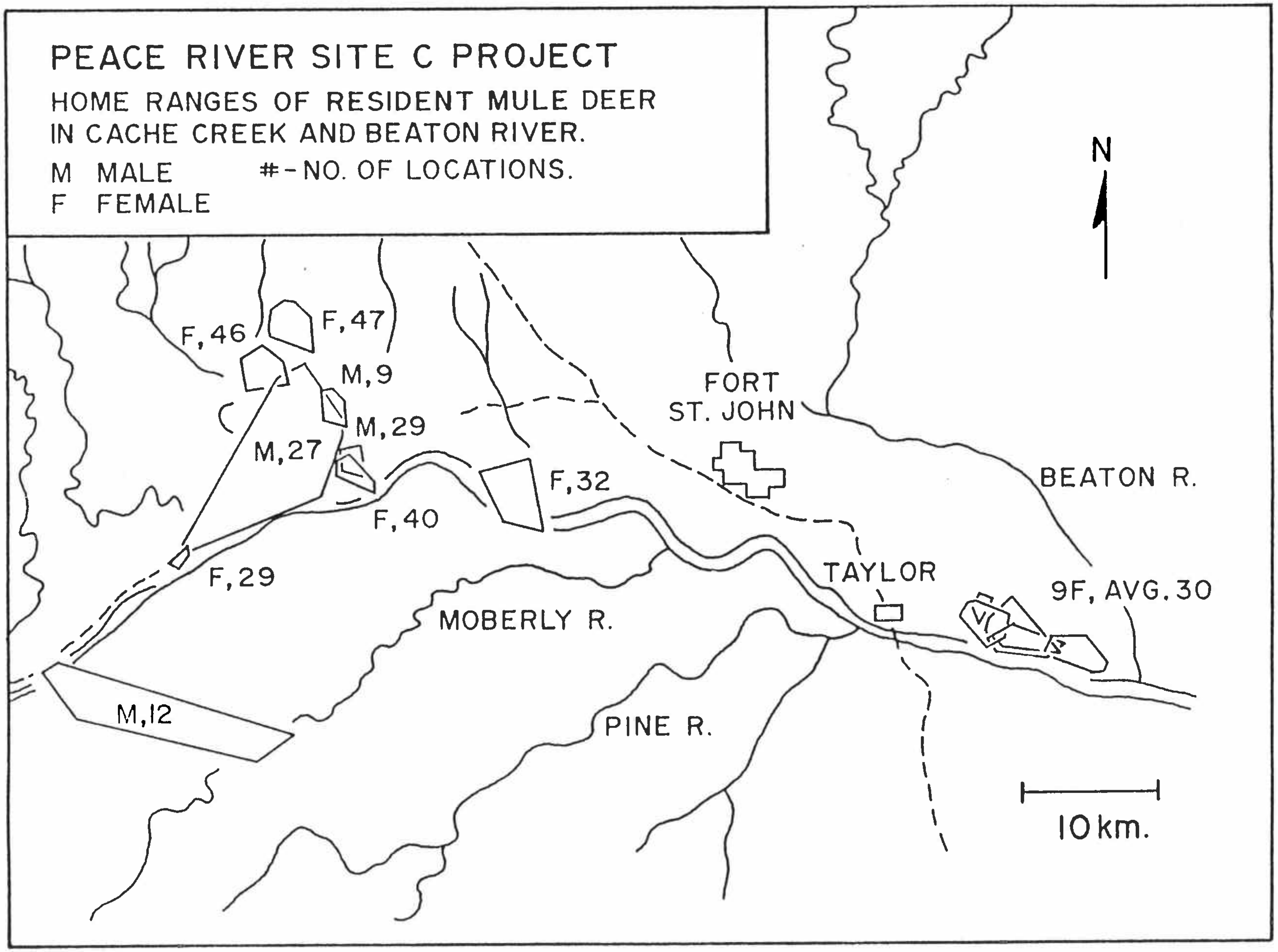

Figure 3. Annual ranges of resident mule deer east and west of Ft. St. John.

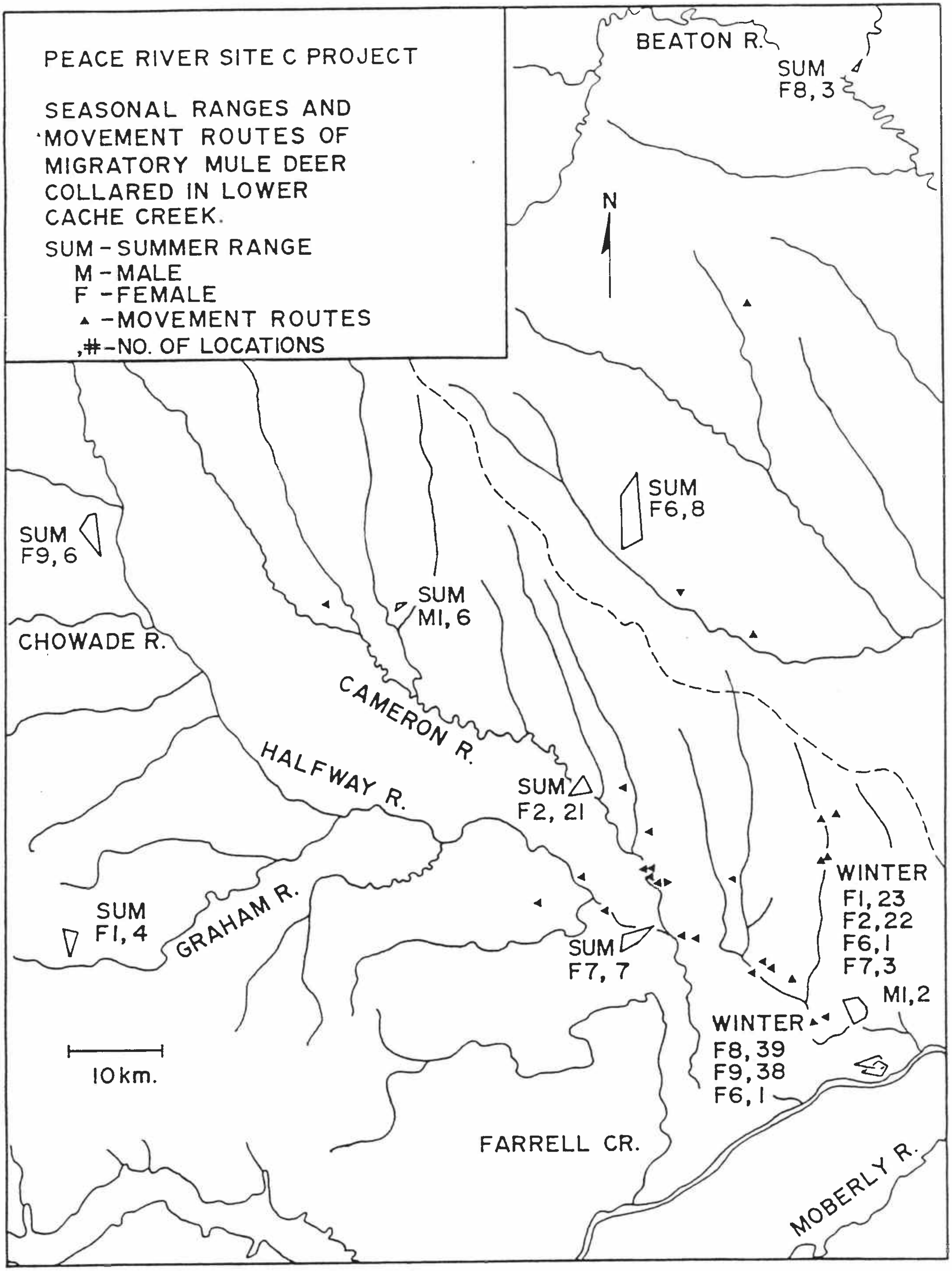

Figure 4. Seasonal ranges of migratory deer which winter near the Site C flood zone.

Table 2. Time periods on summer and winter ranges and timing of migrations for Cache Creek mule deer, 1987 to 1991.

ID	Years	Spring Migration	Summer Range	Fall Migration	Winter Range
F1	87				Fb 28-My 1
F1	87/88				Oc 20-My 9
F1	88/89	My 12-15	My 16-Jn 25	Sp 26-Oc 10	Nv 13-My 10
F1	90	My 16-Jn 1	Jn 7-Ag 12		
F2	87				Mr 7-Ap 27
F2	87/88		Jn 4-Oc 14	Oc 30	Nv 1-My 12
F2	88/89	My 14-16	My 17-Oc 9		Oc 30-Ap 27
F2	89/90	My 16	My 19-Ag 12		
F6	89	My 16-25	My 29-Ag 12		
F6	90		Au 30-Sp 26		
F7	89				Fb 23-My 16
F7	89		My 25-Ag 12		Dead
F8	89				Fb 18-My 16
F8	89/90	My 19-Jn 7	Jn 12-Ag 12		Ap 3
F8	90/91				Oc 13-Fb 20
F9	89	My 16-25	Jn 7-Ag 12		Ap 3
F9	90		Au 30-Sp 26		Oc 13-Fb 20
M1	89				Fb 24
M1	89		My 25-Jn 21	Nv 14	

summer and others moved below the flood line occasionally in winter. One crossed the proposed reservoir but was never located below the flood line.

Moose Winter Ranges

No moose were collared in the area prior to initiation of the B.C. Hydro 1990 studies. Winter range sizes were calculated for 8 moose tracked since December 14 and 6 tracked since January 11 (Appendix V). Because of the short duration of the radio-tracking period and the absence of early winter data, range sizes were much smaller than expected (Table 3). Movements did

Table 3. Partial winter home range sizes for 14 moose captured in the Site C flood zone in December 1990 and January 1991.

	Cow Moose ATT	BFL	BGG	DUU	FRR	HFF	HLL	MLL	MBB	SNO
km^2	1.6	2.4	6.6	3.5	3.9	5.7	6.8	14.4	5.6	20.3
N	14	16	12	20	17	8	11	12	10	12
	TCK		Bull Moose KMS	RVV	TFF					
km^2	10.1		5.7	11.2	11.5					
N	10		18	10	16					

demonstrate that moose using the reservoir also ranged onto the plateau and other drainages during the winter (Figure 5) and that back and forth movement was common. The extent of spring movement was unknown and the summer distribution of moose using the flood zone was also undetermined.

Elk Seasonal Ranges

The first 4 elk were collared in the study area in July and August 1990. Four others were collared in December and 2 in March 1991 (Appendix V). Although the data are based on less than a full year, some possible migration patterns were discernable for 2 Moberly elk (Figure 6). The movement of the yearling bull to the Pine River in winter was unexpected and may not be typical of adults in the Moberly population. Movements of the adult female from plateau areas, in summer, to the Moberly breaks in winter, may be more representative. Halfway elk made some significant movements across the proposed reservoir area in the Halfway and Peace Rivers, but did not shift their centres of activity from summer to winter. Two of the collared elk made use of the flood zone along the Peace, one in summer and the other in winter.

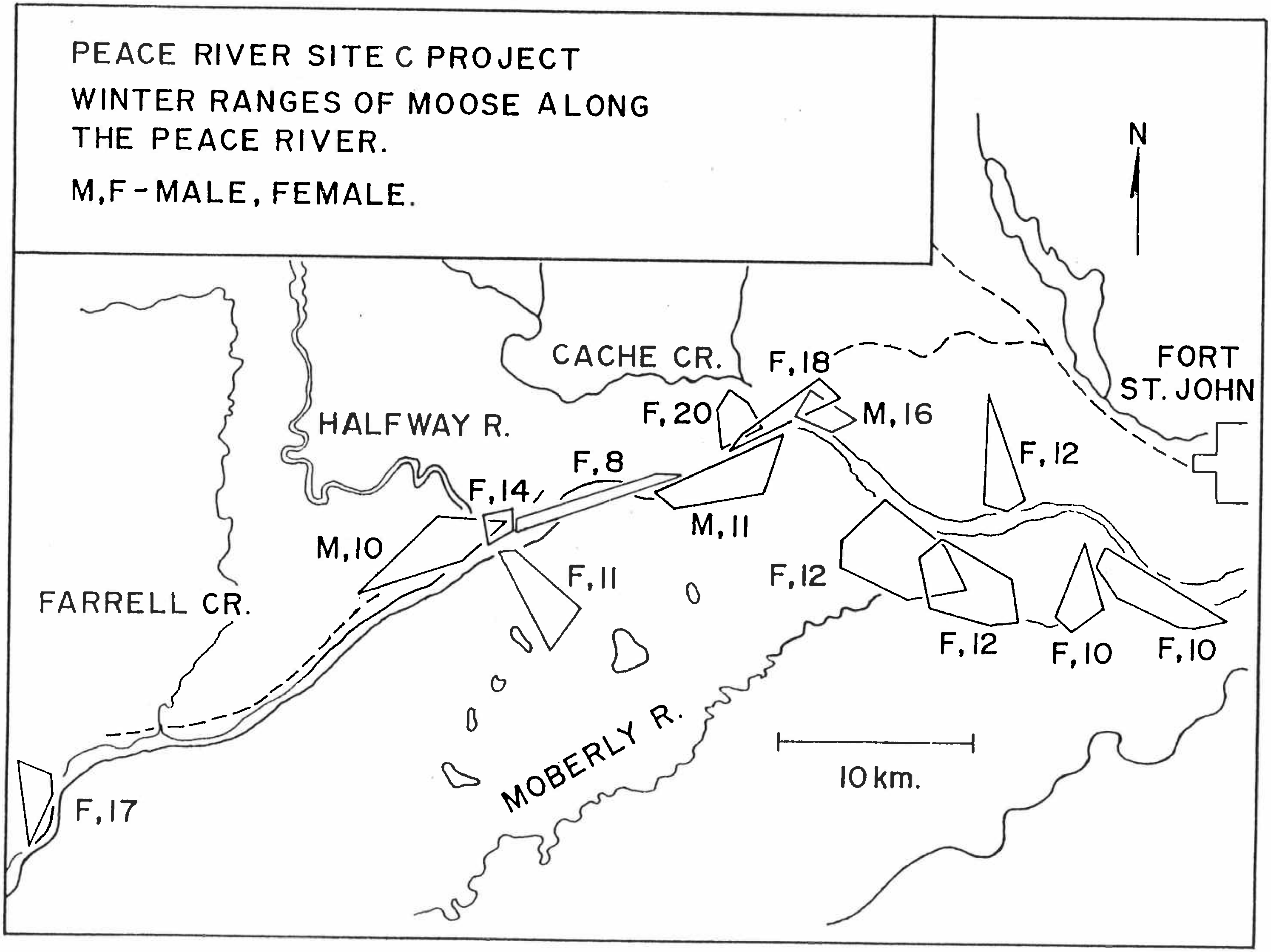

Figure 5. Partial (December - February) winter ranges of moose captured in the Site C reservoir area.

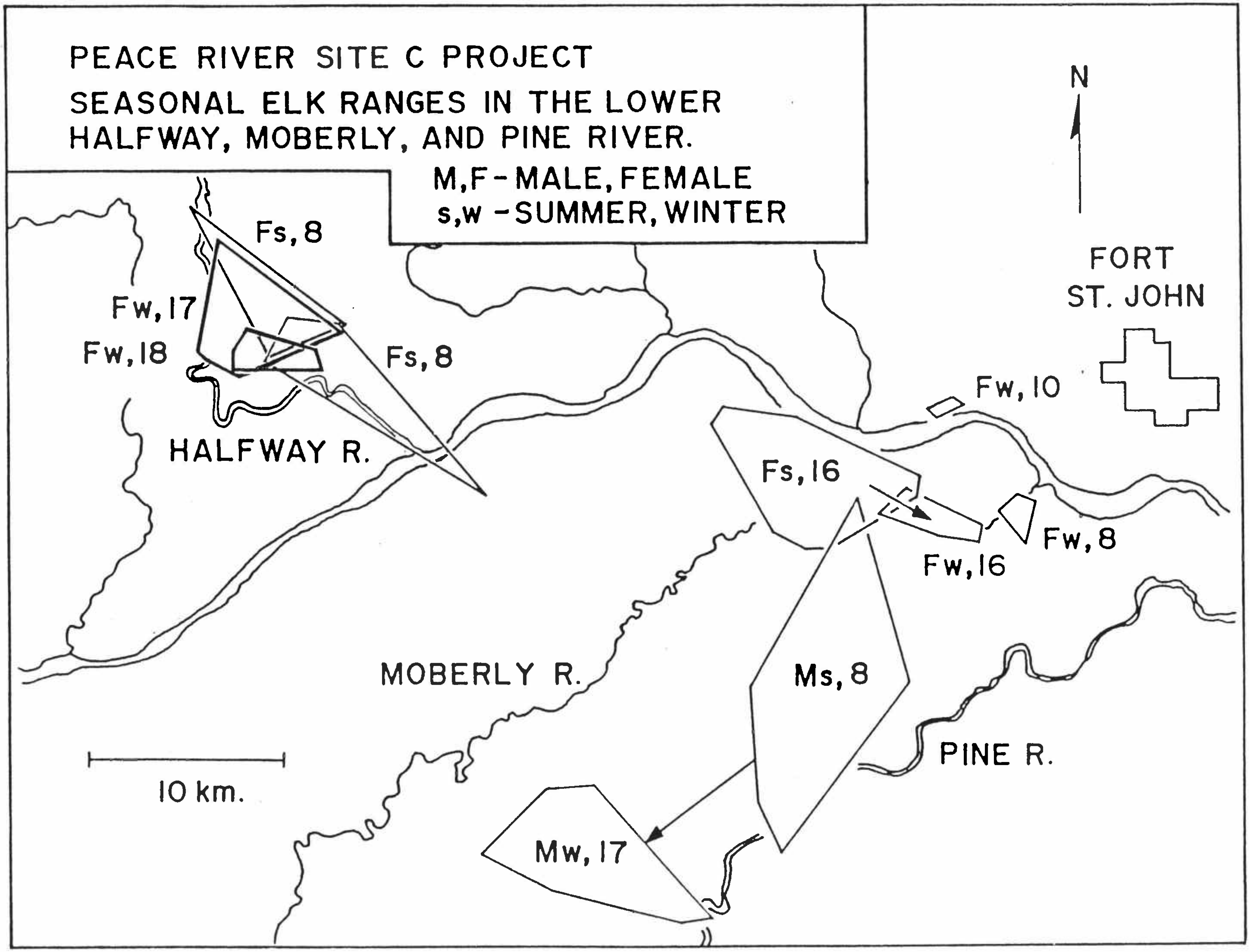

Figure 6. Seasonal ranges of elk captured from the Moberly and Halfway populations.

Table 4. Habitats used by 6 resident mule deer in summer (July - October) and 9 deer, including returning migrants, in winter (November - February).

SEASON	N	% OF RADIO LOCATIONS / HABITAT					
		Aspen Rose	Aspen Sask.	Sask. Whtgr	Cult. Field	Flood-plain	Other
Summer	76	24	29	3	25	18	1
Winter	221	19	20	24	14	20	4

Seasonal Habitat Use

Mule Deer

Habitat use data were available for summer locations of 6 resident deer within or near the reservoir area. Radio-collared deer were located most often in aspen forested habitats (AR, AS) or cultivated fields (CF) and 18% of all locations were within the flood zone (Table 4). Winter habitat use was assessed using 5 resident deer (1 was shot), 2 migratory deer and 2 deer captured in the flood zone in November. Use of the flood zone was . similar in winter (20%) although different animals contributed to the counts. There was a noticeable increase in use of south aspect breaks (saskatoon-wheatgrass) and slight decreases in use of aspen forests and cultivated fields.

Consecutive evening/night/morning locations were completed for 3 deer in summer and 6 in winter to determine if deer moved into the reservoir area after dark. No movement into the reservoir was noted (Table 5), however, many deer were seen in cultivated fields at night by using a spotlight.

Table 5. Use of the flood zone by mule deer during consecutive day and night locations.

Time	N	% In Reservoir	% Above Reservoir
Day	149	42	58
Night	72	42	58

Moose

Habitats used by moose in winter were assessed based on radio locations of 3 males and 11 females. Floodplains were used most often by cows (44% of locations) while bulls used aspen-saskatoon habitats most often (39%, Table 6). Since some of the aspen forests used by bull moose were below the flood elevation, bulls were actually located in the proposed reservoir area 32% of the time and cow moose 43% of the time (Table 7). Most collared moose were not accessible from the ground so only 35 night locations were obtained. Moose were found in the same areas after dark that they occupied the previous evening and following morning.

Elk

Elk habitat use, in summer, was based on data collected from 1 yearling bull and 3 cows. Two additional cows and a bull calf contributed to the winter locations. Aspen-rose habitats were the most consistently used, accounting for about 50% of year round locations (Table 8). Elk increased their use of south aspect slopes (aspen-saskatoon and saskatoon-wheatgrass) in winter and regularly used cultivated fields within their ranges at all times of year. Elk were rarely located below the flood elevation. Night locations were obtained only twice for a cow using the slopes south of the Peace River during the day. On both occasions the animal moved into the flood zone at night and back onto the higher slopes during the day. Subsequent ground investigations confirmed that the river bottom in that area was regularly used by elk.

Table 6. Winter habitat use by collared moose from December 1990 to February 1991.

SEX	N	% OF RADIO LOCATIONS / HABITAT: Aspen Rose	Aspen Sask.	Flood-Plain	Sedge Swamp	Pine forest
Male	38	32	39	21	8	0
Female	137	20	32	44	1	3

Table 7. Use of the flood zone by collared male and female moose in winter.

Sex	N	% below flood elevation	% above flood elevation
Male	38	32	68
Female	137	43	57

Table 8. Seasonal habitat use by collared elk from July 1990 to February 1991.

SEASON	N	% OF RADIO LOCATIONS / HABITAT: Aspen Rose	Aspen Sask.	Sask. Whtgr	Cult. Field	Flood-plain	Spruce Forest	Other
Summer-Fall	71	56	7	3	11	3	8	11
Winter	77	49	13	21	16	0	0	1

Note: Sask. = saskatoon, Cult. = cultivated, Whtgr = wheatgrass.
Spruce forest includes BP, BS and SB habitat units.
Other includes BD, PC, WB and WI habitat units.

Winter Snow Depths

Accumulated snow on the ground can restrict the movements of and habitats used by ungulates in winter. Snow depths approaching chest height on ungulates make movement difficult and most animals seek areas with less snow (Telfer and Kelsall 1979, Parker et al. 1984). Deer were the least tolerant of snow and avoided areas with depths exceeding 40 cm. The threshold depth for elk is 50 cm and for moose, 70 cm.

Snow depths, which exceeded 50 cm on upper slopes and plateau areas near the Peace River, probably precluded any use by deer and restricted use by elk in 1991. Snow depths were marginally lower in the valley bottom and lowest on south aspect river breaks and benches (Figure 7). Most deer and elk use would, therefore, be expected on the breaks while moose would have been largely unrestricted by snow in 1990-91.

Ungulate Census

The census was designed to estimate numbers of deer, elk and moose using the reservoir area in winter and the number of animals close-by which might be impacted by flooding of the bottomlands. Most of the land lost to flooding (76%) is located downstream of the Attachie slide. Only 14.5 km^2 of land would be flooded above the Attachie slide. The river breaks adjacent to the reservoir up to Attachie from Site C and the flood zone were thought to contain most of the deer and elk which might be affected by flooding. Moose ranged further on plateau areas but surveys were not extensive enough to sample populations in those areas.

Survey blocks from 4 to 10 km^2 were recently defined by MOE for a winter deer inventory in the south Peace subregion. We used the same blocks for our inventory but truncated the lower boundaries at the flood elevation and defined 6 new blocks within the flood zone. Our survey area included 29 blocks

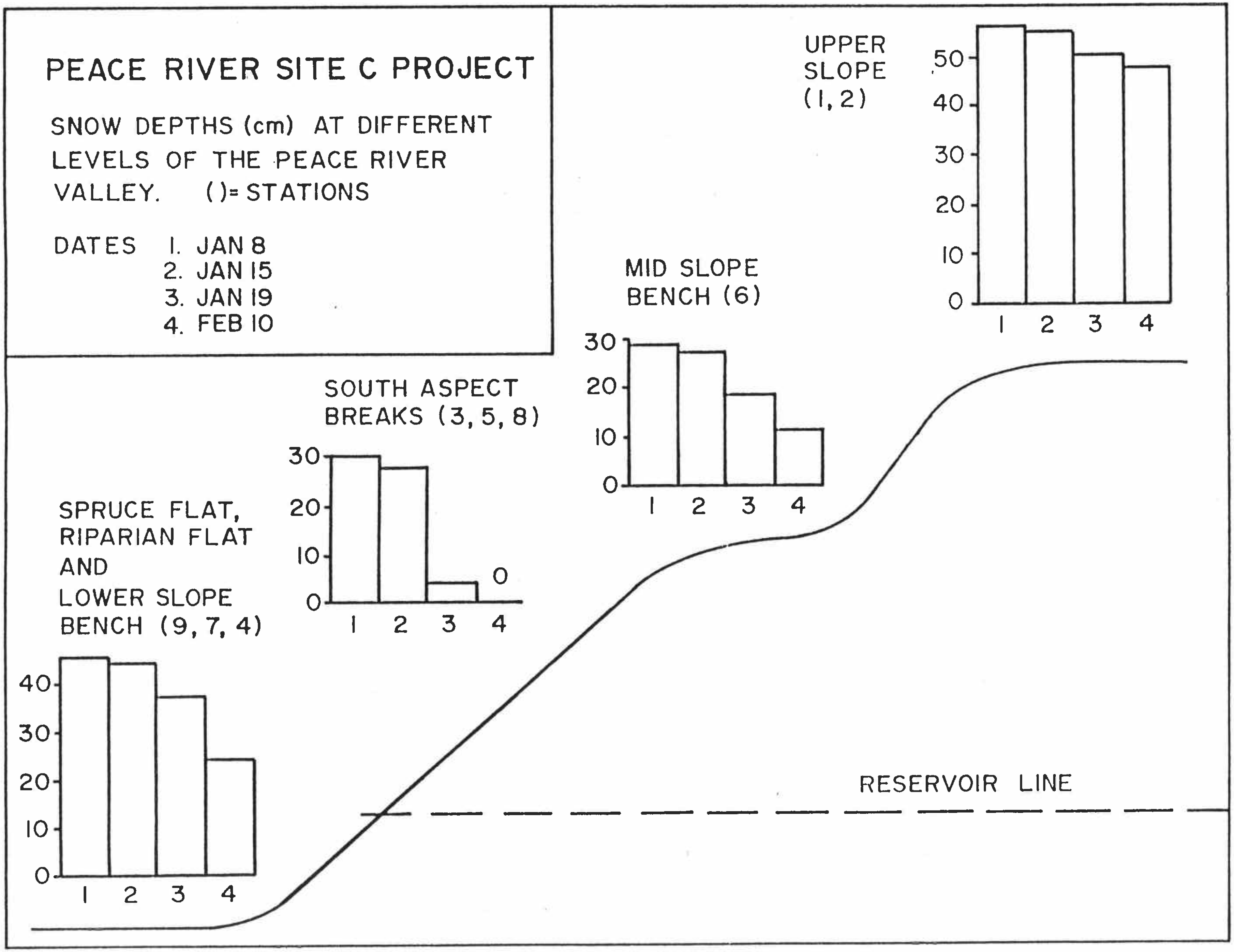

Figure 7. Mid-winter snow depths in different topographical locations within the Peace River valley and adjacent plateau.

covering a total of 180.8 km^2 in land area. Blocks 1-6 included all land within the reservoir (Figure 8). Blocks 7-20 included south aspect slopes along the Peace, Moberly, Cache and Halfway drainages. Blocks 21-29 included north aspect slopes along the Peace, Moberly and Cache drainages.

We stratified the sample blocks based on a January survey of the reservoir area when 342 mule deer, 142 moose and 2 elk were counted. Eighteen randomly chosen blocks were surveyed (Gasaway et al. 1986). Search time varied from 19 to 79 minutes depending on the block size, the density of cover and the number of animals encountered. In total 1,721 mule deer, 228 moose, 99 elk and 78 white-tailed deer were counted (Table 9). For the 6 blocks within the reservoir we counted 181 mule deer, 114 moose, 9 white-tailed deer and 7 elk. Population estimates in the survey area at 95% confidence were 307 ± 10% moose and 2533 ± 14% mule deer (Appendix VI, Reed 1989). Populations of elk and white-tailed deer could not be estimated from the available information.

Moose densities were similar for all strata (1.7/km^2 overall). Trends were noted for some areas. Densities appeared highest in deciduous river bottom habitats from the Moberly to the Halfway River (blocks 1-4, 2.1/km^2). Slightly lower numbers of moose were found on south facing breaks and evergreen dominated river bottoms upstream of the Attachie slide (blocks 5-20, 1.8/km^2) and fewer on north aspect breaks (blocks 21-29, 1.2/km^2). Mule deer were concentrated on south aspect breaks (33/km^2) with much lower densities in the reservoir (3/km^2) and north aspect breaks (4/km^2). Most elk were seen on the south aspect breaks along the Moberly River (69) and Cache Creek (22). White-tailed deer were also concentrated on the Moberly (42). Most other white-tails were seen close to agricultural land on the breaks north of the Peace.

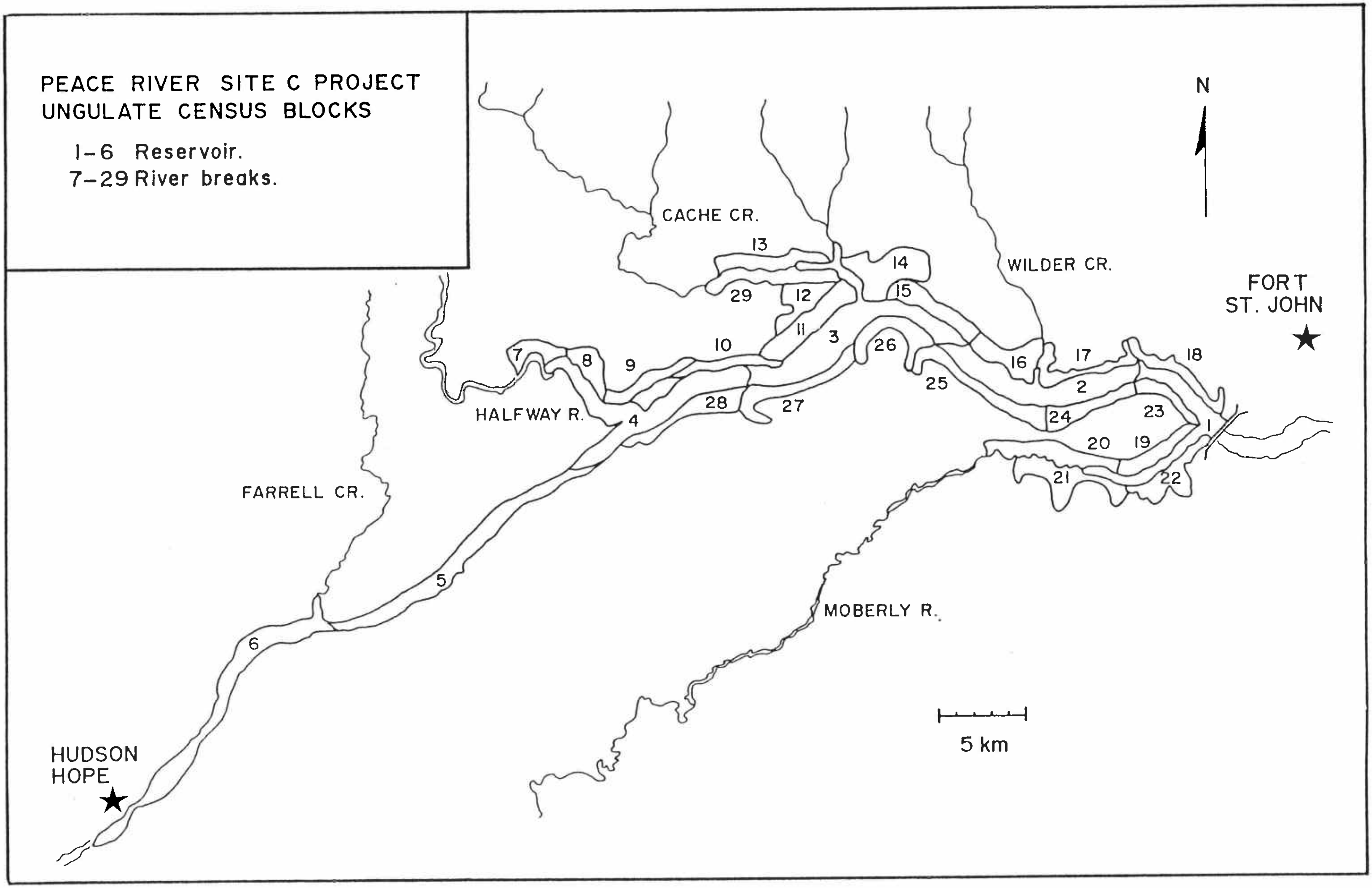

Figure 8. Survey blocks used to census deer, moose and elk in the Site C project area.

Table 9. Peace River Site C ungulate census, Feb 27 to Mar 1, 1991.

Block	Area	Search	Moose		Mule Deer		Wt	
#	km^2	(min)	Strata	#	Strata	#	Deer	Elk
Reservoir								
1	6.8	38	M	14	M	5		
2	11.3	57	H	25	M	21		5
3	14.5	79	H	35	M	33	5	
4	13.3	62	H	24	M	31	4	2
5	7.7	70	L	10	M	13		
6	6.8	64	L	6	M	78		
Sub-Total				114		181	9	7
South Aspect Breaks								
7	3.5		M		H			
8	2.3		M		H	(80)		
9	3.0	19	M	1	H	184		
10	3.2		M		H	(241)		
11	5.5		L		M			
12	5.5	32	M	18	H	293	7	
13	5.6	39	M	8	H	160	4	22
14	6.0	34	M	7	H	121	7	
15	7.3	68	M	13	H	260	8	
16	6.9		M		H	(72)		
17	5.8	37	M	4	H	248		
18	5.5		M		H			
19	4.1	29	M	7	H	64 (63)		50
20	6.0	61	M	17	H	114	42	19
North Aspect Breaks								
21	6.8		L		L			
22	5.2	59	M	14	L	52		
23	2.7		L		L			
24	5.5	22	L	8	L		1	
25	6.6		L		L			
26	5.5	33	L	9	L	35		1
27	5.9		L		L			
28	7.7	40	L	8	L	9		
29	4.3		L		L			
TOTALS	180.8	843		228		1721	78	99

( ) MOE count Jan. 28, 1991.

MOE also completed deer, elk and moose censuses in the Peace sub-region in December and January. Census blocks for deer were defined along the Peace River and tributaries (n=179) and 31 were sampled from January 24 to 29, 1991 (Appendix VII). The estimated mule deer population in the survey area was 8,739 ± 23% at 95% confidence. The highest block count (241) was obtained along the Peace upstream of Site C. We obtained higher counts (293, 260, 248) on three other blocks near the Site C flood zone. Elk were counted along the lower 25 km of the Moberly River on December 19, 1990. 84 were seen, including 46 cows, 20 calves and 18 bulls, in a 26 minute search. Moose were also censused on December 19 using line transects on the plateau south of the Peace River. Along 44 km of lines between the Peace and Moberly Rivers, 23 moose were seen, including 14 cows, 6 calves and 3 bulls. Assuming a transect width of 300 m, the density of moose in December was approximately 1.7 / km^2.

Sightability

Deer sightability has been estimated to be near 100% by MOE based on helicopter searches near the Beaton River where known numbers of collared deer were always seen. The Beaton study area is located on open south facing breaks where aspen and shrubs are the only cover (Figure 3). In the Site C study area, during 157 fixed-wing relocations of collared deer in winter, 43% were sighted. Fixed-wing searches result in lower sightability of deer than helicopter searches. In floodplain habitats, sightability from fixed-wing aircraft declined to 24% (n=33), and in areas with significant conifer cover, deer were seen only 17% of the time (n=12). This data suggests that numbers of deer using river bottom habitats, particularly spruce forests, were substantially underestimated by our census. Obtaining an accurate correction factor would require more intensive trials using helicopter searches for collared animals in river bottom habitats. With the current information we estimated that approximately 50% of the deer present in the flood zone and on north slopes were counted and that 100% were seen on south aspect breaks. Deer in the flood zone were, therefore, estimated at 360 animals.

Moose sightability was also assessed based on sightings during fixed-wing radio location flights. Collared moose were seen 100% of the time in shrubland (n=21), 60% in deciduous forests (n=135) and 30% in coniferous forest (n=30). Three of 4 collared moose known to be within our census blocks were seen during our helicopter searches, all in deciduous forests. Sightability of moose from helicopters should be similar to deer in deciduous forests in winter but probably declines to 50% in areas with significant coniferous cover. This would increase the number estimated in the flood zone from 114 to 146.

Elk tend to have greater sightability than deer or moose because they occur in large groups within limited areas and are most often found in open habitats. Both collared elk within our census area were seen during the helicopter searches. Two small groups (2 and 5) were seen in forested reservoir areas and a single bull was seen in mixed forest south of the Peace. Elk distributed in small groups and dense cover would certainly be underestimated but adequate corrections are difficult to estimate with the available data.

Ungulate Population Trends

Mule deer numbers are currently much higher than previously recorded. Average winter densities in the Peace valley upstream of Site C never exceeded 2.4 $/km^2$ before 1982 (Blood 1991). The mean winter density in the Peace was 5.6 $/km^2$ in the late 1980's with maximum densities on some blocks of 10 deer $/km^2$. In 1991, the average winter density in the Peace valley was 14 $/km^2$ with a maximum density of 53 $/km^2$. Current deer densities are approximately 5 to 6 times higher than the maximum recorded in the 1960's or 1970's.

Long term data on moose abundance and harvest indicate that populations have remained fairly stable (Blood 1991). Winter densities in the Peace River valley have varied from 0.7 to 3.4 /km^2 and counts varied from 164 to 574 (Blood 1991). The highest count was obtained in February 1982 when snow depths on the plateau exceeded 75 cm. Recent counts within the reservoir area of 142 and 114 moose and the estimated population in the Peace River valley of 307 are certainly within the range of previous counts although the area surveyed was somewhat smaller in 1991 (181 vs 250 km^2). Densities calculated from 1.2 to 2.1 moose /km^2 are also similar to previous estimates.

Elk numbers appear to be increasing steadily and groups have been found in more locations each winter. In 1991, 84 were counted on the Moberly, 68 on the Pine, 75 on the Halfway, 22 on Cache Creek and 8 at various locations along the Peace between the Moberly and Halfway Rivers. Although this total (257) is somewhat less than 275 recently estimated by Blood (1991), they are distributed over a wider area and no systematic attempt was made to search for elk in all the areas that they occur. Movement data from radio-collared elk shows that ranges of animals in the main population areas (Pine, Moberly, Halfway) probably overlap. Interchange between these populations may account for the annual variation in numbers and distribution of elk.

White-tailed deer have been recorded regularly during most MOE censuses. On 24 surveys since 1965 the mean number of white-tails seen was 5 per 100 mule deer (Blood 1991). On our 1991 survey we counted 4.5 white-tails per 100 mule deer. Given the substantial increases in numbers of mule deer we suspect that numbers of white-tails must be increasing at a similar rate to maintain the same ratios.

Importance of the Proposed Reservoir to Ungulates

Importance of lands to ungulates can be assessed based on season of use, purpose of use and amount of use. Areas occupied in winter and lands supporting reproduction are generally considered critical to ungulate populations. Areas occupied for extended periods may also be important.

Elk and white-tailed deer were rarely seen in the reservoir area and radio-tracking data showed that elk only occasionally used riparian habitats. Moose and mule deer were present in the reservoir area in larger numbers during the winter and it was the highest use component of winter habitat for cow moose. Moose also used the plateau and river breaks. In most years with the average 50 cm of snow on the plateau, moose would be largely unrestricted in their choice of winter range. In deep snow years, south aspect river breaks provide the lowest snow environment. Habitats on steep south aspects are essential to deer and elk in most years but would be critical to moose only in years with above average snow accumulations. North aspect breaks and some river islands support spruce forests which may also provide snow shelter for moose in severe winters. High snow depths in the river bottom lands would likely preclude any use by deer or elk in severe winters.

River islands were also used by mule deer does and fawns in summer. Islands may provide safe birth sites and/or rearing areas for young deer and moose. Two moose and one mule deer moved to river islands for calving/fawning in June 1991. Five collared elk moved to riparian flats in April and May 1991. Further data are currently being collected. The extent and timing of use of islands and riparian flats in the proposed reservoir area by deer, moose and elk needs further investigation to determine the importance of river bottom habitats in seasons other than winter.

PROJECT IMPACTS on WILDLIFE

Quantification of Habitat Losses

Biophysical habitat mapping was completed for 4 complete map sheets and one partial sheet within our study area (Figure 9). The mapped area included the entire winter range of radio-collared moose, elk and deer captured in the project area. Some migratory deer did move outside of the mapped area in summer. Moose were widely distributed in winter 1990 and probably had access to all suitable habitat units within the mapped area. Elk occurred more sporadically but we assumed that most suitable habitats were also available to elk in the mapped area. Deer were restricted to low snow habitats in winter. Deer moved to these areas in fall prior to heavy snowfalls when their movements were not restricted. For purposes of quantifying the significance of habitats which may be lost to flooding, we assumed that all suitable habitats within the mapped area were available to ungulates.

Excluding lakes and rivers the mapped area included 384,753 ha. The proposed reservoir comprised of 7246 ha of this total area (1.9%, Table 10). In order to assess the local significance of habitat losses in the proposed reservoir, we compared the number of hectares lost to the number available in the mapped area for each habitat type. The most significant losses occurred in the spruce-poplar floodplain. Floodplain habitats accounted for the greatest area lost in a single habitat type (4263 ha) and losses comprised a significant portion (39.6 %) of similar habitat available in nearby areas. Losses in the saskatoon- wheatgrass habitat which represented only a small area (251 ha, 4.3 %) were significant because of their limited availability in

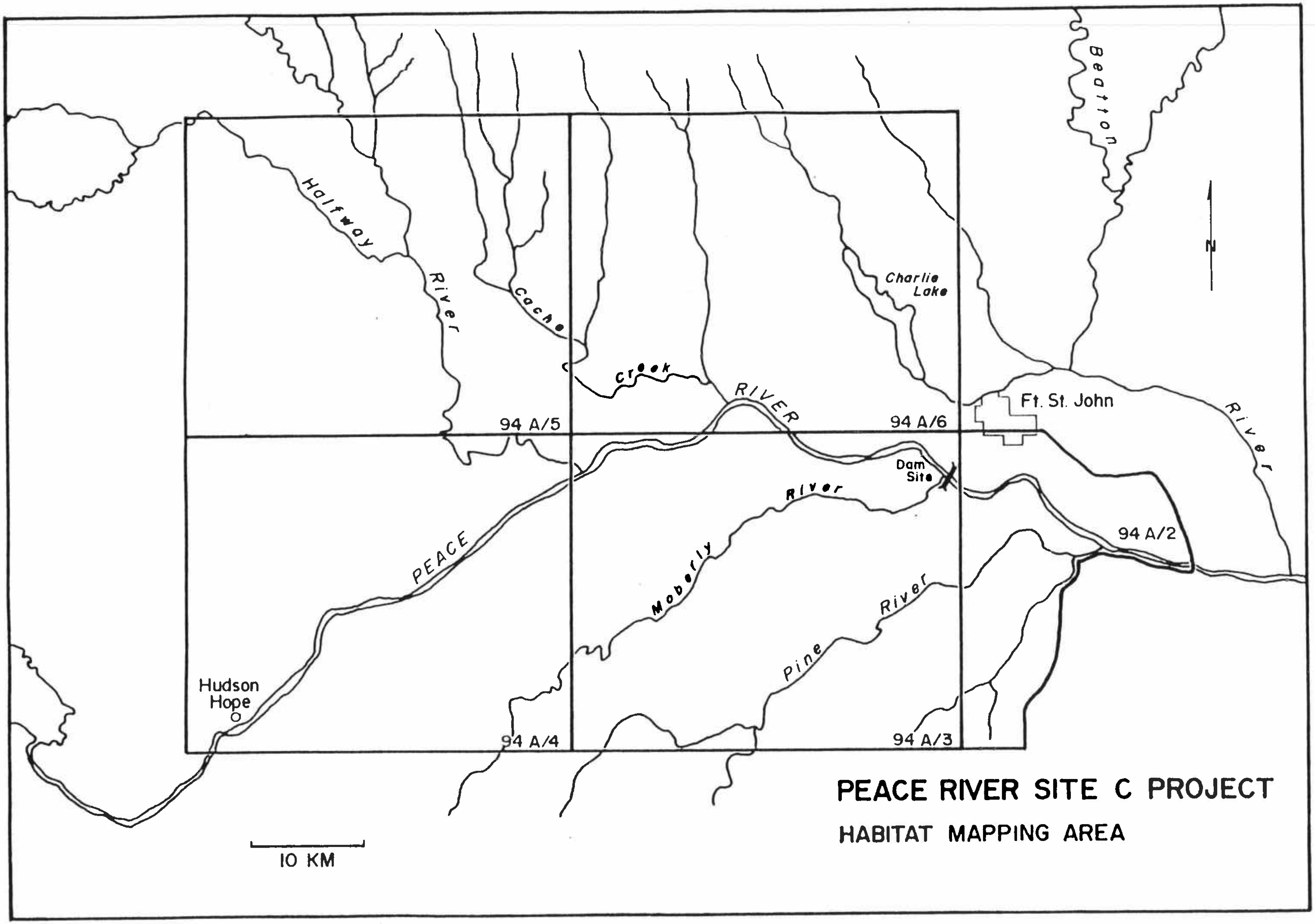

Figure 9. Topographical sheets where biophysical habitat mapping was completed in the project area.

Table 10. Habitats available within the mapped portion of the study area and potential losses below the flood elevation.

Habitat type	Total area (ha)	Flood zone (ha)	% loss
SP Spruce-poplar floodplain	10837	4263	39.3
South Breaks			
ARc Aspen rose crest	4607	0	0
ARr Aspen rose ridge	7972	0	0
AS Aspen saskatoon	22775	399	1.8
SW Saskatoon wheatgrass	5894	251	4.3
CF Cultivated field	43187	587	1.4
Sub-total	84435	1237	1.5
North Breaks			
BD Birch dogwood	18558	323	1.7
LS Lodgepole pine-soopolallie	16946	80	0.5
PC Poplar-cranberry	28145	642	2.3
Sub-total	63649	1045	1.6
Plateau			
AR Aspen rose	103857	514	0.5
SB White spruce-bunchberry	55968	41	0.1
SS Scrub birch-sedge fen	35428	13	0.04
WI Willow swamp	1181	0	0
WB Willow-bluejoint swamp	1412	0	0
Other (Barren, Black spruce bog, Rock, Black spruce upland)	27986	133	0.5
Sub-total	225832	701	0.3
TOTAL	384753	7246	1.9

the mapped area (5894 ha). Losses to 5 other habitat units were more extensive (399-642 ha - Table 10) but those habitats were also more common in adjacent areas making the proportion lost less significant (0.5-2.3 %).

Wildlife Population Effects

In order to estimate the potential effects of habitat losses on wildlife populations we identified key habitats for each species based on radio-tracking and survey information. Population densities for key habitats were estimated based on survey information for ungulates. It is likely that in winters with greater snow accumulations, observed densities on key habitats may increase as ungulates, especially moose, are excluded from fringe habitats. Existing densities best represent current losses which may result from flooding, however, actual losses will depend on the population status for each species when the project is completed. Densities for furbearers were obtained from the literature and from surveys for beavers. We assumed that all animals occupying key habitats were dependant on that land base for survival and would be lost after flooding. Some species including wolf, fox, wolverine, mink and otter occurred infrequently or not at all during our surveys. We did not attempt to estimate losses for those rarely occurring species. More extensive sampling would be required to provide meaningful estimates.

Mule Deer and Elk

Mule deer and elk were restricted primarily to south aspect breaks in winter. Some were counted in floodplain and north aspect habitats during census surveys but those areas had limited capability to support deer or elk through the winter because of snow depths. Cultivated fields were also extensively used by deer and elk, however, their capability to support wildlife was primarily related to availability of livestock feed, mainly hay or grain. Although cultivated fields are important "habitats", management by owners influences wildlife use much more than areal extent or relative availability. Key winter range habitats for mule deer and elk were SW, AS and ARc types (Table 11).

Table 11. Wildlife losses based on estimated animal densities and losses of key habitats.

Species	Key Habitats	Habitat % lost	Habitat km^2 lost	Species # / km^2	Species # lost
Mule deer	SW, AS, ARc	1.9	6.5	33	214
Elk	SW AS ARc	1.9	6.5	1.3	8
Moose	SP AS ARc ARr BD PC	6.1	56.3	1.7	96
Beaver	SP	39.3	42.6	8.9	347[a]
Lynx	BD SS SP	7.1	46.0	.27[b]	12
Fisher	BD SB SS SP AR	0.2	51.5	.03[c]	2
Marten	BD AR SB SP	0.3	51.4	0.3[d]	15
Weasel	BD AR SS SP	0.3	12.8	0.2[c]	3
Coyote	SW SP AS BD	9.0	52.4	0.2[d]	10
Red squirrel	SP LS SB BD	4.6	47.1	200[e]	9414
	AS ARc ARr PC AR	0.9	15.6	50[e]	780

a. see text.
b. Brand et al. 1976, B.C. Fish and Wildlife Br. 1980a.
c. B.C. Fish and Wildlife Br. 1979.
d. B.C. Fish and Wildlife Br. 1980b.
e. Rusch and Reeder 1978.

Winter range densities for mule deer and elk were estimated from Table 9. For mule deer, the current density may be above the long term capability of the area. Elk densities may increase in the future. Probable mule deer and elk losses based on reductions in key habitats after flooding were 214 deer and 8 elk (Table 10).

White-tailed deer also occurred in the study area but information on their winter habitat use was not available, so no assessment of the effects of flooding was possible. It is suspected that they are more dependant on forest-cultivated land complexes than mule deer or elk. Two have been recently radio-collared to better define habitat use patterns.

Moose

Radio-collared moose occupied nearly all available habitats in the study area in winter 1990-91. Snow records indicated that snow depths frequently exceed the tolerance of moose on plateau habitats. During deep snow periods most moose would be restricted to valley slopes and floodplain habitats. Key winter range habitats for moose were defined as SP, AS, ARc, ARr, BD and PC (Table 10).

Overall moose densities in those habitats averaged 1.7 $/km^2$ in winter 1990-91. Higher densities up to double that figure have been recorded in deep snow years. Not all moose using the proposed reservoir would be lost after flooding because they do use large areas above the flood elevation. Probable moose losses resulting from flooding were estimated at 96 animals.

Beaver

The beaver population in the proposed reservoir area was restricted exclusively to spruce-poplar floodplain habitats. The estimated density was $8.9/km^2$. Virtually all of the existing habitat would be eliminated after flooding. New habitats would be available for colonization by beavers along the edge of the newly formed reservoir. The beaver population would not be eliminated but would be substantially reduced since all of the productive edge habitat currently available along braided river channels would be replaced by single narrow bands of reservoir edge habitat. Much of the reservoir edge will be along steep slopes or evergreen forested banks unsuitable for beavers. Productive edge habitats (AR, AS, SP, BD, PC) within 100m of the reservoir edge were estimated from habitat mapping to be 4 km^2. This area would support approximately 33 beaver, so net losses from flooding would be 347 beaver.

Other Furbearers

Tracking data for other furbearers including lynx, fisher, marten, weasel and coyote was used to define the habitats occupied by each species (Table 10). Habitats used by red squirrels and densities of all species were obtained from literature for the Peace Region or central Alberta. For lynx which have distinct cyclic abundance maximum densities were used to calculate losses. Where a range of densities was specified, maximum densities were also used. Figures quoted should, therefore, represent maximum expected impacts on furbearer populations (Table 10).

Furbearer densities other than squirrels are relatively low so expected losses were minor compared to larger species which concentrate in the project area during winter. Mink and otter which are dependant on riparian habitats may be more significantly affected as were beavers, however, inventory methods did not adequately represent their abundance or habitat use in the project area.

Reproductive Habitats

The proposed reservoir area, particularly the river islands, may be important calving /fawning areas for moose, deer and elk. Radio-collared animals have provided information on the relative importance of habitat units to ungulates in winter but not in spring and early summer when young are born. Moose are known to be particularly sensitive to habitat disruption and substantial reductions in reproductive success have been documented in one population where range use was altered by highway construction (Simpson and Gyug 1991). Characteristics of birthing areas should be documented and the potential effects of the reservoir on reproduction should be assessed. This effect could be more significant than winter range losses because equivalent valley bottom habitats, particularly large river islands, are not readily available in the project area outside of the flood zone.

Other Ecological Changes and Impacts

Prior to construction of the Bennet dam, the Peace River froze solid every year. Moose and other animals regularly crossed the river in winter (B. Churchill - personal communication). Now the Peace River is free flowing all winter and crossings by ungulates are infrequent. No collared animals have crossed the river in winter although several crossed in summer. Additional tracking data will determine if open water is a barrier to movement of the collared animals in winter. Open water and the ice shelves which form along the shore may prevent crossings in winter. Open water also causes valley fog which could reduce the insolative value of south aspect slopes in the Peace River valley (Blood 1979). Deer populations have not been affected by increased fog in the valley, however.

If the valley bottom was flooded, access to alternate habitats may be important for displaced animals, particularly moose. In deep snow winters, many animals south of the Peace may attempt crossing to reach low snow habitats on the south aspect breaks. Current information suggests that the Site C reservoir will freeze in winter but that open water or thin ice may prevail near the center. A solidly frozen reservoir would provide necessary movement opportunities while a partially frozen lake may result in many drownings.

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Appendix I. Radio frequencies, ear tags and measurements of mule deer captured in the Site C project area 1987-1990.

Date YYMMDD	Freq.	I.D.	Left Ear	Right Ear	Sex	Total Length	Chest Girth
Beaton River (MOE)							
870102	0.510		Prp 324	Prp 323	F		106
870129	9.057	F	Grn 269	Grn 268	F		110
870130	8.751	G	Grn 257	Grn 267	F		106
870131	8.810	H	SHOT OCT 1987		F		109
870202	8.540	I	Grn 294	Grn 295	F		109
870204	8.600	J	SHOT NOV 1988		F		104
871223	8.810	N	Prp 313	Prp 314	F		
871229	9.150		DEAD NOV 1988		M		
871230	0.470		Wht 301	Wht 302	M		99
880106	8.641	K	Prp 301	Prp 302	F		97
880106	9.140	L	Prp 308	Prp 307	F		
880106	9.220	M	Prp 317	Prp 318	F		104
Lower Cache (MOE)							
870228	9.190	F1	Grn 276	Grn 275	F		
870307	9.111	F2	Grn 278	Grn 277	F		
870312	9.171	F3	Grn 25	Grn 24	F		
870315	9.181	F4	Grn 16	Grn 17	F		
870306	9.122	F5	DEAD MARCH 27, 1987		F		
890218	9.514	WTT	Red 52	Red 52	F		
890216	9.505	RBB	Red 39	Red 39	F		
890219	9.534	HGG	Red 58	Red 58	F		
890224	9.384	M1	SHOT NOV 4, 1989		M		
890223	9.150	F6	Red 66	Red 66	F		
890223	9.524	F7	DEAD		F		
890307	9.298	M2	Red 77	Red 77	M		
Highway 29 (B.C. Hydro)							
900726	8.705	BSS	SHOT OCT. 25, 1990		M		
900815	8.725	UDD	Yel G3-11		F	175	98
900817	8.744	STA		Red 99	M	167	94
900817	8.765	NYM	Blu 99		F	151	87
900817	8.785	SLL		Red 100	M		
901124	8.705	SPP			F		
901125	9.905	TDD			F		

Appendix II. Seasonal home range sizes for migratory mule deer in lower Cache Creek, 1987 to 1991.

	Female						Male
	F1	F2	F6	F7	F8	F9	M1
Summer							
km^2	2.3	3.1	13.0	3.7	0.2	4.6	0.2
N	4	21	7	7	3	6	6
months	3	15	5	4	2	4	2
Winter							
km^2	2.3	3.0		0.7	4.7	6.6	
N	23	22	2	3	39	38	2
months	19	16	2	2	7	7	2

Appendix III. Home range sizes for resident mule deer in lower Cache Creek, 1987 to 1991.

	Female							Male			
	F3	F4	RBB	NYM	UDD	SPP	TDD	M2	BUS	STA	SLI
Summer											
km^2	6.2	3.9	3.4	0.6	0.9			2.0	5.0	0.4	5.6
N	24	23	15	7	11			7	7	10	7
months	14	14	6	3	3			2	3	3	3
Winter											
km^2	3.1	6.7	1.6	1.4	5.0	0.7	0.6		1.9	10	2.8
N	21	24	25	22	21	25	23	2	5	17	22
months	15	18	7	5	4	4	4	2	2	5	5
Annual											
km^2	6.6	7.9	4.0	1.4	13.9			2.2	50	115	5.6
N	45	47	40	29	32			9	12	27	29
months	26	28	12	7	7			2	4	7	7

Appendix IV. Home range sizes for resident mule deer in the lower Beaton River, 1987 to 1989.

	F	G	H	I	J	K	L	M	N
Summer									
km^2	3.1	4.7	0.8	4.5	5.5		0.2	2.5	1.9
N	17	15	6	17	9	3	13	4	12
months	10	10	5	10	8	2	6	6	6
Winter									
km^2	3.6	12.5	0.7	7.3	2.4	0.8	0.9	1.7	2.9
N	28	31	8	28	15	15	18	18	12
months	19	19	5	17	10	9	11	11	7
Annual									
km^2	4.1	13.2	1.2	8.5	7.6	0.9	0.9	3.8	3.1
N	45	46	14	45	25	18	31	22	24
months	24	25	8	24	15	10	15	15	12

Appendix V. Radio frequencies, ear tags and measurements of elk and moose captured in the Site C project area 1990-1991.

Date YYMMDD	Freq.	I.D.	Left Ear	Right Ear	Sex	Total Length	Chest Girth
Elk (Moberly R., Halfway R., Wilder Cr., Cache Cr.)							
900724	8.605	BBA		Grn 40	M (yrlg)		
900724	8.624	NBA	Blu 100		F	236	144
900819	8.644	ALL	Wht 49	Wht 50	F		
900819	8.684	RCC	Grn 42	Grn 43	F		
910104	8.664	GMM	Prp 40	Prp 41	F		
910104	8.338	SQQ		Grn 31	M (calf)		
910104	8.058	JOO	Blu 216		F		
910104	8.319	DBB		Wht 321	F		
910302	8.268	PNE		Wht	F		
910324	8.239	CCH			F		
Moose (Peace R., Moberly R.)							
901213	9.654	BGG	Prp	Yel	F	290	198
901213	9.663	SNO	Wht 328	Red 68	F	285	188
901213	9.673	MLL	Wht 358	Wht 359	F	279	200
901214	9.683	BFL	Grn 300	Prp 355	F	270	
901214	9.693	DUU	Yel	Wht 360	F	274	
901214	9.703	KMS	Prp 357	Wht 357	M	282	175
901214	9.713	TFF	Yel	Yel	M	274	169
901214	9.723	HFF	DEAD Jan 25, 1991		F	297	190
910111	9.735	MBB	Red 60	Yel	F	258	179
910111	9.745	TCK	Prp 356	Red 64	F	292	186
910111	DIED				M	279	177
910111	9.775	HLL	Red 57	Red 21	F	254	190
910111	9.755	RVV	Yel	Grn 49	M	255	175
910111	9.785	ATT	Prp 359	Prp 358	F	272	182
910111	9.765	FRR	Grn 25	Wht 327	F	278	192
910301	9.795	LDI	Grn 298	Grn 297	F	279	197
910301	9.723	BDR	Red 86	Red 86	F	297	

Appendix VI. Estimated populations for moose and deer in the Peace Site C study area based on stratified block counts .

	STRATA			
	high	medium	low	TOTAL
Moose Inventory				
N	4	14	11	29
Total area	45.9	69.9	65.0	180.8
n	4	9	5	18
Area surveyed	45.9	48.5	33.2	127.6
# seen	98	89	41	228
Density	2.1	1.8	1.2	1.7
Total observed	98	128.3	80.3	306.5
Variance	0.0	170.6	38.2	208.7
df	3	8	4	11

Total estimate Te = 306.5   Variance V(Te) = 208.74   df(Te) = 11

80% CI around Te = (299.0, 347.1) is +/- 7.45%
90% CI around Te = (280.6, 332.5) is +/- 8.46%
95% CI around Te = (274.7, 338.3) is +/- 10.37%

	high	medium	low	TOTAL
Deer Inventory				
N	13	7	9	29
Total area	64.7	65.9	50.2	180.8
n	11	6	4	21
Area surveyed	55.7	60.4	23.9	140.0
# seen	1837	181	96	2114
Density	33.0	3.0	4.0	14.0
Total observed	2133.8	197.5	201.6	2532.9
Variance	19288.7	818.6	6874.4	26981.7
df	10	5	3	14

Total estimate Te = 2532.9   Variance V(Te) = 26981.7   df(Te) = 14

80% CI around Te = (2312.0, 2753.9) is +/- 8.72%
90% CI around Te = (2243.7, 2822.2) is +/- 11.42%
95% CI around Te = (2180.6, 2885.3) is +/- 13.91%

Appendix VII. Ministry of Environment regional mule deer census January 24 - 29, 1991.

Block #	Location	Area (km^2)	Search (min.)	Strata	Mule Deer	Wt Deer	Elk
2	Alces R.	6.0	28	H	129	7	
16	Peace R.	6.4	20	H	93		
45	Trueman Cr.	6.9	25	H	53	4	
52	Peace R.	5.8	26	H	26		
56 (19)	Moberly R.	4.9	17	H	63		
17	Peace R.	6.2	28	H	82		
78 (16)	Wilder Cr.	8.8	27	H	72		
79 (10)	Peace R.	4.9	22	H	241		
82 (8)	Halfway R.	3.1	15	H	80		
125	Cache Cr.	9.2	25	H	100		
151	St. John Cr.	5.4	16	H	92		
153	Stoddart Cr.	1.9	5	H	5		
161	Beaton R.	5.1	20	H	94		
1	Peace R.	4.1	16	M	34	16	
27	8 Mile Cr.	6.5	25	M	58		
41	Kiskatinaw	5.6	13	M	51		
75	Peace R.	6.1	21	M	45	2	
88	Moberly R.	4.6	17	M	28	3	68*
96	Pine R.	6.0	12	M	14		
120	Cache Cr.	5.4	13	M	35	6	
122	Red Cr.	5.5	24	M	101		
146	Stoddart Cr.	3.9	12	M	45		
176	Beaton R.	5.0	15	M	44		
70	Septamus Cr.	5.1	18	M	37		1
23	Beaton R.	5.3	12	L	19		
24	Beaton R.	5.6	16	L	16		
44	Kiskatinaw	5.9	18	L	33		
92	Moberly R.	6.3	29	L	2		
101	Pine R.	6.1	20	L	6		
166	Beaton R.	9.3	37	L	34	7	
169	Beaton R.	2.7	10	L	19		

High strata 13/58 blocks (74.6/337.2 km^2) sampled.
Medium strata 11/47 blocks (57.8/256.9 km^2) sampled.
Low strata 7/74 blocks (41.2/477.1 km^2) sampled.

( ) Site C inventory block number.
* elk counted in Moberly and Pine in 3.8 hours.