HABITAT INVENTORY OF THE YUKON FLATS AS POTENTIAL WOOD BISON RANGE

Alaska Department of Fish and Game
Division of Wildlife Conservation
March 1995

Photo by C. Gates

Maria Berger
Alaska Cooperative Fisheries and Wildlife Research Unit
University of Alaska Fairbanks

Robert O. Stephenson
Alaska Department of Fish and Game
Fairbanks, Alaska

Paul Karczmarczyk
Alaska Department of Fish and Game
Delta Junction, Alaska

C. Cormack Gates
Government of the Northwest Territories
Fort Smith, NWT

STATE OF ALASKA
Tony Knowles, Governor

DEPARTMENT OF FISH AND GAME
Frank Rue, Commissioner

DIVISION OF WILDLIFE CONSERVATION
Wayne L. Regelin, Acting Director

This report was prepared by:

Alaska Department of Fish and Game
1300 College Road
Fairbanks, Alaska 99701-1599
(907) 459-7213

TABLE OF CONTENTS

HABITAT INVENTORY OF THE YUKON FLATS

AS POTENTIAL WOOD BISON RANGE

SUMMARY

A habitat inventory of meadows on the Yukon Flats identified several large areas suitable for year-round use by wood bison (Bison bison athabascae). Extensive areas of wet and dry meadows support plant communities that are similar to existing wood bison range in northern Canada, including substantial amounts of preferred forage species.

In the Birch Creek intensive study area southwest of Fort Yukon, a combination of wet and dry graminoid meadows interspersed with white spruce and mixed forest would provide excellent year-round habitat for wood bison, with good summer and winter forage availability. Similar habitat was found in less intensively studied areas north of Chalkyitsik and in the Bearman Lake area northwest of Venetie Landing.

Bison forage is also abundant adjacent to the Black River east of Fort Yukon and in a less intensively studied area north of Fort Yukon, but relatively wet conditions could limit summer foraging by bison in some parts of these two study areas.

Conventional forage models and a qualitative comparison with other wood bison habitat indicate that the two intensively studied areas could support at least 2,000 wood bison. Substantial additional bison habitat exists in three less intensively studied areas as well as on lands adjacent to the western boundary of the Birch Creek area.

INTRODUCTION

A preliminary evaluation of the Yukon Flats for suitability as wood bison habitat was conducted in August 1992 by Cormack Gates, a bison ecologist with the Northwest Territories Department of Renewable Resources and chairman of the Wood Bison Recovery Team. He found that floristic composition of meadows in the Yukon Flats strongly resembled meadows used by the Mackenzie and Slave River lowlands wood bison herds and also bison habitat in Wood Buffalo National Park (Gates 1992). He suggested more intensive studies to quantify plant species composition and forage availability. In 1994 the Alaska Department of Fish and Game (ADF&G) undertook a detailed habitat inventory in two areas on the Yukon Flats and examined three other areas more extensively for potential as wood bison range. This study was supported by Alaska Federal Aid in Wildlife Restoration Project W-23 and by ADF&G, the University of Alaska, and Government of the Northwest Territories. We are grateful to the Fish and Wildlife Service, Doyon Limited and the villages of Beaver and Birch Creek for permission to conduct studies on their lands.

STUDY AREA

Two intensively studied areas were located southwest and east of Fort Yukon, respectively (Fig. 1). The Birch Creek study area is bounded by the Yukon River on the north, the lower mouth of Birch Creek on the south, and the winter trail between Birch Creek and Fort Yukon on the east. It encompasses 410 mi^2 (1,066 km^2 or 262,400 acres). The Black River study area is bounded by the Black River and lower Porcupine River on the north, and the Sucker River on the south. Tiinkdhul Lake is at the eastern boundary. This area totals 633 mi^2 (1,646 km^2 or 405,120 acres).

Figure 1 shows three additional areas in which we conducted preliminary surveys for potential bison range. The Scotty Lake study area is located between the Black River and the Porcupine River north of Chalkyitsik, south of Shuman House and Joe Ward camp. The Shovun Lake study area is between the Porcupine, lower Sheenjek and Chandalar Rivers. The Bearman Lake study area is north of the Yukon River, between the lower Hadweenzic and Chandalar Rivers.

The Yukon Flats is a level plain covering several thousand km^2 adjacent to the Yukon River. The area is a Holocene floodplain made up of 5-6 m of horizontally interbedded calcareous sands and silts with commonly redeposited organic layers and occasionally underlain by river gravels. Soils throughout much of the area are pedocal, containing many alkaline, calcium compounds. Potential evapotranspiration is 38 cm, exceeding the mean annual precipitation of 16.5 cm of water equivalent per year. Because of this deficit, no leaching occurs and alkali flats are found in some dry areas (Farjon and Bogaers 1985).

Thermokarst lakes (formed by local thawing of permafrost) in varying stages of development are common in a large area which is slightly elevated above the active floodplain (Farjon and Bogaers 1985). Meadows are usually associated with thermokarst lakes or with oxbow lakes and meander scars formed by riverine disturbance. Alkali flats are commonly associated with drying thermokarst lake beds.

METHODS

The general distribution of potential wood bison habitat on the Yukon Flats was determined by examining high altitude infrared photos combined with our familiarity with the locations of major meadow systems. The most extensive meadow habitat is located at low elevation in an area of about 4,000 mi^2, encompassing the flats north and south of the Yukon River from the vicinity of Beaver on the west to Chalkyitsik on the east. Aerial and ground reconnaissance in August 1992 showed that meadow habitat at higher elevation outside this general area was limited and of poor quality for bison, while plant species composition and other characteristics of low elevation meadow habitat were suitable for wood bison (Gates 1992).

The first step in this habitat inventory was to map all meadows 5 acres or larger on 1:63,360 topographical maps produced in the late 1950s. NASA color-infrared high altitude photographs taken between 1978 and 1980 were used to map more recent changes in lake beds and meadows.

Because many meadows, especially those associated with thermokarst lake beds, show a drying trend, mapping the changes in their extent gave a more accurate estimate of their current area and simplified locating them in the field. The size of each meadow was calculated using a dot grid.

We could not visit all meadows mapped within the two main study areas. Therefore, we attempted to visit all large meadows (200 acres or larger) and randomly sampled one-eighth of the remaining smaller meadows (<200 acres) in each study area. By incorporating random sampling into our study design and sampling enough meadows, we could extrapolate from the meadows visited to all meadows in each study area.

A total of 431 meadows were mapped in the Birch Creek area southwest of Fort Yukon. Of these, 21 were large (200 acres or greater), and 410 were smaller than 200 acres. We were able to sample 14 (17 locations) of 21 large meadows and 43 of 51 randomly chosen small meadows.

A total of 463 meadows were mapped in the Black River area east of Fort Yukon. Sixteen of these were large and 447 were small. We visited all 16 large meadows (18 locations) and 45 of 56 randomly selected small meadows.

Fieldwork occurred from June 25 to June 30, 1994. A Robinson R-22 helicopter was used to access meadows. To allow field sampling on a large scale, vegetation was classified using a simple logarithmic cover scale consisting of 4 categories. Category 4 represented dominant plant species, with cover values >10 to 100%. Category 3 included common plant species, with cover values >1 to 10%. Plant species in categories 2 and 1 were rarer, with cover values >0.1 to 1% and >0.01 to 0.1%, respectively. Percent cover was obtained by translating the cover category recorded for each plant species into a percent value. The percent value used was the geometric midpoint of the category. This is the number midway between the log of the upper and the log of the lower category boundaries. Thus, the category 4 value was 31.623%, category 3 was 3.162%, category 2 was 0.316% and category 1 was 0.032% (J. Ver Hoef, ADF&G Biometrician, pers. commun.).

Initial sampling was done by walking from the edge to center of each meadow, crossing as many different vegetation zones as possible. All species encountered and characteristics of the meadow were recorded on standard forms (Appendix A, Tables 1 and 2). The percent cover for each species was then estimated and the appropriate cover category was marked. One or more color photographs were taken from the air and ground at most meadows. Lists of Latin, common, and abbreviated names of plant species found in each study area are given in Appendix A, Tables 1-3.

After becoming familiar with vegetation patterns, much of the cover estimation was done from the air by flying low (3-20 ft above ground level) at 0-15 mph and recording cover categories on a simplified data form (Appendix A, Table 3). Floral heads of grasses and sedges could usually be recognized from this height. When floral heads were not visible, we landed to positively identify plants. Fewer rare species were recorded during aerial sampling and less attention was paid to tree and shrub species than had been done initially. However, our major objective was to assess the more abundant grasses and sedges used as bison forage.

Percent cover is the sum of cover for a species in all locations in which it was found divided by the number of locations in the study area. Calibrated percent cover is percent cover adjusted so that total cover of grasslike and herbaceous plants equals 100%. Area occupied by a plant species was calculated by multiplying percent cover by the sample area. Calibrated area is the area adjusted so that total area of grasslike and herbaceous plants equals the size of the sample area.

We estimated the area of each plant species for 26,562 acres of meadows in the Birch Creek area and 26,864 acres in the Black River area. We extrapolated to all small meadows from our random sample of 14% of them (2,607 acres) in the Birch Creek area, and 12% (1,807 acres) in the Black River area. This yielded an estimate of acreage covered by each species in 18,792 and 15,024 acres of small meadows, respectively.

We then added areas estimated for these species in 7,770 and 11,840 acres of large meadows in Birch Creek and Black River study areas, respectively, to arrive at estimates of total acreage for each species. These calculations are summarized in Table 1.

Total minimum and maximum areas for each species (Tables 13-16) were calculated as follows. The minimum estimate is the sum of uncalibrated total area estimates for small and large meadows in that study area. The maximum estimate is the sum of calibrated total area estimates for small and large meadows in that study area. A summary of the steps used to calculate values in Tables 2-16 is shown in Table 17.

We used estimates of forage species cover to calculate potential forage production (Tables 18 and 19). First, forage species were categorized as wet or dry meadow species. We assumed average annual productivity of 4,000 kilograms of dry matter per hectare (3,570 lbs/acre) for wet meadows and 2,000 kilograms of dry matter per hectare (1,785 lbs/acre) for dry meadows, as reported in a study of the Slave River bison range (Reynolds and Peden 1987). The Slave River lowlands are characterized by wet and dry meadow habitat with plant species composition similar to that of the Yukon Flats. Finally, a forage intake value of 10 kilograms (22 lbs) of dry matter per day for an average bison (Telfer and Scotter 1975) was used to estimate an 8 month (241 day) winter forage requirement of 2,410 kg/bison and a 4 month (124 day) summer forage requirement of 1,240 kg/bison (2,734 lbs/bison). We calculated summer and winter stocking rates by assuming a moderate grazing intensity of 33% of forage biomass.

RESULTS AND DISCUSSION

General Description of Study Areas

Birch Creek:

The Birch Creek study area southwest of Fort Yukon is characterized by an abundance of thermokarst lakes, many of which are diminishing in size. However, several lakes and meadows adjacent to the upper and lower mouths of Birch Creek had been flooded prior to the fieldwork, probably during floods in the late 1980s and early 1990s. Meadows are often extensive, rather than being limited to margins of lakes and rivers as is common in the Black River area east of Fort

Yukon. In most cases, bluegrass, narrow reedgrass, wheatgrass and other grasses and forbs used as summer forage by bison are found along meadow edges where shrubs are encroaching. Rushes, foxtail barley and reedgrass often occur downslope in moist soil, while water sedge, slough sedge and beaked sedge dominate saturated soils at lake edges. Slough sedge and beaked sedge are important winter forage for wood bison in other areas (Reynolds and Peden 1987). Wetland grasses such as manna grass are abundant in some areas. The ground is generally firm except where soil is saturated. There are some bogs and marshes dominated by horsetails, cottongrass and buckbean, but these are rare.

Forage biomass is highest in wet areas surrounding pothole lakes, where sedges are often 3 ft (1 m) or more in height. Mesic and dry areas produce medium to low forage biomass. Dead grasses are often densely matted along dry meadow edges. This shades new growth and retards plant phenology. Encroaching shrubs are dominated by barren ground and park willow. Other common shrubs include diamondleaf willow, grayleaf willow, dwarf birch and prickly rose. Succession is increasing canopy cover of balsam poplar, aspen and ultimately white spruce. The forest surrounding the meadows, especially at the east end of this region, is dominated primarily by tall, widely spaced white spruce. There are signs of old burns in many areas.

Black River:

Meadows in this area are generally associated with riverine features such as oxbows and meander scars. Some areas were flooded in 1992, especially near the Grass and Sucker Rivers, and the water table was still high in these areas. Most meadows are marshes or occur along the edges of lakes and are dominated by slough sedge, water sedge and beaked sedge. The greater abundance of horsetails also reflects wetter conditions. These marshes support a high biomass of these species, many of which are good winter forage for bison. Another common meadow type is a post-fire reedgrass-marsh cinquefoil meadow. Diamondleaf and barren ground willow are common along meadow edges.

Spruce forest is generally denser than in the Birch Creek study area. There is considerable growth of shrubs and saplings as a result of frequent burns (the Porcupine-Black River area has the shortest fire cycle in Interior Alaska). Bison movements could be limited in summer by soft footing and dense tree and shrub growth. However, there are some large meadows, especially at the east end of this study area near Chalkyitsik, that are similar to those predominating in the Birch Creek area. These meadows include dry alkali flats as well as mesic and wet vegetation types. Soils here are firm and would provide good footing for bison.

Scotty Lake:

The area north of Chalkyitsik includes several thousand acres of alkali and dry meadows interspersed with pothole lakes. Species composition is similar to the Birch Creek area. Potholes are fringed with wetland sedges and grasses suitable as bison winter forage, while the dry meadows support summer forage types. Some oxbows and meander scars adjacent to the Porcupine River support pure stands of slough sedge, the preferred winter forage for wood bison.

Shovun Lake:

Meadows in the Shovun Lake area are generally associated with large lakes and rivers. Wet meadows are common between the Yukon River and Shovun Lake, with the highest biomass in winter forage species (wetland sedges and horsetails). Some summer forages (bluegrasses, rushes and foxtail barley) are found only occasionally along margins of wet meadows. A pure stand of slough sedge is found in the southern portion of the area northwest of Fort Yukon. The northern and eastern parts of the Shovun Lake area include a variety of meadow habitats, with numerous dry meadows that would provide summer range.

Bearman Lake:

The area northwest of Venetie Landing supports a mixture of wet and dry meadows. Extensive stands of wetland sedges and horsetails are found along meander scars and oxbows in the southeast part of the area. These are often surrounded by dry meadows supporting bluegrass and other summer forage. To the northwest are large open meadows associated with extensive drying lake beds. Both summer and winter forage is abundant. Further to the northwest in the area around Cache Lake, the terrain is wetter, but low ridges bordering some lakes would provide good footing for bison. Some dry meadows were encountered here also. These were dominated by tufted hairgrass and field oxytrope which are used by bison in summer. This area appears to provide good summer and winter habitat for bison.

Extent of Meadow Plant Communities

The number and total area of meadows sampled in the 2 intensive study areas and calculations used to extrapolate from the random samples to all small meadows are shown in Table 1. Fourteen large meadows in the Birch Creek area totaled 7,770 acres and 43 random small meadows totaled 2,607 acres for a grand total of 10,377 acres sampled. This represents 40% of the meadow acreage suitable for bison. In the Black River area, 16 large meadows totaled 11,840 acres and 45 small meadows totaled 1,807 acres for a grand total of 13,647 acres sampled. This represents just over 50% of meadow habitat suitable for bison. Meadows larger than 5 acres covered between 10 and 11% of the Birch Creek area and approximately 7% of the Black River area. Although meadows in three additional areas (Scotty Lake, Shovun Lake, and Bearman Lake) have not yet been mapped using infrared photographs, the extent of meadow habitat in these areas is substantial.

We sampled only 7,770 of the 10,060 acres of large meadows in the Birch Creek area. An additional 2,290 acres of known meadow habitat were not included in the grand total for this area. There are many forest openings smaller than 5 acres that would further increase the actual amount of available meadow habitat, especially in the Birch Creek area where the forest canopy is relatively open. Therefore, estimates of available meadow habitat are conservative. In addition, aerial reconnaissance and examination of IR photographs indicate the high quality habitat identified in the Birch Creek area extends westward well beyond the study area boundary. This area is west of the lower mouth of Birch Creek, between Beaver Creek and the Yukon River. Suitable bison habitat appears to extend west at least as far as the Mud Lakes area.

Estimates of Cover by Species

Tables 2 through 12 show the estimates of percent cover and total area occupied by each plant species in the two main study areas and percent cover only in the three additional study areas. Two additional estimates are shown for the random sample of small meadows. These represent extrapolations from sampled meadows to all small meadows in the study area.

It is evident that graminoids (grasses and sedges) dominate meadow communities in all study areas, with several species accounting for most of the herbaceous cover. In wet areas, dominant species are slough sedge, water sedge, beaked sedge and reedgrass. Each of these species consistently comprises between 4 and 20% of the total cover in each study area. Horsetails are also common in large meadows in all areas studied. Most of these species provide winter forage for bison and some are also used in summer, especially before they mature.

Dry meadows generally show greater species diversity, so percent cover of each species is usually less than in wet meadows. Dominant species often include bluegrasses, alkali grasses, rushes and reed grasses. These species are common in all study areas and usually make up from 1 to 10% of the total cover. Alkali grasses dominate cover in several large alkali flats.

Throughout the year, wood bison show a marked affinity for wet and mesic meadows characterized by the presence of slough sedge, a key forage species, in association with other grasses and sedges (Larter and Gates 1991). Slough sedge was present in 60% of the small meadows and 76% of the large meadows in the Birch Creek area, and in 42% of the small meadows and 61% of the large meadows in the Black River area. This species was also common in the three less intensively studied areas.

Although grasses and sedges dominate meadow ground cover, a variety of forbs occur in each study area. None is widely abundant in all study areas, but some are codominants with graminoids in local areas. Arrowgrass is common in alkali flats in the Birch Creek area. Marsh cinquefoil is a codominant with several graminoids in the post-burn reedgrass meadows in the Black River area. In the Shovun Lake area, the south slope of Shovun Hill is dominated by the forb sagewort. The Bearman Lake area has local areas with abundant fireweed and field oxytrope. Based on observations of Delta River bison, some of the forbs found in dry meadows are known to be used by bison. These include fireweed, swamp willow-herb, goldenrod, common burnet and oxytrope (M. Berger, personal observation).

The total acreage of all plants and of forage plants in the Birch Creek area is shown in Tables 13 and 14, respectively. As discussed earlier, graminoids far exceed forbs in area covered. The eight groups of plants providing greatest cover include reedgrasses, water sedge, rushes, slough sedge, manna grass, bluegrass, beaked sedge and horsetails.

Tables 15 and 16 show total plant and forage plant acreage respectively for the Black River area. Reedgrasses cover the greatest area, followed by water sedge. Horsetails rank third in total area covered, followed by slough sedge, beaked sedge, rushes, slough grass and bluegrass.

Potential Forage Production and Stocking Levels

The results of habitat inventory and forage abundance studies done to date indicate the Yukon Flats could support a substantial population of wood bison. Our conservative estimates suggest that wet meadows in the Birch Creek area could support approximately 1,999-2,219 bison. Dry meadows could support approximately 1,189-1,328 bison (Table 18). Estimates for the Black River area are 1,747-2,622 bison for wet meadows and 768-1,195 for dry meadows (Table 19).

Although many summer forage plants occur in dry meadows, while winter forage species are found primarily in wet meadows, there is some overlap between summer and winter forages. Several wetland sedges are attractive to bison during early summer when they are more palatable than later in the growing season. Similarly, dry meadow grasses such as wheatgrass and red fescue are often used in late winter, before new growth emerges.

In addition to forage production, the suitability of terrain in allowing bison access to forage must also be considered. The mosaic of wet and dry terrain in the Birch Creek, Bearman Lake and Scotty Lake areas and parts of the Shovun Lake area should provide good year-round travel conditions for bison. Wet terrain and dense shrubs in parts of the Black River and Shovun Lake areas could limit bison movements during summer. Winter foraging conditions in these areas should be favorable, however.

CONCLUSIONS

Our study indicates the Birch Creek area southwest of Fort Yukon offers excellent year-round habitat for a large population of bison. Substantial habitat also exists in the other areas studied, although large areas of uniformly wet terrain may limit summer foraging in some areas, particularly in the western portion of the Black River area. Estimates of forage production indicate that at least 1,100 bison could be supported year-round in the Birch Creek area. Forage availability in the Black River area is somewhat less, with carrying capacity being estimated conservatively at 800 bison.

The characteristics of potential bison habitat on the Yukon Flats compares favorably with the Slave River lowlands and Mackenzie Bison Sanctuary in Canada, where wood bison have existed for many years. While a strict comparison is difficult, the amount of forage and suitable habitat on the Yukon Flats appears to exceed the amount found in any of the existing or potential wood bison ranges in northern Canada. Both conventional forage modeling and our familiarity with other northern bison habitat indicate that several different areas on the Yukon Flats could easily sustain a population of 400-500 wood bison, currently regarded as a minimum viable population. The actual number of wood bison that could be sustained in at least 2 of the 5 areas surveyed is considerably greater than the minimum viable population, and the carrying capacity of the Yukon Flats as a whole appears to be in excess of 2,000 bison.

Additional assessment of meadow habitat in areas that have not yet been intensively sampled would be useful in the future if managing agencies and the public support a reintroduction and proceed to develop a cooperative management plan. These areas include the Scotty Lake, Shovun Lake and Bearman Lake areas, the southern portion of the Venetie Reservation and the lowlands west of the lower mouth of Birch Creek.

LITERATURE CITED

Farjon, A., and P. Bogaers. 1985. Vegetation zonation and primary succession along the Porcupine River in Interior Alaska. Phytocoenologia. 13(4):465-504.

Gates, C. C. 1992. Cursory evaluation of the habitat potential of the Yukon River Flats, Alaska, for a reintroduction of wood bison. Unpublished report 7pp. text + 9pp. figures and tables.

Larter, N. C., and C. C. Gates. 1991. Diet and habitat selection of wood bison in relation to seasonal changes in forage quantity and quality. Can. J. Zool. 69:2677-2685.

Reynolds, H. W., and D. G. Peden. 1987. Vegetation, bison diets and snow cover. Pages 39-44 *in* H. W., Reynolds and A. W. L. Hawley. 1987. Bison ecology in relation to agricultural development in the Slave River lowlands, NWT. Canadian Wildlife Service Occasional Paper Number 63. 74pp.

Reynolds, H. W., R. Hansen, and D. Peden. 1978. Diets of the Slave River lowland bison herd, Northwest Territories, Canada. J. Wildl. Manage. 42:581-590.

Telfer, E. S., and G. W. Scotter. 1975. Potential of game ranching in boreal aspen forests of Western Canada. J. Range Manage. 28:172-180.

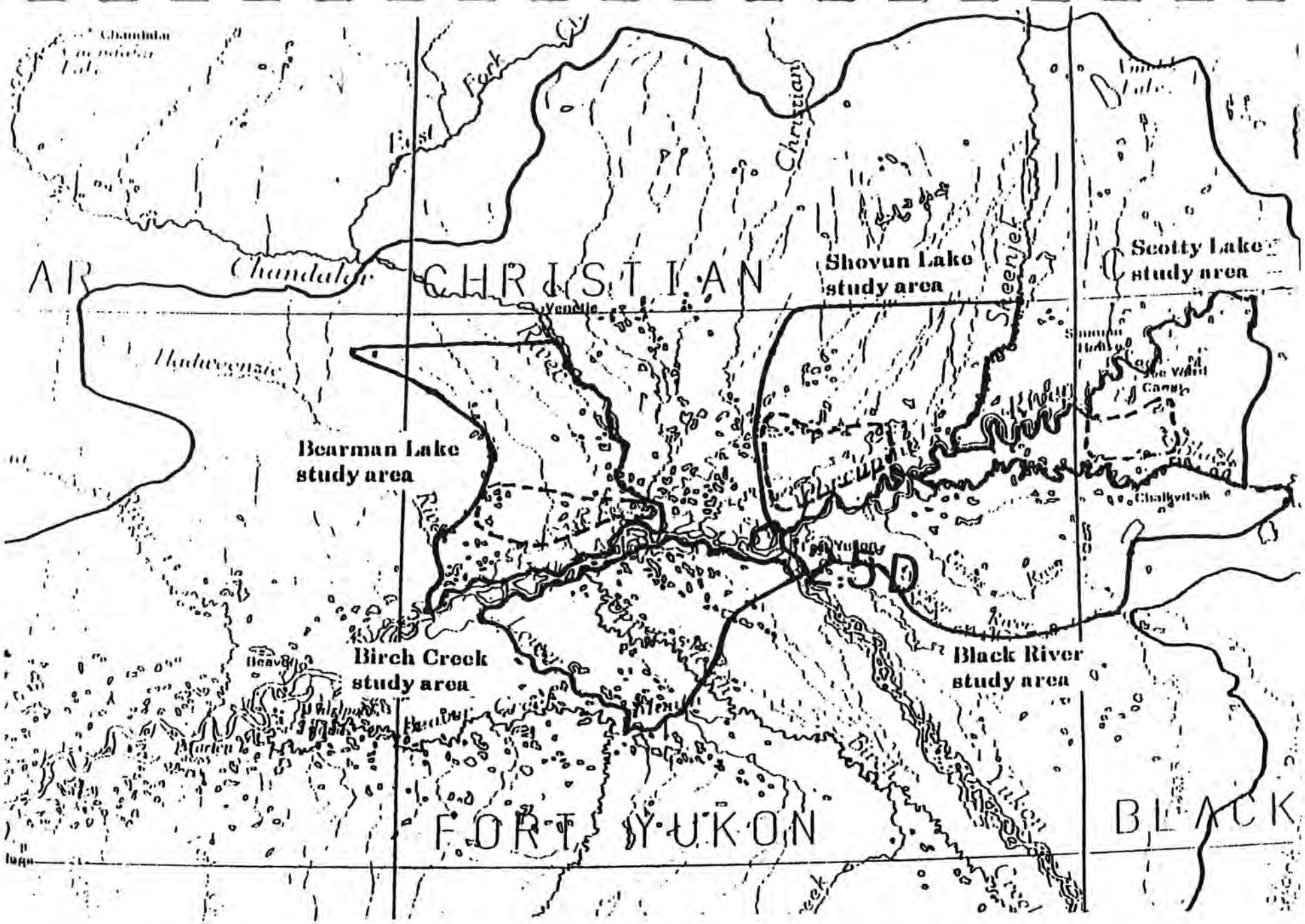

Figure 1. Study areas used in wood bison range assessment. Dotted lines indicate areas surveyed by helicopter in 3 areas that were extensively surveyed.

Table 1. Summary of number and area of meadows sampled in the Birch Creek and Black River study areas.

			Birch Creek	Black River
Large meadows (·200 acres)	Number	Total	21	16
		Sampled	14 (17 locations)	16 (18 locations)
	Acreage	Total	10,060	11,840
		Sampled	7,770	11,840
		Not sampled	2,290	0
Random small meadows (<200 acres)	Number	Randomly selected	1/8 or 51	1/8 or 56
		Attempted	46	51
		Unsuitable*	3	6
		Sampled	43	45
	Acreage	Attempted	2,717	1,967
		Unsuitable	110 (4% of total attempted)	160 (8% of total attempted)
		Sampled	2,607	1,807
Calculations to obtain total small meadow area usable by bison	Acreage	Total meadow area mapped	29,644.50	28,194
		Subtract large (·200 ac)	10,060	11,840
		Total small (<200 ac)	19,584.50	16,354
		Unsuitable	4% or 793	8% or 1,330
		Total suitable	18,792	15,024
		Percent of total suitable sampled	14%	12%
	Grand Totals	Suitable large and small	18,792+7,770 = 26,562	15,024+11,840 =26,864
		Sampled large and small	7,770+2,607 =10,377	11,840+1,807 =13,647
		Percent of suitable area sampled	39.1%	50.8%

* Flooded or overgrown by shrubs.

Table 2. Occurrence of grasses, sedges, rushes, and horsetails in 17 large meadows in the Birch Creek study area.

Species	# of locations	% cover	Calibrated % cover	Area (acres)	Calibrated area (acres)
CXAT	13	13.97	14.835	1085	1152
CXAQ	14	12.649	13.432	983	1044
CACA	12	8.929	9.482	694	737
JUAR	7	7.999	8.494	622	661
CXRO	5	5.953	6.321	463	492
CCNE	4	5.767	6.124	448	476
POSP	10	5.208	5.53	405	430
EQFL	5	4.278	4.543	332	353
GLST	5	4.111	4.365	319	339
EQAR	4	4.092	4.345	318	338
JUFI	6	2.79	2.963	216	229
HOJU	8	0.802	0.852	62	66
SCVA	5	0.763	0.81	59	63
FERU	4	0.744	0.79	58	62
CXSR	7	0.632	0.671	49	52
ELPA	5	0.595	0.632	46	49
PUCC	3	0.558	0.593	43	46
AGSP	5	0.428	0.454	33	35
ARFU	3	0.374	0.397	29	31
CANE	2	0.205	0.218	16	17
ERVA	2	0.205	0.218	16	17
SCFE	2	0.037	0.039	3	3.2
DECA	1	0.019	0.02	1.5	1.6
BEER	1	0.002	0.003	0.2	0.21
TOTALS		81.11	86.131	6300.7	6694.01

Table 3. Occurrence of herbaceous plants, including aquatics, in 17 large meadows in the Birch Creek study area.

Species	# of locations	% cover	Calibrated % cover	Area (acres)	Calibrated area (acres)
TRMA	8	4.502	4.781	350	372
TYLA	6	2.455	2.607	191	203
METR	1	1.86	1.975	145	154
PTSP	9	0.67	0.711	52	55
PTAN	10	0.655	0.696	51	54
EPAN	4	0.577	0.613	45	48
STSP	6	0.446	0.474	35	37
PTPA	5	0.428	0.454	33	35
HIVU	4	0.392	0.416	30	32
ACHI	6	0.279	0.296	22	23.4
EPPA	2	0.205	0.218	16	17
GLMA	1	0.186	0.198	14	15
SAOF	5	0.076	0.081	5.9	6.3
ARTI	2	0.037	0.039	3	3.2
CAPA	2	0.037	0.039	3	3.2
RMAR	3	0.039	0.041	3	3.2
SOSP	4	0.041	0.044	3	3.2
AQBR	1	0.019	0.02	1.5	1.6
CSCA	2	0.02	0.021	1.5	1.6
ERCH	1	0.019	0.02	1.5	1.6
ERSP	1	0.019	0.02	1.5	1.6
PEFR	1	0.019	0.02	1.5	1.6
RASP	1	0.019	0.02	1.5	1.6
RUAR	2	0.02	0.021	1.5	1.6
SESP	1	0.019	0.02	1.5	1.6
PRST	6	0.011	0.012	0.9	0.96
CNCN	3	0.006	0.008	0.5	0.53
CIMA	2	0.004	0.0042	0.3	0.32
SECO	1	0.002	0.002	0.2	0.21
TOTALS		13.062	13.8712	1015.8	1079.32

Table 4. Occurrence of grasses, sedges, rushes and horsetails in a random sample of 43 small meadows and estimated occurrence in all small meadows in the Birch Creek study area.

Species	# of locations	% cover	Calibrated % cover	Min area (acres)	Calibrated max area (acres)	Total area (acres)	Calibrated total area (acres)
AGSP	12	1.28	1.452	33	37	241	273
ARFU	6	1.03	1.168	27	31	194	220
BEER	4	1.545	1.753	40	45	290	329
CACA	27	11.053	12.539	288	327	2077	2356
CANE	6	1.765	2.002	46	52	332	377
CCNE	15	9.708	11.013	253	287	1824	2069
CXAQ	38	17.356	19.689	452	512	3262	3700
CXAT	26	8.531	9.678	222	252	1603	1818
CXAU	2	0.001	0.0011	0.03	0.034	0.2	0.23
CXRO	16	3.626	4.113	95	108	681	773
CXSR	8	0.251	0.285	7	8	47	53
DECA	1	0.007	0.008	0.2	0.22	1.3	1.5
ELPA	3	0.154	0.175	4	5	29	33
EQAR	2	0.147	0.167	4	5	28	32
EQFL	2	0.743	0.843	19	22	140	159
ERAN	1	0.074	0.839	1.9	2.2	14	16
ERVA	1	0.735	0.834	19	22	138	157
FERU	7	0.382	0.433	10	11	72	82
GLST	28	5.17	5.865	135	153	972	1103
HOJU	11	1.934	2.194	50	57	363	412
JUAR	16	5.082	5.765	132	150	955	1083
JUFI	6	3.023	3.429	79	90	568	644
JUSP	4	2.28	2.586	59	67	428	486
POSP	16	4.354	4.939	114	129	818	928
PUCC	3	0.882	1.001	23	26	166	188
SCFE	17	0.913	1.036	24	27	172	195
SCVA	14	0.831	0.943	22	25	156	177
TOTALS		82.857	94.7501	2159.13	2450.454	15571.5	17664.73

Table 5. Occurrence of herbaceous plants, including aquatics, in a random sample of 43 small meadows and estimated occurrence in all small meadows in the Birch Creek study area.

Species	# of locations	% cover	Calibrated % cover	Min area (acres)	Calibrated max area (acres)	Total area (acres)	Calibrated total area (acres)
ACHI	20	0.941	1.067	25	28	177	201
PTSP	28	0.854	0.969	22	25	160	182
RUAR	11	0.677	0.768	18	20	127	144
EPAN	14	0.626	0.71	16	18	118	134
HIVU	13	0.426	0.026	11	12.5	80	91
PTPA	8	0.324	0.368	8.4	9.5	61	69
STSP	17	0.304	0.345	8	9	57	65
TRMA	9	0.265	0.301	7	8	50	57
TYLA	8	0.251	0.285	6.5	7.4	47	53
ARTI	6	0.157	0.178	4	4.5	30	34
PEFR	5	0.156	0.177	4	4.5	29	33
PTAN	5	0.096	0.109	2.5	2.8	18	20
AQBR	6	0.031	0.0352	0.8	0.9	6	6.8
EPPA	4	0.023	0.026	0.6	0.7	4	4.5
SAOF	9	0.02	0.023	0.5	0.6	4	4.5
SECO	3	0.022	0.025	0.6	0.7	4	4.5
PRST	4	0.016	0.0182	0.4	0.45	3	3.4
RAGM	3	0.015	0.017	0.4	0.5	3	3.4
SESP	3	0.015	0.017	0.4	0.5	3	3.4
UTVU	2	0.015	0.017	0.4	0.45	3	3.4
RMAR	3	0.009	0.01	0.2	0.23	2	2.3
SOSP	10	0.12	0.136	3	3.4	2	2.3
CNCN	2	0.008	0.0091	0.2	0.23	1.5	1.7
PMSP	1	0.007	0.008	0.2	0.23	1.3	1.5
POAM	1	0.007	0.008	0.2	0.23	1.3	1.5
PLHY	1	0.001	0.0011	0.02	0.022	0.2	0.23
RASP	1	0.001	0.0011	0.02	0.022	0.2	0.23
TOTALS	197	5.387	5.6547	140.34	158.364	992.5	1126.66

Table 6. Occurrence of grasses, sedges, rushes, and horsetails in 18 large meadows, Black River study area.

Species	# of locations	% cover	Calibrated % cover	Area (acres)	Calibrated area (acres)
CCNE	18	12.649	6.167	1498	2779
CXAQ	18	9.266	4.23	1097	2035
EQFL	11	5.31	0.683	629	1167
JUSP	11	3.456	0.273	409	759
CXAT	11	3.324	3.276	394	731
BEER	4	2.28	6.412	270	501
POSP	7	1.766	0.15	209	388
ERAN	3	1.472	0.358	174	323
HOJU	12	1.412	0.286	167	310
AGSP	1	0.735	23.466	87	161
CXRO	8	0.522	2.62	62	115
PUCC	5	0.368	0.013	44	82
SCVA	2	0.193	0.013	23	43
ALAE	4	0.162	17.19	19	35
GLST	4	0.162	0.301	19	35
ARFU	3	0.154	9.851	18	33
CXSR	2	0.147	1.364	17	32
ELPA	2	0.081	0.968	10	19
CXAU	1	0.007	2.731	0.8	1.5
FERU	1	0.007	0.301	0.8	1.5
TOTALS		43.473	80.653	5147.6	9551

Table 7. Occurrence of herbaceous plants, including aquatics, in 18 large meadows, Black River study area.

Species	# of locations	% cover	Calibrated % cover	Area (acres)	Calibrated area (acres)
PTPA	5	3.709	6.881	439	814
POAM	1	1.757	3.26	208	386
POSU	1	1.757	3.26	208	386
METR	4	0.703	1.304	83	154
PEFR	7	0.581	1.078	69	128
HIVU	4	0.545	1.011	65	121
TYLA	7	0.423	0.785	50	93
TRMA	2	0.351	0.651	42	78
EPAN	7	0.249	0.462	29	54
ACHI	6	0.09	0.167	11	20
PTSP	10	0.097	0.18	11	20
STSP	6	0.042	0.078	5	9
SUDE	2	0.035	0.065	4	7
ARTI	3	0.021	0.039	2.5	5
EPPA	2	0.019	0.035	2	4
LEMN	1	0.018	0.033	2	4
RUAR	1	0.018	0.033	2	4
RMAR	3	0.005	0.009	0.6	1
SECO	2	0.004	0.007	0.5	1
CNCN	1	0.002	0.004	0.2	0.4
RAGM	1	0.002	0.004	0.2	0.4
TOTALS		10.428	19.346	1234	2289.8

Table 8. Occurrence of grasses, sedges, rushes, and horsetails in a sample of 45 small meadows and estimated occurrence in all small meadows in the Black River study area.

Species	# of locations	% cover	Calibrated % cover	Min area (acres)	Calibrated max area (acres)	Total area (acres)	Calibrated total area (acres)
CCNE	35	21.433	29.432	387	531	3220	4422
CXAQ	27	12.017	16.502	217	298	1805	2479
CXAT	19	10.822	14.861	196	269	1626	2233
EQFL	16	9.979	13.703	177	243	1499	2058
CXRO	16	4.287	5.887	77	106	644	884
ARFU	3	1.476	2.027	27	37	222	305
JUSP	6	0.991	1.361	18	25	149	205
POSP	5	0.984	1.351	18	25	148	203
CXDI	5	0.921	1.265	17	23	138	190
ELPA	4	0.914	1.255	17	23	137	188
ERAN	4	0.914	1.255	17	23	137	188
ALAE	6	0.864	1.186	16	22	130	179
EQAR	3	0.843	1.158	15	21	127	174
BEER	3	0.717	0.985	13	18	108	148
HOJU	9	0.443	0.608	8	11	67	92
GLST	4	0.281	0.386	5	7	42	58
CXSR	2	0.141	0.194	2.5	3.4	21	29
FERU	2	0.077	0.106	1.4	2	12	16
TOTALS		68.104	93.522	1228.9	1687.4	10232	14051

Table 9. Occurrence of herbaceous plants, including aquatics, in 45 randomly sampled small meadows and estimated occurrence in all small meadows in the Black River study area.

Species	# of locations	% cover	Calibrated % cover	Min area (acres)	Calibrated max area (acres)	Total area (acres)	Calibrated total area (acres)
PEFR	15	1.56	2.142	28	38	234	321
POAM	3	1.476	2.027	27	37	222	305
METR	4	0.281	0.386	5	7	42	58
EPAN	5	0.225	0.309	4	5.5	34	47
PTSP	13	0.205	0.282	4	5.5	31	43
PTPA	4	0.155	0.213	3	4	23	32
TYLA	4	0.155	0.213	3	4	23	32
HIVU	5	0.098	0.135	2	2.7	15	21
LEMN	5	0.098	0.135	2	2.7	15	21
PTAN	2	0.077	0.106	1.4	1.9	12	16
CALL	1	0.07	0.096	1.3	1.8	11	15
CAPA	1	0.07	0.096	1.3	1.8	11	15
ERCH	1	0.07	0.096	1.3	1.8	11	15
STSP	6	0.03	0.0041	0.5	0.7	4.5	6
RAGM	4	0.028	0.038	0.5	0.7	4	5.5
ACHI	2	0.014	0.019	0.3	0.4	2	2.7
RMAR	3	0.015	0.021	0.3	0.4	2	2.7
CIMA	1	0.007	0.01	0.1	0.14	1	1.4
CNCN	1	0.007	0.01	0.1	0.14	1	1.4
SECO	1	0.001	0.0014	0.02	0.03	0.2	0.3
TOTALS		4.642	6.3395	85.12	116.21	698.7	961

Table 10. Occurrence of plant species in 10 meadows in the Scotty Lake study area.

Grasses, sedges, rushes and horsetails

Species	# of locations	% cover	Calibrated % cover
CACA	8	22.452	24.895
CXAQ	6	16.128	17.883
CXAT	6	13.282	14.727
EQFL	3	6.641	7.364
PUCC	2	6.325	7.013
SCFE	5	4.427	4.909
CXRO	4	4.111	4.558
ARFU	3	3.795	4.208
JUSP	2	3.479	3.858
BEER	2	0.632	0.701
POSP	2	0.632	0.7
ALAE	2	0.348	0.386
ELPA	2	0.348	0.386
HOJU	2	0.348	0.386
CXSR	1	0.316	0.35
ERVA	1	0.316	0.35
SCVA	1	0.032	0.035
TOTALS		83.612	92.709

Herbaceous plants, including aquatics

Species	# of locations	% cover	Calibrated % cover
SCFE	5	4.427	4.909
HIVU	4	0.411	0.456
TYLA	3	0.379	0.42
CALL	1	0.316	0.35
CAPA	1	0.316	0.35
EPAN	1	0.316	0.35
TRMA	1	0.316	0.35
PEFR	2	0.063	0.07
SESP	1	0.032	0.035
TOTALS		6.576	7.29

Table 11. Occurrence of plant species in 12 meadows in the Shovun Lake study area.

Grasses, sedges, rushes and horsetails

Species	# of locations	% cover	Calibrated % cover
CACA	10	23.981	27.88
CXAT	9	9.487	11.03
CXAQ	5	8.433	9.804
HOJU	8	6.614	7.689
POSP	6	6.325	7.353
EQFL	4	5.56	6.464
ARFU	6	3.953	4.596
JUSP	6	3.953	4.596
BEER	5	3.689	4.289
AGSP	2	2.899	3.37
SCFE	1	2.635	3.063
CXRO	7	1.607	1.868
ELPA	3	0.553	0.643
ERVA	2	0.29	0.337
ERAN	1	0.264	0.307
GLST	1	0.264	0.307
SCVA	4	0.082	0.095
CXDI	2	0.053	0.062
TOTALS		80.642	93.753

Herbaceous plants, including aquatics

Species	# of locations	% cover	Calibrated % cover
ARFR	2	2.662	3.095
TRMA	5	0.843	0.98
POAM	3	0.553	0.643
SECO	3	0.316	0.367
PTAN	2	0.29	0.337
METR	1	0.264	0.307
PTSP	5	0.132	0.153
EPAN	3	0.079	0.092
HIVU	2	0.053	0.062
ACHI	1	0.026	0.03
POSU	1	0.026	0.03
RMAR	1	0.026	0.03
SPAN	1	0.026	0.03
STSP	1	0.026	0.03
TYLA	1	0.026	0.03
UMBL	1	0.026	0.03
TOTALS		5.374	6.246

Table 12. Occurrence of plant species in 5 meadows in the Bearman Lake study area.

Grasses, sedges, rushes and horsetails

Species	# of locations	% cover	Calibrated % cover
EQFL	3	18.974	21.723
CACA	4	13.914	15.93
CXAQ	5	8.854	10.137
CXAT	4	8.222	9.413
CXRO	3	7.589	8.689
POSP	3	7.589	8.689
PUCC	3	1.897	2.172
SCVA	3	1.328	1.52
BEER	2	1.265	1.448
JUSP	2	1.265	1.448
SCFE	2	1.265	1.448
HOJU	2	0.696	0.797
AGSP	1	0.632	0.724
DECA	1	0.632	0.724
ELPA	1	0.632	0.724
EQAR	1	0.632	0.724
ERAN	1	0.632	0.724
ERVA	1	0.632	0.724
GLST	1	0.632	0.724
JUAL	1	0.632	0.724
CXAU	1	0.063	0.072
TOTAL		77.977	89.278

Herbaceous plants, including aquatics

Species	# of locations	% cover	Calibrated % cover
EPAN	4	1.391	1.593
METR	2	1.265	1.448
OXCA	2	1.265	1.448
PTAN	2	0.696	0.797
PTSP	2	0.696	0.797
HIVU	1	0.632	0.724
SESP	1	0.632	0.724
SPAN	1	0.632	0.724
STSP	1	0.632	0.724
TRMA	1	0.632	0.724
ACHI	3	0.19	0.218
PEFR	2	0.126	0.144
AQBR	1	0.063	0.072
ARFR	1	0.063	0.072
ERCH	1	0.063	0.072
PAPA	1	0.063	0.072
PRST	1	0.063	0.072
RAGM	1	0.063	0.072
RMAR	1	0.063	0.072
RUAR	1	0.063	0.072
SODE	1	0.063	0.072
ARAL	1	0.006	0.007
SAOF	1	0.006	0.007
TOTAL		9.368	10.727

Table 13. Minimum and maximum estimates of coverage for all plant species in the Birch Creek study area, extrapolated from 43 small and 17 large meadow locations.

Herbaceous plants, including aquatics

Species	Area (acres) Minimum	Maximum
ACHI	199	224
AQBR	7.5	8
ARTI	33	37
CAPA	3	3.2
CIMA	0.3	0.32
CNCN	2	2.2
CSCA	1.5	2
EPAN	163	182
EPPA	20	22
ERCH	1.5	2
ERSP	1.5	2
GLMA	14	15
HIVU	110	123
METR	145	154
PEFR	31	35
PLHY	0.23	0.23
PMSP	1.3	1.5
POAM	1.3	1.5
PRST	4	4.4
PTAN	69	74
PTPA	94	104
PTSP	212	237
RAGM	3.3	3.4
RASP	1.7	2
RMAR	5	6
RUAR	129	146
SAOF	10	11
SECO	4.2	5
SESP	4.5	5
SOSP	5	6
STSP	92	102
TRMA	400	429
TYLA	238	256
UTVU	3.3	3.4
TOTALS	2010.13	2209.15

Grasses, sedges, rushes and horsetails

Species	Area (acres) Minimum	Maximum
AGSP	274	308
ARFU	223	251
BEER	290	329
CACA	2771	3093
CANE	348	394
CCNE	2272	2545
CXAQ	4245	4744
CXAT	2688	2970
CXAU	0.2	0.23
CXRO	1144	1265
CXSR	96	105
DECA	3	3.1
ELPA	75	82
EQAR	346	370
EQFL	472	512
ERAN	14	16
ERVA	154	174
FERU	130	144
GLST	1291	1442
HOJU	425	478
JUAR	1577	1744
JUFI	784	873
JUSP	428	486
POSP	1223	1358
PUCC	209	234
SCFE	175	198
SCVA	215	240
TOTALS	21872.2	24358.3

MAXIMUM GRAND TOTAL
24358 + 2209 = 26567 Acres*

* This number corresponds approximately with the total suitable large and small meadows in Table 1 (26,562). Differences in these values are due to rounding error.

Table 14. Minimum and maximum estimates of the occurrence of bison forage species in the Birch Creek study area, extrapolated from 43 small and 17 large meadows.

Summer forage Estimated area (acres)			Winter forage Estimated area (acres)			Summer and winter forage Estimated area (acres)		
Species	Min	Max	Species	Min	Max	Species	Min	Max
Grasses, sedges, rushes and horsetails								
JUSP	2847	3103	CXRO	1144	1265	CCNE	5391	6032
POSP	1223	1358	EQFL	472	512	CXAT	2688	2970
HOJU	425	478	EQAR	346	370	GLST	1291	1442
BEER	290	329						
AGSP	274	308	TOTAL	1962	2147	TOTAL	9370	10444
PUCC	209	234						
FERU	130	144						
CXSR	96	105						
CXAU	0.2	0.23						
TOTAL	2647	2956						
Herbaceous plants								
PTSP	212	237						
EPAN	163	182						
PTPA	94	104						
EPPA	20	22						
SAOF	10	11						
SOSP	5	6						
TOTAL	573	636						

Total acreage summer forage	Total acreage winter forage	Total acreage both summer and winter forage
3,220 - 3592 acres	1,962 - 2,147 acres	9,370 - 10,444 acres
5.0 - 5.6 mi^2	3.1 - 3.4 mi^2	14.6 - 16.3 mi^2
13.0 - 14.6 km^2	8.0 - 8.7 km^2	38.1 - 42.4 km^2

Grand total acreage of bison forage plant species

14,552 - 16,183 acres
22.7 - 25.3 mi^2
59.0 - 65.8 km^2

Table 15. Minimum and maximum estimates of occurrence of plant species in the Black River study area, extrapolated from 45 small and 18 large meadow locations.

Grasses, sedges, rushes and horsetails

	Area (acres)	
Species	Minimum	Maximum
CCNE	4718	7201
CXAQ	2902	4514
EQFL	2128	3225
CXAT	2020	2964
CXRO	706	999
JUSP	558	964
BEER	378	649
POSP	357	591
ERAN	311	511
HOJU	234	402
ARFU	240	338
ALAE	149	214
ELPA	147	207
CXDI	138	190
EQAR	127	174
AGSP	87	161
GLST	61	93
PUCC	44	82
CXSR	38	61
SCVA	23	43
FERU	13	18
CXAU	0.8	1.5
TOTALS	15379.8	23602.5

Herbaceous plants, including aquatics

	Area (acres)	
Species	Minimum	Maximum
PTPA	462	846
POAM	430	691
PEFR	303	449
POSU	208	386
METR	125	212
HIVU	80	142
TYLA	73	125
EPAN	63	101
TRMA	42	78
PTSP	42	63
LEMN	17	25
ACHI	13	23
PTAN	12	16
CALL	11	15
CAPA	11	15
ERCH	11	15
STSP	9.5	15
SUDE	4	7
RAGM	4.2	6
ARTI	2.5	5
EPPA	2	4
RMAR	2.6	4
RUAR	2	4
CNCN	1.2	2
CIMA	1	1.4
SECO	0.7	1.3
TOTALS	1932.7	3251.7

MAXIMUM GRAND TOTAL 23602.5 + 3251.7 = 26854 acres*

* This number corresponds approximately with the total suitable large and small meadows in Table 1 (26,864). Differences in these values are due to rounding errors.

Table 16. Minimum and maximum estimates of the occurrence of bison forage species in the Black River study area, extrapolated from 45 small and 18 large meadows.

Summer forage Estimated area (acres)			Winter forage Estimated area (acres)			Summer and winter forage Estimated area (acres)		
Species	Min	Max	Species	Min	Max	Species	Min	Max
Grasses, sedges, rushes and horsetails								
JUSP	558	964	EQFL	2128	3225	CCNE	4718	7201
BEER	378	649	CXRO	706	999	CXAT	2020	2964
POSP	357	591	EQAR	127	174	GLST	61	93
HOJU	234	402						
ALAE	149	214	TOTAL	2961	4398	TOTAL	6799	10258
CXDI	138	190						
AGSP	87	161						
PUCC	44	82						
CXSR	38	61						
FERU	13	18						
CXAU	0.8	1.5						
TOTAL	1439	2370						
Herbaceous plants								
PTPA	462	846						
EPAN	63	101						
PTSP	42	63						
EPPA	2	4						
TOTAL	569	1014						

Total acreage summer forage	Total acreage winter forage	Total acreage both summer and winter forage
2,008 - 3,384 acres	2,961 - 4,398 acres	6,799 - 10,258 acres
3.1 - 5.3 mi^2	9.2 - 13.9 mi^2	10.6 - 16.0 mi^2
8.1 - 13.8 km^2	23.8 - 36.2 km^2	27.6 - 42.0 km^2

Grand total acreage of bison forage plant species

11,768 - 18,040 acres
18.4 - 28.2 mi^2
47.8 - 73.3 km^2

Table 17. Summary of procedures used to estimate plant cover.

Number of Locations: Number of meadow locations in which that species occurred. The maximum possible number of locations for each study area follows:

Birch Creek large	= 17 locations
Birch Creek random	= 43 locations
Black River large	= 18 locations
Black River random	= 45 locations

Percent Cover: Total cover/number of locations in study area.

Values used:	Category 4 (10-100%)	= 31.623% cover
	Category 3 (1-10%)	= 3.162% cover
	Category 2 (.1-1%)	= .316% cover
	Category 1 (.01-.1%)	= .032% cover

Calibrated Percent Cover: Percent cover adjusted so that total percent cover (herbaceous and grasslike) = 100% - calculated separately for random and large meadows.

Values used:	Birch Creek large	x 1.0619
	Birch Creek random	x 1.1344
	Black River large	x 1.8552
	Black River random	x 1.3732

Area: Percent cover x sample area (acres).

Values used:	Birch Creek large	x 7770
	Birch Creek random	x 2607
	Black River large	x 11840
	Black River random	x 1807

Total Area: (Used only for random meadows) Percent cover x total area (acres).

Values used:	Birch Creek	x 18,792
	Black River	x 15,024

Calibrated Sample Areas and Total Areas: As per calibrated percent cover.

Minimum and maximum total area estimates for all meadows in each study area.
Minimum estimate: Sum of uncalibrated total areas for random and large (acres).
Maximum estimate: Sum of calibrated total areas for random and large (acres).

Table 18. Total estimated forage production in wet and dry meadows in the Birch Creek study area, and number of bison that could be supported in each meadow type.

ACREAGE OF WET MEADOW SPECIES

Species	Minimum Estimate	Maximum Estimate
BEER	290	329
CXRO	1,144	1,265
EQAR	346	370
EQFL	472	512
CXAT	2,688	2,970
GLST	1,291	1,442
TOTAL	6,231	6,888

plus ½ of CCNE to wet meadows*
½ of CCNE to dry meadows
= 5,391 - 6,032 – 2
= 2,696 - 3,016 acres
of CCNE to each wet and dry meadows

WET MEADOW GRAND TOTAL

= 6,231+2,696 & 6,888+3,016
= 8,927 & 9,904 acres
– 2.47 acres/hectare
= 3,614 - 4,010 hectares
x 4,000 kg/ha (3,570 lbs/acre)** forage produced in wet meadows (Reynolds and Peden, 1987)
= 14,456,000 - 16,040,000 kg forage produced (31,869,987 - 35,362,105 lbs)
average use of 10 kg (22 lbs) forage/bison/day (Telfer and Scotter, 1975)
= 2,410 kg (5,313 lbs) forage/bison/8 month winter period (=241 days)
assuming desirable moderate forage removal of 1/3 of total forage production
= 4,818,667 - 5,346,667 kg of forage available for removal
(10,623,330 - 11,787,369 lbs)
= 1,999 - 2,219 bison supported by Birch Creek wet meadows annually

ACREAGE OF DRY MEADOW SPECIES

Species	Minimum Estimate	Maximum Estimate
AGSP	274	308
CXAV	.2	.23
CXSR	96	105
FERV	130	144
HOJU	425	478
POSP	1,223	1,358
PUCC	209	234
EPAN	163	182
EPPA	20	22
PTSP	212	237
SAOF	10	11
SOSP	5	6
TOTAL	2,767	3,085

DRY MEADOW GRAND TOTAL

= 2,767+2,696 & 3,085+3,016
= 5,463 & 6,101 acres
– 2.47 acres/hectare
= 2,212 - 2,470 hectares
x 2,000 kg/ha (1,785 lbs/acre) forage produced in dry meadows (Reynolds and Peden, 1987)
= 4,424,000 - 4,940,000 kg forage produced (9,753,239 - 10,890,823 lbs)
average use of 10 kg (22 lbs) forage/bison/day (Telfer and Scotter, 1975)
= 1,240 kg (2,734 lbs) forage/bison/4 month summer period (=124 days)
assuming desirable moderate forage removal of 1/3 of total forage production
= 1,474,667 - 1,646,667 kg of forage available for removal
(3,251,080 - 3,630,274 lbs)
= 1,189 - 1,328 bison supported by Birch Creek dry meadows annually

* CCNE includes CANE and CACA which occur in dry and wet meadows.
** Conversion factors are 1 kg = 2.20462 lbs and kg/ha x .89256 = lbs/acre.

Table 19. Total estimated forage production in wet and dry meadows in the Black River area, and number of bison that could be supported in each meadow type.

ACREAGE OF WET MEADOW SPECIES

Species	Minimum Estimate	Maximum Estimate
BEER	378	649
CXRO	706	999
EQAR	127	174
EQFL	2,128	3,225
CXAT	2,020	2,964
GLST	61	93
TOTAL	5,420	8,104

plus ½ of CCNE to wet meadows*
½ of CCNE to dry meadows
= 4,718 - 7,201 – 2
= 2,359 - 3,601 acres
of CCNE to each wet and dry meadows

WET MEADOW GRAND TOTAL

= 5,420+2,359 & 8,104+3,601
= 7,779 & 11,705 acres
– 2.47 acres/hectare
= 3,149 - 4,739 hectares
x 4,000 kg/ha (3,570 lbs/acre)** forage produced in wet meadows (Reynolds and Peden, 1987)
= 12,596,000 - 18,956,000 kg forage produced (27,769,394 - 41,790,777 lbs)
average use of 10 kg (22 lbs) forage/bison/day (Telfer and Scotter, 1975)
= 2,410 kg (5,313 lbs) forage/bison/8 month winter period (=241 days) (wet meadow forage required annually)
assuming desirable moderate forage removal of 1/3 of total forage production
= 4,198,667 - 6,318,667 kg of forage available for removal
(9,256,465 - 13,930,260 lbs)
= 1,742 - 2,622 bison supported by Black River wet meadows annually

ACREAGE OF DRY MEADOW SPECIES

Species	Minimum Estimate	Maximum Estimate
AGSP	87	161
ALAE	149	214
CXAV	.8	1.5
CXDI	138	190
CXSR	38	61
FERV	13	18
HOJU	234	402
POSP	357	591
PUCC	44	82
EPAN	63	101
EPPA	2	4
PTSP	42	63
TOTAL	1,168	1,889

DRY MEADOW GRAND TOTAL

= 1,168+2,359 & 1,889+3,601
= 3,527 & 5,490 acres
– 2.47 acres/hectare
= 1,428 - 2,223 hectares
x 2,000 kg/ha (1,785 lbs/acre) forage produced in dry meadows (Reynolds and Peden, 1987)
= 2,855,870 - 4,446,000 kg forage produced (6,296,108 - 9,801,741 lbs)
average use of 10 kg (22 lbs) forage/bison/day (Telfer and Scotter, 1975
= 1,240 kg (2,734 lbs) forage/bison/4 month summer period (=124 days) (dry meadow forage required annually)
assuming desirable moderate forage removal of 1/3 of total forage production
= 951,957 - 1,482,000 kg of forage available for removal
(2,098,703 - 3,267,247 lbs)
= 768 - 1,195 bison supported by Black River dry meadows annually

* CCNE includes CANE and CACA which occur in dry and wet meadows.
** Conversion factors are 1 kg = 2.20462 lbs and kg/ha x .89256 = lbs/acre.

APPENDIX A

Table 1. Data form for recording plant species composition.

SPECIES COMPOSITION ON PLOTS	LEGEND: 1 = 0-.1/ 2 = .1-1/ 3 = 1-10/ 4 = 10-100																			
Date:	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10		P1	P2	P3	P4	P5	P6	P7	P8	P9	P10
Mosses/Lichens ht(cm):___											Forbs(cont'd)										
											MENYTRI										
											TRIGLMARI										
Graminoids ht(cm):___																					
CXAQ																					
CXAT																					
CXRO																					
CXSA																					
CX___																					
CX___																					
ERAN											Ericaceous/dwarf shrubs ht(cm):___										
ERVA											CHAMCALY										
SCRPVAL											ANDRMPOL										
JU___											ARUV										
EL___											AR__										
BCKERU											VAVI										
PUCC___											VAUL										
GLYCMAX											EMNI										
CA___											LEDUM___										
ARLA											RUCHAMAE										
ARFU											SALIX___										
ELYM___											BENA										
AGRO___											ROAC										
ALOAE/AL																					
HORDJU																					
DECA																					
											Taller shrubs ht(cm):___										
											SAAL										
											SAAR										
											SAPU										
											SA___										
											SA___										
Forbs ht(cm):___											ALN___										
EPILOB___											BEGL										
SOLIDG___																					
SAOFF																					
POTPAL																					
ACHILL___																					
EQUIS___																					
EQUIS___											Trees ht(cm):___										
RUAR/SI											POBA										
CALLAPAL																					
TYPHLAT																					

APPENDIX A

Table 2. Data form for recording meadow characteristics.

DATE:_____ TIME:_____ PLOT#:___ SITE#:_____ GPS:_____

PHOTO #'S: AERIAL___ PROFILE___ OTHER ___ ___ ___

SOIL: DRY, MOIST, SAT'D, FLOOD GRAMIN BIOMASS: LOW_____ MED_____ HI_____
(KG/HA) 500-1000 1000-2200 2200+

PROFILE DIAGRAM:
N S

SAME/DIFF THAN MAPPED?
HOW? _____

COMMENTS (ZONES,SUCCSN,BRWS POT'L,UNG,WTRFL USE)_____

SAMPLE #'S, NAMES: ___ _____ ___ _____ ___ _____

___ _____ ___ _____ ___ _____ ___ _____

DATE:_____ TIME:_____ PLOT#:___ SITE#:_____ GPS:_____

PHOTO #'S: AERIAL___ PROFILE___ OTHER ___ ___ ___

SOIL: DRY, MOIST, SAT'D, FLOOD GRAMIN BIOMASS: LOW_____ MED_____ HI_____
(KG/HA) 500-1000 1000-2200 2200+

PROFILE DIAGRAM:
N S

SAME/DIFF THAN MAPPED?
HOW? _____

COMMENTS (ZONES,SUCCSN,BRWS POT'L,UNG,WTRFL USE)_____

SAMPLE #'S, NAMES: ___ _____ ___ _____ ___ _____

___ _____ ___ _____ ___ _____ ___ _____

APPENDIX A

Table 3. Simplified data form for recording plant species composition from the air.

Plot #:_____ Date:_____ GPS:_____

Photo No's:_____ Time:_____

Plant Species	Percent Cover			
SPP.	10-100	1-10	.1-1	.01-.1
CXAQ				
CXAT				
CXRO				
CACA				
JUSP				
HOJU				
POSP				
EQSP				
PTSP				
GLST				
SCFE				
BEER				

Nutrient Samples:

APPENDIX B

Table 1: Plant species recorded in Birch Creek study area, June 1994.

Abbreviated name	Latin name	Common name
Grasses, sedges, rushes and horsetails*		
AGSP	*Agropyron spp.*	wheatgrasses
ARFU	*Arctophila fulva*	pendent grass, mud grass
BEER	*Beckmannia erucaeformis*	slough grass
CACA	*Calamagrostis canadensis*	bluejoint reedgrass
CANE	*Calamagrostis neglecta*	narrow reedgrass
CCNE	the above two species combined	reedgrasses
CXAQ	*Carex aquatilus*	water sedge
CXAT	*Carex atherodes*	slough sedge, awned sedge
CXAU	*Carex aurea*	golden sedge
CXRO	*Carex rostrata*	beaked sedge
CXSR	*Carex sartwelli*	Sartwell's sedge
DECA	*Deschampsia caespitosa*	tufted hairgrass
ELPA	*Eleocharis palustris*	spike rush
EQAR	*Equisetum arvense*	field/meadow horsetail
EQFL	*Equisetum fluviatile*	swamp horsetail
EQSP	the above two species combined	horsetail
ERAN	*Eriophorum angustifolium*	tall cottongrass
ERVA	*Eriophorum vaginatum*	tussock cottongrass
FERU	*Festuca rubra*	red fescue
GLST	*Glyceria striata/maxima*	manna grass
HOJU	*Hordeum jubatum*	foxtail barley
JUAR	*Juncus arcticus*	Arctic rush
JUFI	*Juncus filiformis*	filiform rush
JUSP	the above two species combined	rush
POSP	*Poa spp.*	bluegrasses
PUCC	*Puccinellia spp.*	alkali grasses
SCFE	*Scolochloa festucacea*	common river grass
SCVA	*Scirpus validus*	great bulrush
Herbaceous plants, including aquatics*		
ACHI	*Achillea spp.*	yarrows
AQBR	*aquatic Brassica*	
ARTI	*Artemisia tilesii*	common wormwood sage
CAPA	*Caltha palustris*	yellow marsh marigold
CIMA	*Cicuta mackenziana*	poison water hemlock
CNCN	*Cnidium cnidiifolium*	northern hemlock-parsley
CSCA	*Castilleja caudata*	pale paintbrush
EPAN	*Epilobium angustifolium*	fireweed
EPPA	*Epilobium palustre*	swamp willow-herb
ERCH	*Erysimum cheiranthoides*	yellow wallflower, mustard
ERSP	*Erigeron spp.*	fleabanes

Chamaedaphne calyculata

Birch Creek study area (continued)

Abbreviated name	Latin name	Common name
GLMA	*Glaux maritima*	sea milkwort
HIVU	*Hippuris vulgaris*	common mare's tail
METR	*Menyanthes trifoliata*	buckbean
PEFR	*Petasites frigidus*	Arctic sweet coltsfoot
PLHY	*Platanthera hypereborea*	northern green bog orchid
PMSP	*Potamogeton spp.*	pondweeds
POAM	*Polygonum amphibium*	water smartweed
PRST	*Primula stricta*	primrose
PTAN	*Potentilla anserina*	silverweed
PTPA	*Potentilla palustris*	marsh cinquefoil
PTSP	*Potentilla spp.*	other cinquefoil species
RAGM	*Ranunculus gmelini*	creeping crowfoot
RASP	*Ranunculus spp.*	buttercups
RMAR	*Rumex arcticus*	Arctic dock
RUAR	*Rubus arcticus*	nagoon berry
SAOF	*Sanguisorba officionalis*	common burnet
SECO	*Senecio congestus*	mastodon weed, marsh fleabane
SESP	*Senecio spp.*	groundsels
SOSP	*Solidago spp.*	goldenrods
STSP	*Stellaria spp.*	chickweeds
TRMA	*Triglochin maritimum/ palustris*	maritime/marsh arrowgrass
TYLA	*Typha latifolia*	cattail
UMBL	CNCN, CIMA and other parsley family plants combined	
UTVU	*Utricularia vulgaris*	common bladderwort
Dwarf Shrubs, shrubs and trees**		
ARUV	*Arctostaphylos uva-ursi*	bearberry, kinnikinnick
BEGL	*Betula glandulosa*	resin birch
BENA	*Betula nana*	dwarf arctic birch
PIGL	*Picea glauca*	white spruce
PIMA	*Picea mariana*	black spruce
POBA	*Populus balsamifera*	balsam poplar
POTR	*Populus tremuloides*	trembling aspen
ROAC	*Rosa acicularis*	prickly rose
SAAL	*Salix alaxensis*	feltleaf willow
SAAR	*Salix arbusculoides*	littletree willow
SABR	*Salix brachycarpa*	barren ground willow
SACA	*Salix candida*	silver willow
SAGL	*Salix glauca*	grayleaf willow
SAIN	*Salix interior*	sandbar willow
SAMO	*Salix monticola*	park willow
SAPU	*Salix pulchra*	diamondleaf willow

* Lists of herbaceous plants include all species encountered during sampling and are fairly complete lists of all species present.

** Lists only the most common trees and shrubs found along meadow edges and is not a complete list of woody plants.

APPENDIX B

Table 2: Plant species recorded in Black River study area, June 1994.

Abbreviated name	Latin name	Common name
Grasses, sedges, rushes and horsetails*		
AGSP	*Agropyron spp.*	wheatgrasses
ALAE	*Aloecurus aequalis*	squirreltail grass
ARFU	*Arctophila fulva*	pendent grass, mud grass
BEER	*Beckmannia erucaeformis*	slough grass
CACA	*Calamagrostis canadensis*	bluejoint reedgrass
CANE	*Calamagrostis neglecta*	narrow reedgrass
CCNE	the above two species combined	reedgrasses
CXAQ	*Carex aquatilus*	water sedge
CXAT	*Carex atherodes*	slough sedge, awned sedge
CXAU	*Carex aurea*	golden sedge
CXDI	*Carex diandra*	
CXRO	*Carex rostrata*	beaked sedge
CXSR	*Carex sartwelli*	Sartwell's sedge
ELPA	*Eleocharis palustris*	spike rush
EQAR	*Equisetum arvense*	field/meadow horsetail
EQFL	*Equisetum fluviatile*	swamp horsetail
EQSP	the above two species combined	horsetail
ERAN	*Eriophorum angustifolium*	tall cottongrass
FERU	*Festuca rubra*	red fescue
GLST	*Glyceria striata/maxima*	manna grass
HOJU	*Hordeum jubatum*	foxtail barley
JUSP	*Juncus spp.*	rushes
POSP	*Poa spp.*	bluegrasses
PUCC	*Puccinellia spp.*	alkali grasses
SCFE	*Scolochloa festucacea*	common river grass
SCVA	*Scirpus validus*	great bulrush
Herbaceous plants, including aquatics*		
ACHI	*Achillea spp.*	yarrows
ARTI	*Artemisia tilesii*	common wormwood sage
CALL	*Calla palustris*	wild calla lily
CAPA	*Caltha palustris*	yellow marsh marigold
CIMA	*Cicuta mackenziana*	poison water hemlock
CNCN	*Cnidium cnidiifolium*	northern hemlock-parsley
EPAN	*Epilobium angustifolium*	fireweed
EPPA	*Epilobium palustre*	swamp willow-herb
ERCH	*Erysimum cheiranthoides*	yellow wallflower, mustard
HIVU	*Hippuris vulgaris*	common mare's tail
LEMN	*Lemna sp.*	duckweed
METR	*Menyanthes trifoliata*	buckbean

Abbreviated name	Latin name	Common name
PEFR	*Petasites frigidus*	Arctic sweet coltsfoot
POAM	*Polygonum amphibium*	water smartweed
POSU	*Potamogeton subsibiricus*	subsiberian pondweed
PTAN	*Potentilla anserina*	silverweed
PTPA	*Potentilla palustris*	marsh cinquefoil
PTSP	*Potentilla spp.*	other cinquefoil species
RAGM	*Ranunculus gmelini*	creeping crowfoot
RMAR	*Rumex arcticus*	Arctic dock
RUAR	*Rubus arcticus*	nagoon berry
SECO	*Senecio congestus*	mastodon weed, marsh fleabane
STSP	*Stellaria spp.*	chickweeds
SUDE	*Suaeda depressa*	sea-blite
TRMA	*Triglochin maritimum/ palustris*	maritime/marsh arrowgrass
TYLA	*Typha latifolia*	cattail
UMBL	CNCN, CIMA and other parsley family plants combined	
Dwarf Shrubs, shrubs and trees**		
ROAC	*Rosa acicularis*	prickly rose
SABR	*Salix brachycarpa*	barren ground willow
SAOF	*Sanguisorba officionalis*	common burnet
SAPU	*Salix pulchra*	diamondleaf willow

* Lists of herbaceous plants include all species encountered during sampling and are fairly complete lists of all species present.

** Lists only the most common trees and shrubs found along meadow edges and is not a complete list of woody plants.

APPENDIX B

Table 3: Plant species* recorded in the Shovun Lake, Bearman Lake and Chalkyitsik study areas, June 1994.

Abbreviated name	Latin name	Common name	Shovun Lake	Bearman Lake	Chalkyitsik
Grasses, sedges, rushes and horsetails**					
AGSP	*Agropyron spp.*	wheatgrasses	X	X	
ALAE	*Alopecurus aequalis*	squirreltail grass			X
ARFU	*Arctophila fulva*	pendent grass, mud grass	X		X
BEER	*Beckmannia erucaeformis*	slough grass	X		
CACA	*Calamagrostis canadensis*	bluejoint reedgrass	X	X	X
CXAQ	*Carex aquatilus*	water sedge	X	X	X
CXAT	*Carex atherodes*	slough sedge	X	X	X
CXAU	*Carex aurea*	golden sedge		X	
CXDI	*Carex diandra*		X		
CXRO	*Carex rostrata*	beaked sedge	X	X	X
CXSR	*Carex sartwelli*	Sartwell's sedge			X
DECA	*Deschampsia caespitosa*	tufted hair grass		X	
ELPA	*Eleocharis palustris*	spike rush	X	X	X
EQAR	*Equisetum arvense*	field/meadow horsetail		X	
EQFL	*Equisetum fluviatile*	swamp horsetail	X	X	X
EQSP	the above two species combined	horsetail			
ERAN	*Eriophorum angustifolium*	tall cottongrass	X	X	
ERVA	Eriophorum vaginatum	tussock cottongrass	X	X	X
GLST	*Glyceria striata/maxima*	manna grass	X	X	
HOJU	*Hordeum jubatum*	foxtail barley	X	X	X
JUSP	*Juncus sp.*	rushes	X	X	X
POSP	*Poa spp.*	bluegrasses	X	X	X
PUCC	*Puccinellia spp.*	alkali grasses		X	X
SCFE	*Scolochloa festucacea*	common river grass	X	X	X
SCVA	*Scirpus validus*	great bulrush	X	X	X
Herbaceous plants, including aquatics**					
ACHI	*Achillea spp.*	yarrows	X	X	
AQBR	*aquatic Brassica*				
ARAL	*Arnica alpina*	alpine Arnica		X	
ARFR	*Artemisia frigida*	prairie/fringed sagewort	X	X	
CALL	*Calla palustris*	wild calla lily		X	
CAPA	*Caltha palustris*	yellow marsh marigold		X	
EPAN	*Epilobium angustifolium*	fireweed	X	X	X
ERCH	*Erysimum cheiranthoides*	yellow wallflower, mustard		X	X
HIVU	*Hippuris vulgaris*	common mare's tail	X	X	X
METR	*Menyanthes trifoliata*	buckbean	X	X	

Shovun, Bearman and Chalkyitsik study areas (continued)

Abbreviated name	Latin name	Common name	Shovun Lake	Bearman Lake	Chalkyitsik
OXCA	*Oxytropis campestris*	field oxytrope		X	
PAPA	*Parnassia palustris*	grass-of-Parnussus		X	
PEFR	*Petasites frigidus*	Arctic sweet coltsfoot		X	X
POAM	*Polygonum amphibium*	water smartweed	X		
POSU	*Potamogeton subsibiricus*	subsiberian pondweed	X		
PRST	*Primula stricta*	primrose		X	
PTAN	*Potentilla anserina*	silverweed	X	X	
PTSP	*Potentilla spp.*	other cinquefoil species	X	X	
RAGM	*Ranunculus gmelini*	creeping crowfoot		X	
RMAR	*Rumex arcticus*	Arctic dock	X	X	
RUAR	*Rubus arcticus*	nagoon berry		X	
SAOF	*Sanguisorba officionalis*	common burnet		X	X
SECO	*Senecio congestus*	mastodon weed	X		
SESP	*Senecio spp.*	groundsels		X	X
SODE	*Solidago decumbens*	decumbent goldenrod		X	
SPAN	*Sparganium angustifolium*	bur-reed	X	X	
STSP	*Stellaria spp.*	chickweeds	X	X	
TRMA	*Triglochin maritimum/palustris*	maritime/marsh arrowgrass	X	X	X
TYLA	*Typha latifolia*	cattail	X		X
UMBL	CNCN, CIMA and other parsley family plants combined		X		

* Woody plant species were not recorded for these study areas.

** Lists of herbaceous plants include all species encountered during sampling and are fairly complete lists of all species present.