THE GRIZZLY BEARS OF THE MACKENZIE MOUNTAINS NORTHWEST TERRITORIES

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ABSTRACT

In response to concern for the hunted grizzly bear population in the Mackenzie Mountains, N.W.T., a study of bears in a representative area of the Mackenzie Mountains was carried out from 1973 until 1977 by the N.W.T. Wildlife Service. Within the 3000 km^2 study area which is in the Backbone and Sekwi Ranges of the Mackenzie Mountains bears were captured, measured, tagged and equipped with radio collars. All random observations of bears during aircraft surveys were recorded. Faecal collection and analysis was carried out to determine food habits, and habitat studies were done to determine types and extent of vegetation zones. Den characteristics and denning behaviour are described.

From 67 captured bears and a total of 109 random bear observations made from 38 individually marked bears, we determined the age structure and potential growth of the population, and its distribution and abundance. Hunter kill data was used to consider the impact of hunter harvest on the age structure and distribution. The implications to grizzly bear management were then considered.

Our data showed natality rates to be low, and we conclude that this together with the late age of reproduction and the long inter-litter period severely limit the growth potential of the population. Including the observed mortality rates in our model indicates a declining population. We conclude that the Mackenzie Mountains grizzly bear population is marginal and any harvesting, including the current rate, is excessive. Local over-exploitation of the population could cause immigration into the harvested area with a resulting slow decline in the overall population density of the entire area.

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INTRODUCTION

When Europeans first arrived in North America, grizzly bears (Ursus arctos) inhabited the western half of North America from Alaska south to central Mexico (Storer and Trevis 1955, Cowan 1972, Stebler 1972). Today the grizzly is extinct in all eastern portions of its former range, and south of the Canadian border it exists only in a few isolated wilderness areas and National Parks. The early disappearance of bears can be attributed mainly to the advance of settlers who cleared large tracts of wilderness and indiscriminately killed all bears. Before they could be scientifically described, grizzly bear populations were exterminated in many states; Texas - 1890, North Dakota - 1897, Utah - 1923, California - 1924, Oregon - 1931, New Mexico - 1932 (Storer and Trevis 1955, Haynes and Haynes 1966). In Canada, grizzly bear ranges have also diminished (Schoomaker 1968).

Grizzly bears are a major component of the big game fauna of the Mackenzie Mountains, Northwest Territories along with Dall's sheep (Ovis dalli), caribou (Rangifer tarandus), moose (Alces alces) and wolves (Canis lupus). Those animals were traditionally hunted by Indians until the early 1900's. In 1938, the Mackenzie Mountains Game Preserve, covering the mountains east of the Yukon Territory, was set aside to protect the hunting grounds of the Indians from villages along the Mackenzie River. Hunting declined during World War II and the Reserve was abolished in 1953 (Stevens 1958). The Canadian Wildlife Service conducted a survey of the area in 1956 and 1957, and advised the Northwest Territories Council that the game population (including grizzly bears) could withstand moderate hunting and would provide a high percentage of trophy-class animals (Stevens 1958). In

response to Stevens' recommendations, an exploratory hunt was conducted in the fall of 1964 to familiarize potential outfitters with the area and its game resources in a small portion of the old Reserve. The first hunting season for non-resident hunters took place the following year from 1 August to 30 November. In 1967 the area open to non-resident hunting was expanded. Non-resident hunters were required to employ an outfitter who provided licensed guides. A hunter was allowed to take one of each big game species. Although non-resident hunters were primarily interested in obtaining trophy Dall's sheep, grizzly bears and caribou were next in importance (Simmons 1969).

In 1968, the number of grizzly bears harvested by non-residents increased 100% (from 18 to 37 bears) over the previous year. In 1969, a further 40% (15 bears) increase in the grizzly bear harvest was recorded. It was recognized by the N.W.T. Wildlife Service that little information existed on the grizzly bear population in the Mackenzie Mountains. Keele (1910) noted that black, brown, and grizzly bears were more or less numerous but not often encountered. Rand (1945) found grizzlies to be common in the Sekwi Valley and between Godlin and Twitya Rivers along the Canol Road. However, the use of garbage dumps at the construction camps along the Canol Road may have concentrated the animals at that time. Stevens (1958) reported that grizzly bear activity based on sign was common above timberline, but only one grizzly bear was observed.

By 1972, concern for the future of the hunted grizzly bear population in the Mackenzie Mountains precipitated a proposal for a 5 year study. The objectives of the study were:

1. To determine the abundance and seasonal distribution of bears in a representative area of the Mackenzie Mountains.

2. To relate the relative abundance of grizzly bears within the selected study area to the Mackenzie Mountains bear population as a whole.
3. To determine the density, age and sex composition, and reproductive rate of the grizzly population.
4. To describe the habitat of the bears.
5. To determine the food habits of bears in the representative area of the Mackenzie Mountains.
6. To analyze the non-resident hunter grizzly bear kill statistics for the Mackenzie Mountains (Game Management Zones 12 and 19, currently E-1).
7. To recommend a management plan for grizzly bears in the Mackenzie Mountains.

STUDY AREA

Location

The study area (3,000 km^2) is within the Backbone and Sekwi Ranges of the Mackenzie Mountains (Figs. 1 and 2). We selected the area because it was typical grizzly bear habitat and had limited accessibility from the abandoned Canol Road, and the lake and dirt airstrip located near the base camp at Godlin Lake. Helicopter support allowed some access to the remote areas.

Geology

The study area lies within the northeastern section of the Cordilleran region (Douglas et al. 1970). The Backbone Ranges of the Mackenzie Mountains form the major physiographic zone of the study area; a high plateau separates the area from the Selwyn Mountains to the southwest. Those ranges constitute a compact group of mountains, with a few broad valleys, and almost no plateaus or remnants of former land surface. Rock stratification is conspicuous in all parts (Bostock 1948). The region is rugged with local relief as high as 1550 m. Maximum elevations average between 2150 and 2500 m with valleys slightly below 1250 m, the approximate elevation of treeline (Blusson 1971).

The physiography can be broadly divided into three regions of differing lithology and structure (Douglas et al. 1970). In the northeast lies an arcuate belt of folded and faulted lower Paleozoic, consisting of light coloured limestones. The centre of the area consists of a large belt of lower Paleozoic shale, dolomites and

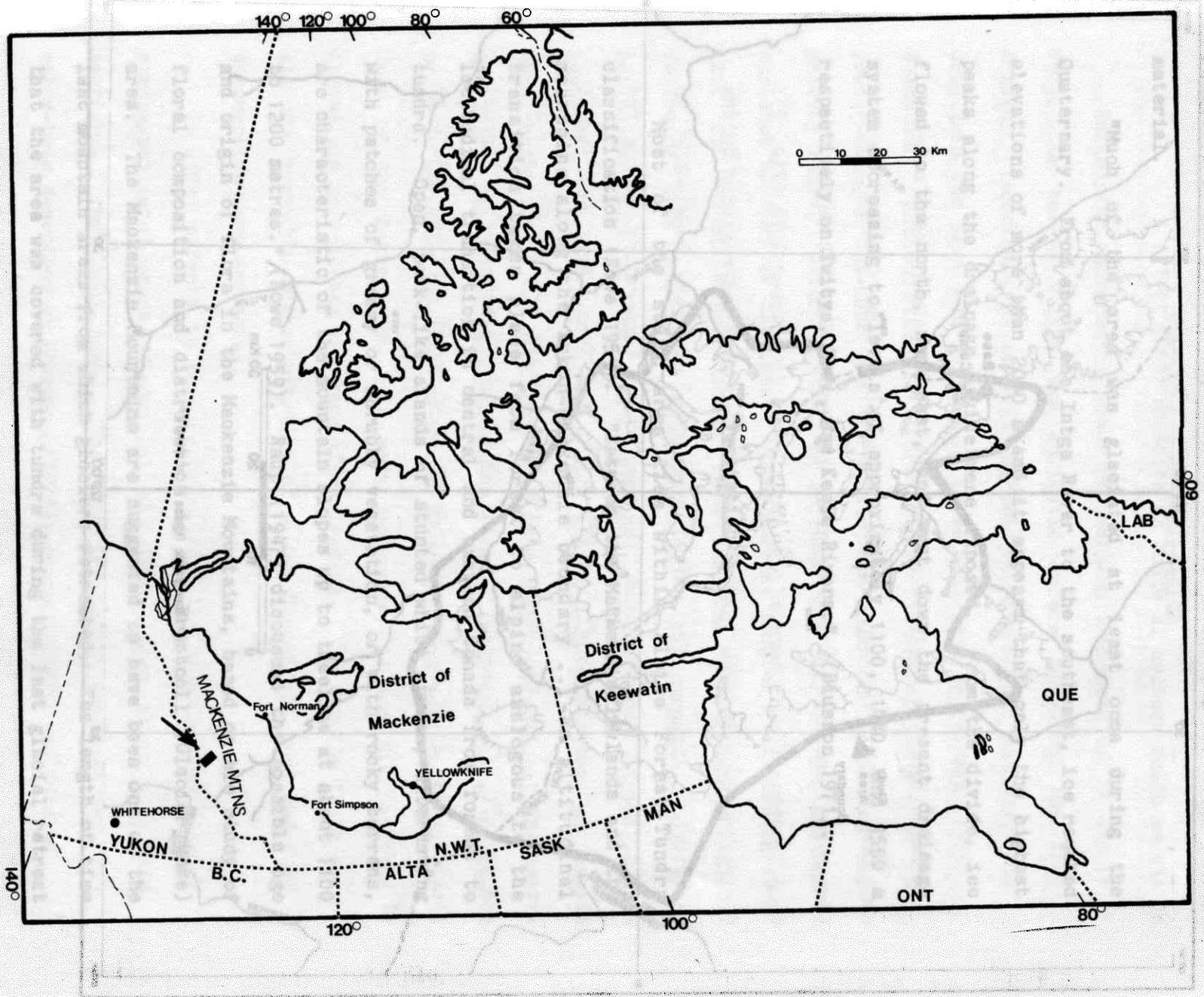

Figure 1. Location of the study area in the Northwest Territories, Canada.

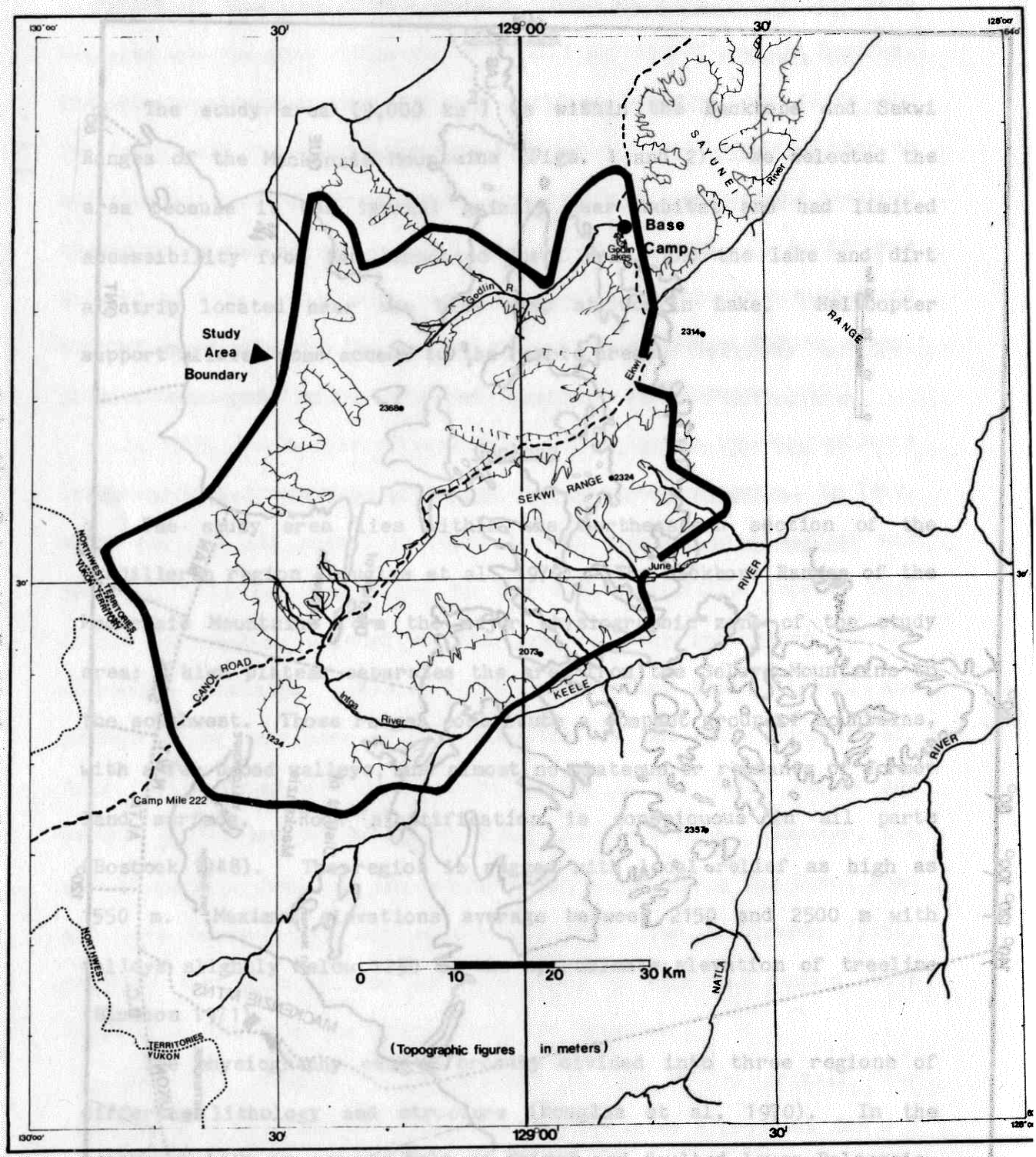

Figure 2. The study area in the Mackenzie Mountains, N.W.T.

slates. The southwest corner of the study area is formed primarily by Pleistocene and recent deposits of unconsolidated glacial alluvial material.

"Much of the area was glaciated at least once during the Quaternary. From about the Intga River to the southeast, ice reached elevations of more than 2000 m and it appears that only the highest peaks along the drainage divide were exposed. From the divide, ice flowed to the north, northeast, and east down the present drainage system decreasing to levels of approximately 1100, 1440, and 1550 m respectively on Twitya, Ekwi, and Keele Rivers." (Blusson 1971).

Vegetation

Most of the study area lies within Alpine Forest-Tundra classification (Rowe 1959). "Between the Mackenzie lowlands and the mountains along the Yukon-Mackenzie boundary ... an altitudinal transition takes place from forest to alpine analogous to the latitudinal transition in central and eastern Canada from forest to tundra. Open, park-like stands of stunted white spruce, alternating with patches of grassy or shrubby vegetation, or with rocky barrens, are characteristic of the mountain slopes up to treeline at about 1100 to 1200 metres." (Rowe 1959). Raup (1947) discusses the possible age and origin of flora in the Mackenzie Mountains, based on his study of floral composition and distribution in the Brentnell (Glacier Lake) area. The Mackenzie Mountains are suggested to have been one of the last mountain areas from which glaciers retreated. The length of time that the area was covered with tundra during the last glacial retreat

is thought to be quite short, with rapid invasion of the forest cutting short the process of alpine colonization. The general paucity of alpine plant species is cited as evidence (Raup 1947).

Climate

The climate is continental, with short, relatively warm summers, and long, cold winters. Amax Northwest Mining Company Limited (Vancouver) installed a meteorolgical station at Camp 222 on the Canol Road (southwest periphery of the study area) in October 1974 (Fig. 2). The following data from that station are based on observations during 1974-1977. Although the daily temperature can vary from -8.9° to 27.2°C, during summer months, the mean daily temperature during the summer is moderate, 7.5°, 10.8°, 7.0°C for June, July and August respectively. The mean daily winter temperatures are -17.0°, -21.9°, and -25.5°C, for December, January and February respectively. Annual precipitation of 47 cm is comprised of 14.30 cm of rain and 324.70 cm of snow.

MATERIALS AND PROCEDURES

Capture and Immobilization

Helicopter captures of bears for marking commenced on 14 August 1973. The bear's weight was estimated before preparing the drug dosage. Techniques of maneuvering the helicopter and shooting the drug into the bear were similar to those described by Pearson (1975). Sernylan (phenocyclidene hydrochloride) administered by a powder-charged Cap-Chur gun projectile was used to immobilize all grizzly bears. After darting, we followed the bear at the maximum distance to keep it in sight. Close pursuit induced fast running so that the animal became unduly exhausted and hyperthermic; close following also increased induction time. Bears were herded by helicopter only if they were approaching areas that might prove hazardous. Several helicopters were used during the study, but the maneuverability of the Bell 206B Jet Ranger made this machine the most suitable. The piston machines and the Hughes 500, required a landing prior to pursuing the bear to unload passengers and equipment, or the door of the Hughes 500. In many instances, it was difficult or impossible to relocate the bear after landing. The Gazelle SA340 has all the desirable characteristics of a Jet Ranger but cost and fuel consumption were excessive.

In 1974, efforts to capture bears with the grizzly size Aldrich spring-activated snare (Troyer et al. 1961) began along a 5 mile section of the Canol Road. The most frequently used set was the cubby-hole described by Erickson (1975), Pearson (1975) and others.

Marking

Bears were marked with Salacoloured numbered ear tags, 2.9 cm in diameter and 15 cm lengths of hollow braided 7.9 mm polypropylene tape to which was attached polyvinylchloride colour-coded tape as illustrated in Figure 3. Different colour combinations of flagging gave each bear a distinct identifying colour code. Ear tag numbers were tattooed on the inside of the bear's upper lip with a Ketchum's model 210B tattoo outfit.

Measurements

Seven body measurements were taken on each captured bear (Appendices I-III). A 508 kg capacity Salter Tension Machine No. 128 Scale attached to an aluminum tripod was used to determine weight. Neck circumferences of bears were taken to order proper collar sizes for the following years. Total body length, standing height, chest girth, foot length, and foot width were measured and later regressed against the live weight of the bear. If a significant linear relationship existed, we would be able to predict the live weight of bears and eliminate unwieldy tripods and weigh scales in the field in future.

Telemetry and Home Range Delineation

We attached transmitter collars around the bears' necks to obtain information on the seasonal movements and home range sizes. Collars consisted of a transmitter unit and a battery pack attached to a 7.5 cm wide strap of double industrial belting (PVC Industrial Belting).

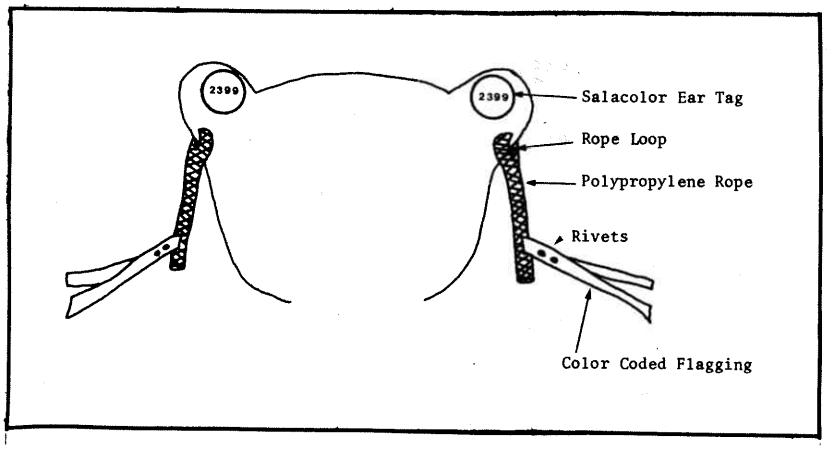

Figure 3. Rear view of a grizzly bear with ear loop, rope and flagging used to identify captured bears.

The collar contained a whip antenna. The transmitter unit and battery pack were covered with fiberglass reinforced acrylic resin to protect them from shock and moisture. Collars could be adjusted to the desired neck diameter by inserting four bolts in a series of holes in the overlapping ends of the straps. The entire transmitter collar weighed 0.76 kg and had a theoretical battery life of 12 months. Continuous scan controlled, and single channel controlled crystal receivers were used to track the collared bears. A description of the receivers and transmitters are given in Appendices IV and V.

We used a Helio-Courier airplane and occasionally a helicopter to search for collared bears. Two five-element yagi antennae were mounted on the airplane's fuselage (Fig. 4) and connected to a coaxial switch box inside the airplane. The coaxial switch box allowed us to monitor for the transmitter's pulsed signals with either the left or right antenna. Bears were monitored by flying to the last recorded position of a radio-tagged bear and searching the area by flying watersheds or transects 16 km apart at high altitudes (usually 2270 m) depending on weather conditions. When a signal was received, we searched the areas where the signal was most intense. The bear's approximate location was then determined by the indication of signal strength, or the exact location by sight. We used the same technique with a helicopter except that only one three-element yagi antenna was attached to the skid gear.

Home range size was calculated using the minimum home range polygon technique as described by Pearson (1975). The location of each bear observed was plotted on a topographic map and the extreme peripheral points were connected. The area within the polygon was measured as the minimum home range size of that bear.

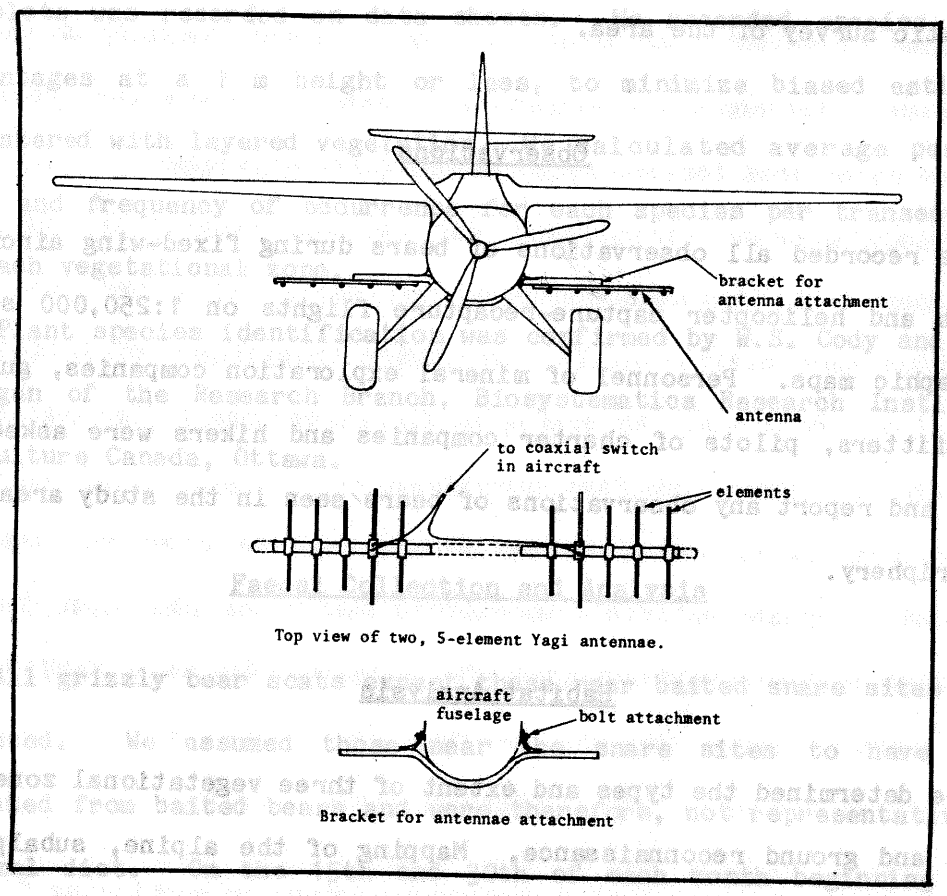

Figure 4. Mounting arrangement of two five-element yagi antennae on a Helio-Courier aircraft used to locate transmitter collared bears.

We attempted to monitor the study area and its periphery by aircraft at least once a week to locate the transmitter collared bears. However, the lack of consistent aircraft support and inaccessibility of the study area by ground travel prohibited a systematic survey of the area.

Observations

We recorded all observations of bears during fixed-wing aircraft surveys and helicopter capture-recapture flights on 1:250,000 scale topographic maps. Personnel of mineral exploration companies, guides of outfitters, pilots of charter companies and hikers were asked to record and report any observations of bears seen in the study area and its periphery.

Habitat Analysis

We determined the types and extent of three vegetational zones by aerial and ground reconnaissance. Mapping of the alpine, subalpine, and forest zones took place from June through September 1975. Each zone was sketched onto a 1:83,000 topographic map of the study area during flights on other phases of the study. The 1:83,000 map was enlarged from a standard 1:250,000 topographic map.

Ground sampling was used to determine the characteristic species composition, relative abundance and distribution of plant series within the three zones. Species composition of a variety of vegetative sites was assessed with transects laid out across the valleys in varying lengths of 250 to 2000 m depending on valley widths. Specific sites were described along 14 transects, each 300 m

long, laid out within a characteristic portion of each site. A 1 m^2 hoop was placed at 30 m intervals along each transect. The species composition for each plot was determined by visually estimating the percentage cover for each plant species within the hoop. A total of 496 plots was recorded on data sheets. We recorded species cover percentages at a 1 m height or less, to minimize biased estimates encountered with layered vegetation. We calculated average percent cover and frequency of occurrence for each species per transect and for each vegetational zone.

Plant species identification was confirmed by W.S. Cody and G.A. Mulligan of the Research Branch, Biosystematics Research Institute, Agriculture Canada, Ottawa.

Faecal Collection and Analysis

All grizzly bear scats except those near baited snare sites were collected. We assumed those near the snare sites to have been defecated from baited bears and were therefore, not representative of a normal diet. On the 15th and 30th of each month beginning with June, we used Honda 125 cc trail bikes on the Canol Road to collect scats from the base camp to mile 222. All scats were individually identified according to location and period of defecation which was classified in 15 day periods, from 1 May to 30 September.

Scats were stored in paper bags and air dried for later analysis in the laboratory. Laboratory analysis followed the techniques of Hatler (1967), Mundy and Flook (1973), and Hamer (1974). Each scat was rehydrated in water for 24 hours, then washed in a size 18 sieve screen, to clean and remove the minute, indiscernible particles. Five

10 ml subsamples, randomly taken from the screen, were each mixed with 70 ml of water to separate food items and then placed in a quadrated petri dish. Where macroscopic identification of the food items was impossible, microscope slides of the contents were prepared and identified by cellular structure with a 100 power compound binocular microscope. Reference collections of plants and seeds were obtained from the study area for use in the identification process.

The occurrence (frequency) and percent composition of each identified food item was recorded for each scat after the five subsamples were analysed. The percentage composition of food items per scat was determined by averaging the percentage volume estimates of single food items from five subsamples.

We identified and recorded food items to species whenever possible; otherwise materials were identified as to genera or family. Food items that we could not identify, were recorded as unidentified.

Denning

Dens were observed during capture-recapture or monitoring flights and their location plotted on a 1:250,000 topographic map. These den sites were later visited whenever a helicopter was available. Internal measurements, slope, aspect, elevation, and habitat types in which the den was located were recorded.

Hunter Kills

From 1973 to 1978 the skulls from every grizzly bear killed in the Mackenzie Mountains by non-resident hunters was requested. Each skull was accompanied by a hunter return booklet which gave the date

and location of the kill, sex of the bear, and indicated whether the hunter was specifically hunting for grizzly bear.

Age Determination

We removed the first lower premolars (PM_1) from each captured bear and hunter killed bear. They were stored in small envelopes marked with the bear's ear tag number, capture location, date, and sex for later laboratory analysis. We decalcified, sectioned, mounted, stained, and counted the annuli in the cementum. The technique of counting annuli has been tested by Stoneberg and Jonkel (1966), Craighead et al. (1970), and Pearson (1975).

Teeth were prepared for examination by being soaked for at least 72 hours in 10% formalin. The volume of formalin was at least 10 times greater than the volume of the tooth. After soaking, the teeth were rinsed with water. Each tooth was decalcified in 150 ml of a 1:1 solution of 22.5% formic acid buffered with 20% sodium citrate. The solution was replaced every 2 days. If decalcification was incomplete, a white precipitate formed in the buffered formic acid within 2 to 4 hours; a clear solution indicated complete decalcification. The tooth was also tested daily for flexibility.

Decalcification took between 4 and 10 days depending on the size of the tooth and the degree of calcium fixation. After decalcification, the teeth were rinsed in running water for 15 hours to neutralize the acid and to prevent the teeth from drying out. The teeth were embedded in Ames O.X.T. embedding compound on a brass disc and frozen in a Cryostat at $-17^{o}C$. Four groups of twenty 10 micron thick sections were cut from each tooth with a freezing microtome and

placed for 20 minutes in a solution of slightly basic water. Two sections from each group were mounted on an albuminated microscope slide, dried, and stained with a solution of toluidine blue. The annuli in the tooth cementum were read under a 100 power compound binocular microscope.

RESULTS AND DISCUSSION

Capture and Immobilization

Sixty-seven grizzly bears were captured from 1973 to 1977. Of those, seven were captured with foot snares. All snared bears suffered skin abrasions on the snared foot but no permanent damage was observed when we recaptured the bears.

The average dosage of Sernylan used to immobilize a bear was 4.33 mg/kg with a range of 1.43 to 11.38 mg/kg. There was a significant difference between the mean dosage required from one month to the next ($F = 2.44$, $P < 0.1$). The mean dosage for June, July, August, and September was 3.44, 3.18, 5.00, and 5.29 mg/kg respectively. One possible cause of the difference in dosages may be that as fat deposits increase in fall, injections are more frequently subcutaneous. Subcutaneous injections result in slower absorption than those into muscle tissue.

Weights and Measurements

Body Weights

Males were heavier than females in all ages except for age 8.0 to 8.9 years; however, this exception was most likely due to small sample size (Table 1). The average weight of 20 adult males ($\geq$ 5 years) was 148.5 kg, and 109.8 kg for 28 females. This is similar to previously reported results from southwestern Yukon (Pearson 1975) but smaller than that reported for Alberta (Nagy and Russell 1978) and Alaska (Crook 1971, Reynolds 1976). The heaviest male was a 21 year old weighing 214 kg captured on 26 June 1976. The heaviest female was a

Table 1. Average weights by age class of grizzly bears captured in the Mackenzie Mountains, N.W.T. from 1973 to 1977.

	Male			Female		
Age class	n	$\bar{x}$(kg)	Range (kg)	n	$\bar{x}$(kg)	Range (kg)
0.0- 0.9	2	30.1	25.4- 34.9	-	-	-
1.0- 1.9	3	62.9	58.5- 66.1	-	-	-
2.0- 2.9	6	98.1	76.1-138.1	-	-	-
3.0- 3.9	1	99.1	-	2	76.3	67.6- 85.3
4.0- 4.9	2	110.5	107.9-113.0	3	89.8	65.1-113.0
5.0- 5.9	4	116.8	88.9-138.1	3	105.8	91.4-113.0
6.0- 6.9	2	114.9	113.0-116.8	5	103.4	84.8-129.6
7.0- 7.9	1	113.0	-	-	-	-
8.0- 8.9	1	113.0	-	2	125.6	118.0-133.1
9.0- 9.9	1	107.9	-	-	-	-
10.0-10.9	-	-	-	1	97.9	-
11.0-11.9	-	-	-	1	81.3	-
12.0-12.9	1	135.6	-	2	108.8	107.9-109.8
13.0-13.9	1	173.4	-	5	115.6	104.2-129.6
14.0-14.9	1	191.0	-	3	123.2	106.7-147.3
15.0-15.9	1	186.0	-	2	110.5	107.9-113.0
16.0-16.9	1	206.1	-	1	97.9	-
17.0-17.9	-	-	-	1	110.4	-
18.0-18.9	2	174.6	-	-	-	-
19.0-19.9	1	150.7	-	1	107.9	-
20.0-20.9	1	145.7	-	-	-	-
21.0-21.9	1	213.7	-	1	106.7	-
22.0-22.9	-	-	-	-	-	-
23.0-23.9	1	178.4	-	-	-	-

14 year old weighing 147 kg captured on 4 July 1976. If the weights of bears are grouped in three ages of 3.0 - 5.9, 6.0 - 9.9 and 10 plus, the weight of males increases significantly with age ($F = 4.66$, $p < 0.10$) but that of females does not ($F = 0.26$) (Table 2).

The relationship between male weight and age was regressed using the formula of weight = 61.18 + 7.45 (age). The correlation coefficient was calculated to be 0.85 as expected, since males become heavier as they grow older. Females did not have a good relationship with a correlation coefficient of 0.38. This is probably a result of their larger energy committment to reproduction.

Seasonal Weight Changes

Little information was available on seasonal weight changes as only one bear was captured twice in any one field season.

Bear 2378 (Tease) was first captured on 28 June 1975 at 5 years of age weighing 91 kg. She was recaptured on 30 July 1976 and weighed 97 kg. On 22 August, Tease weighed 85 kg, a loss of 12 kg in 23 days. This loss cannot be explained. Pearson (1975) found that the period of weight increase corresponded to the ripening and utilization of berries. The year 1976 appeared to be a good berry year based on comparison of diets of bears in 1975; therefore Tease should have increased in weight.

Length - Weight Relationship

The length-weight relationships of 60 captured bears can be expressed by the regression equation, weight = 1.22 (length) - 89.53. The low correlation coefficient of 0.638 indicated that length should not be used to estimate weight.

Table 2. Area extent of plant groups and bare ground within three vegetation zones, plus primarily unvegetated terrain, and lakes on the 3000 km^2 grizzly study area in the Mackenzie Mountains, N.W.T.

	Forest zone		Subalpine shrub zone		Alpine heath-meadow zone		Totals	
	Area km^2	% of total area	Area km^2	% of total area	Area km^2	% of total area	Area km^2	% of total area
Bare ground	24	0.8	58	1.9	178	5.9	260	8.6
Erect trees and shrubs	143	4.8	374	12.5	30	1.0	547	18.2
Prostrate shrubs and heaths	76	2.5	210	7.0	283	9.4	569	19.0
Sedges and rushes	41	1.4	113	3.8	74	2.5	288	7.7
Grasses	6	0.2	33	1.1	64	2.1	103	3.4
Forbs	13	0.4	67	2.2	177	5.9	257	8.6
Mosses	26	0.9	85	2.8	94	3.1	205	6.8
Lichens	57	1.9	137	4.6	49	1.6	243	8.1
subtotal	386	12.9	1077	35.9	949	31.5	2412	80.4
Primarily unvegetated terrain (ice, rock, gravel river beds)							580	19.3
Lakes							8	0.3
Total							3000	100.00

Weight - Chest Girth Relationship

The weight of bears was regressed against chest girth and found to be highly correlated, r = 0.96, using the formula, weight = 2.518 (chest girth) - 149 (Fig. 5). Outfitters and biologists should be able to use this formula to obtain accurate weights of hunter killed bears (Appendix XIX).

Habitat

On the basis of aerial and ground reconnaissance, we divided the study area into three vegetation zones. The remainder of the study area was classified as unvegetated terrain. The zones were identified by the presence of visually dominant plant species. White spruce (Picea glauca), was considered the dominant indicator species for the forest zone, shrub birch (Betula glandulosa) and willow (Salix spp.), the co-dominants in the subalpine shrub zone, and their absence delineated the alpine heath-meadow zone. Generally steep slopes made transition between zones abrupt, and the zones could be easily distinguished. Where the transition from one zone to another was more gradual, the zone boundaries were drawn approximately through the middle of the transition area.

Figure 6 illustrates the area of forest, subalpine shrub, alpine heath-meadow, and primarily unvegetated terrain in the study area. The forest, subalpine and alpine heath-meadow zones covered 12.9%, 35.9%, and 31.5% of the study area respectively. Primarily, unvegetated terrain covered the remaining 19.3%. The proportion of plant groups in each zone is given in Table 2. Cover and frequency of individual plant species are given in Appendices XI, XII, XIII, and XIV.

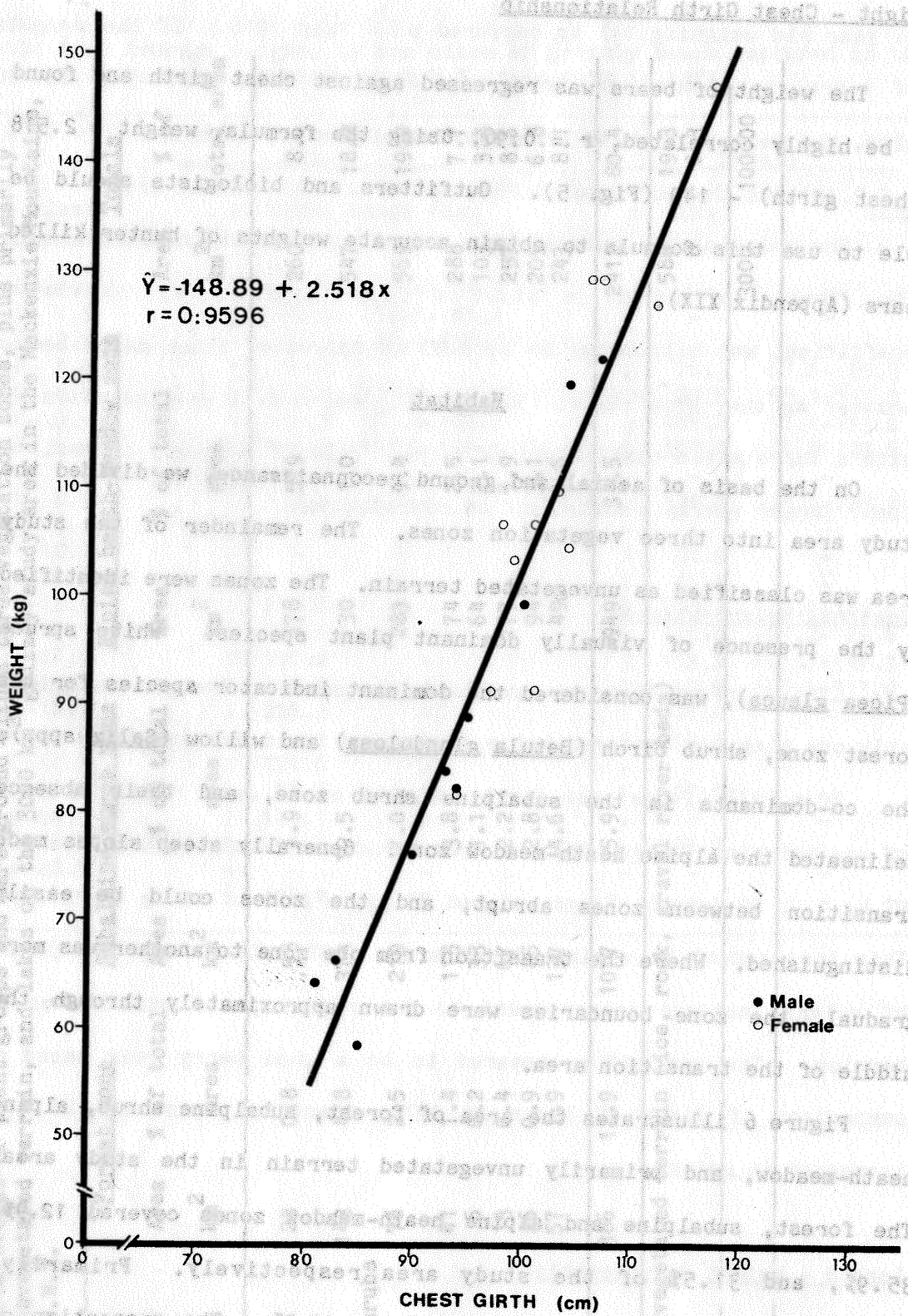

Figure 5. Plotted regression line on the relationship between chest girth and weight of grizzly bears in the Mackenzie Mountains, N.W.T.

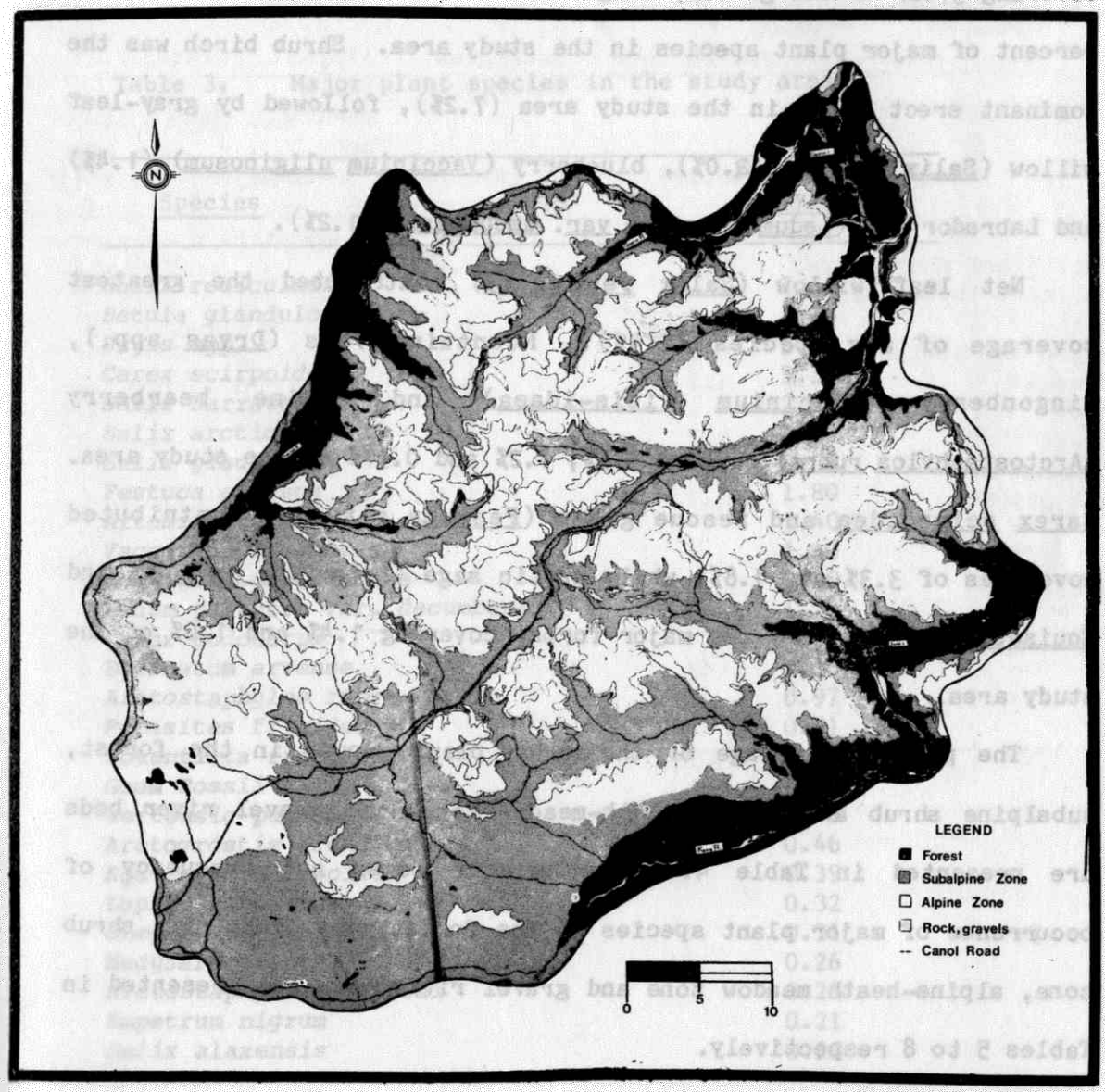

Figure 6. Vegetation zones of the study area in the Mackenzie Mountains, N.W.T.

Over the entire study area, erect trees and shrubs, and prostrate shrubs and heath, comprised the major portion of the vegetation covering 37.2% of the grizzly range (Table 2). Table 3 shows the area percent of major plant species in the study area. Shrub birch was the dominant erect shrub in the study area (7.2%), followed by gray-leaf willow (Salix glauca) (2.0%), blueberry (Vaccinium uliginosum) (1.4%) and Labrador tea (Ledum palustre var. decumbens) (1.2%).

Net leaf willow (Salix reticulata) contributed the greatest coverage of any species (7.4%). Mountain avens (Dryas spp.), lingonberry (Vaccinium vitis-idaea) and alpine bearberry (Arctostaphylos rubra) covered 5.5%, 1.2% and 0.97% of the study area. Carex scirpoidea and fescue grass (Festuca altaica) contributed coverages of 3.3% and 1.8%, while arctic sage (Artemisia arctica) and Equisetum arvense were the major forbs, covering 1.4% and 1.0% of the study area.

The percent coverage of the major plant groups in the forest, subalpine shrub and alpine heath-meadow zones and gravel river beds are presented in Table 4. The percent cover and frequency of occurrence of major plant species in the forest zone, subalpine shrub zone, alpine-heath meadow zone and gravel river beds are presented in Tables 5 to 8 respectively.

Table 3. Major plant species in the study area.

Species	Percent of study area
Salix reticulata	7.40
Betula glandulosa	7.20
Dryas spp.	5.50
Carex scirpoidea	3.30
Salix Barrattiana	2.90
Salix arctica	2.40
Salix glauca	2.00
Festuca altiaca	1.80
Artemisia arctica	1.40
Vaccinium ulginosum	1.40
Vaccinium vitis-idaea	1.20
Ledum palustre var. decumbens	1.20
Carex podocarpa	1.10
Equisetum arvense	1.00
Arctostaphylos rubra	0.97
Petasites frigidus	0.71
Potentilla fruticosa	0.59
Geum Rossii	0.53
Mertensia paniculata	0.49
Arctogrostis arundinacea	0.46
Equisetum scirpoides	0.39
Lupinus arcticus	0.32
Shepherdia canadensis	0.31
Hedysarum alpina	0.26
Arctostaphylos uva-ursi	0.23
Empetrum nigrum	0.21
Salix alaxensis	0.20

Table 4. Cover percentages for major plant groups and bare ground within the forest, subalpine shrub, alpine heath-meadow zones, and gravel river beds in the study area (n = number of quadrats).

	Forest zone (n=129)	Subalpine shrub zone (n=167)	Alpine heath-meadow zone (n=200)	Gravel river beds (n=34)
Erect trees and shrubs	36.7	34.7	3.2	10.9
Prostrate shrubs and heaths	19.5	19.5	29.9	5.2
Sedges amd rushes	10.6	10.5	7.8	1.5
Grasses	1.7	3.1	6.7	0.0
Forbs	3.4	6.2	18.6	6.5
Mosses	6.7	7.9	9.8	3.9
Lichens	14.7	12.7	5.2	-
Bare ground	6.7	5.4	18.8	72.0
Totals	100.0	100.0	100.0	100.0

Table 5. Percent cover and frequency of major plant species in the forest zone.

Species	Percent cover	Percent frequency
Betula glandulosa	15.1	55.8
Dryas spp.	9.9	46.2
Carex scirpoidea	8.3	46.9
Ledum palustre var. decumbens	5.4	46.9
Vaccinium uliginosum	3.4	23.9
Salix glauca	3.3	16.9
Vaccinium vitis-idaea	3.0	38.5
Arctostaphylos rubra	2.0	28.7
Potentilla fruticosa	1.9	30.8
Salix reticulata	1.8	14.6
Sheperdia canadensis	1.7	9.2
Picea glauca	1.6	10.8
Equisetum scirpoides	1.5	12.3
Arctostaphylos uva-ursi	1.3	10.0
Festuca altaica	1.3	16.9
Hedysarum alpina	1.1	25.4
Salix Barrattiana	0.83	6.9
Salix alaxensis	0.62	6.9
Empetrum nigrum	0.55	8.5
Lupinus arcticus	0.43	6.9
Equisetum arvense	0.18	3.1

Table 6. Percent cover and frequency of major plant species in the subalpine shrub zone.

Species	Percent cover	Percent frequency
Betula glandulosa	13.8	49.7
Salix reticulata	7.9	46.7
Salix Barrattiana	6.5	29.9
Dryas spp.	5.9	27.0
Carex scirpoidea	4.1	49.9
Salix glauca	3.9	12.6
Festuca altaica	2.8	33.3
Vaccinium uliginosum	2.5	21.0
Vaccinium vitis-idaea	2.3	16.8
Equisetum arvense	1.9	13.8
Arctostaphylos rubra	1.6	21.6
Ledum palustre var. decumbens	1.4	13.8
Potentilla fruticosa	0.82	11.4
Lupinus arcticus	0.70	10.3
Equisetum scirpoides	0.54	8.4
Petasites frigidus	0.45	10.2
Mertensia paniculata	0.39	12.0
Artemisia arctica	0.32	9.6
Hedysarum alpina	0.14	8.4

Table 7. Percent cover and frequency of major plant species in the alpine heath-meadow zone.

Species	Percent cover	Percent frequency
Salix reticulata	13.4	49.0
Salix arctica	7.3	49.0
Dryas spp.	6.3	28.5
Artemisia arctica	4.1	38.5
Carex podocarpa	2.6	25.0
Carex scirpoidea	2.3	20.0
Festuca altaica	1.8	12.5
Petasites frigidus	1.7	18.0
Geum Rossii	1.6	22.0
Salix Barrattiana	1.4	6.0
Arctogrostis arundinacea	1.3	14.0
Equisetum arvense	1.1	9.0
Mertensia paniculata	1.0	14.5
Betula glandulosa	0.97	3.5
Astragalus umbellatus	0.45	22.0

Table 8. Percent cover and frequency of major plant species on gravel river beds.

Species	Percent cover	Percent frequency
Salix alaxensis	5.4	26.5
Arctostaphylos rubra	3.7	14.7
Equisetum scirpoides	2.9	11.8
Salix Barrattiana	2.0	8.8
Hedysarum alpina	1.5	23.5
Salix reticulata	1.3	14.7
Sheperdia canadensis	1.1	5.9
Carex capillaris	0.38	14.7

Food Habits

A summary of grizzly bear food habits in the Mackenzie Mountains from 1975 to 1977 is given in Table 9. Individual scat analyses are given in Appendices VI, VII and VIII. Eight species of plants make up 96% of the diet: Equisetum spp. (40%), and Hedysarum alpinum (20%), Graminae spp. (9%), Vaccinium uliginosum (9%), Shepherdia canadensis (7%), Carex spp. (4%), Empetrum nigrum (4%), and Vaccinium vitis-idaea (3%). Although the two most important food species, horsetails and Hedysarum alpinum comprised 60% of a bear's diet, they ranked only 14th and 24th respectively in the percentage coverage of vegetation in the study area (Table 4).

No bear scats were collected in May when grizzly bears usually emerge from their dens. In the southern Yukon, Pearson (1975) found that bears fed primarily on roots at this time prior to green-up.

In June and July, bears in the study area were feeding primarily on horsetails and to a lesser extent on sedges, grasses and roots. Green matter made up more than 85% of their diet during June and July. Meat constituted only 3% of their summer diet.

In early August, green vegetation, especially horsetails, made up 27% of the bear's diet (Fig. 7). The berries of Vaccinum uliginosum, Shepherdia canadensis and to a lesser extent Empetrum nigrum were eaten as well as an increased usage of Hedysarum roots (Table 9). By late August, green vegetation was of minor importance and berries and roots comprised 84% of the diet. Empetrum nigrum as a seasonally important food has not been noted by other bear researchers and its use appears to be limited to the Mackenzie Mountains. In August 1975, crowberries made up 13% of bear diets and 9% and 21% respectively for

Table 9. Major food items in the diets of grizzly bears in the Mackenzie Mountains from scats collected from 1975 through 1977.

Period of defecation	June 1-15	June 16-30	July 1-15	July 16-31	August 1-15	August 16-31	Sept. 1-15	Total
Sample size	20	17	41	68	65	66	55	332
Food items	Percent composition (Frequency of occurrence)							
Equisetum spp.	52(75)	50(90)	69 (100)	70(97)	27(66)	12(41)	1(30)	40(71)
Hedysarum alpinum	8(42)	14(53)	tr.(42)	11(42)	28(89)	30(85)	52(92)	20(64)
Graminae spp.	16(56)	16(65)	16 (53)	6(63)	3(38)	2(5)	3(17)	9(48)
Vaccinium uliginosum	0(0)	4(20)	0 (0)	2(26)	22(79)	15(66)	20(57)	9(35)
Shepherdia canadensis	0(0)	tr. (11)	0 (0)	3(19)	11(71)	26(69)	9(41)	7(30)
Carex spp.	8(88)	8(86)	7 (90)	6(86)	2(57)	tr. (35)	1(46)	4(70)
Empetrum nigrum	tr.	tr. (32)	0 (0)	tr.(12)	3(51)	13(64)	13(49)	4(30)
Vaccinium vitis-idaea	10(25)	tr. (3)	0 (0)	tr.(7)	tr.(9)	tr. (16)	tr.(23)	3(12)
Unidentified	0.5(50)	5(30)	8 (35)	tr.(4)	1.8(25)	1(50)	tr.(67)	2(28)
Animal matter	3(14)	3(10)	tr.(3)	tr.(14)	1(15)	tr. (96)	5(8)	2(10)
Arctostaphylos uva-ursi	3(13)	0(0)	0 (0)	tr.(2)	tr.(2)	tr. (9)	0(0)	0.4(4)
Arctostaphylos rubra	0(0)	tr. (11)	0 (0)	tr.(5)	2(7)	tr. (3)	0(0)	0.3(4)
Salix spp.	tr.(53)	tr. (25)	tr.(14)	tr.(13)	tr.(24)	tr. (43)	tr.(46)	tr.(31)
Insect matter	tr.(50)	tr.(26)	tr.(3)	tr.(4)	tr.(10)	tr. (7)	tr.(30)	tr.(19)
Ledum palustre	tr.(3)	tr.(11)	0(0)	tr.(8)	tr.(48)	tr. (16)	tr.(22)	tr.(15)

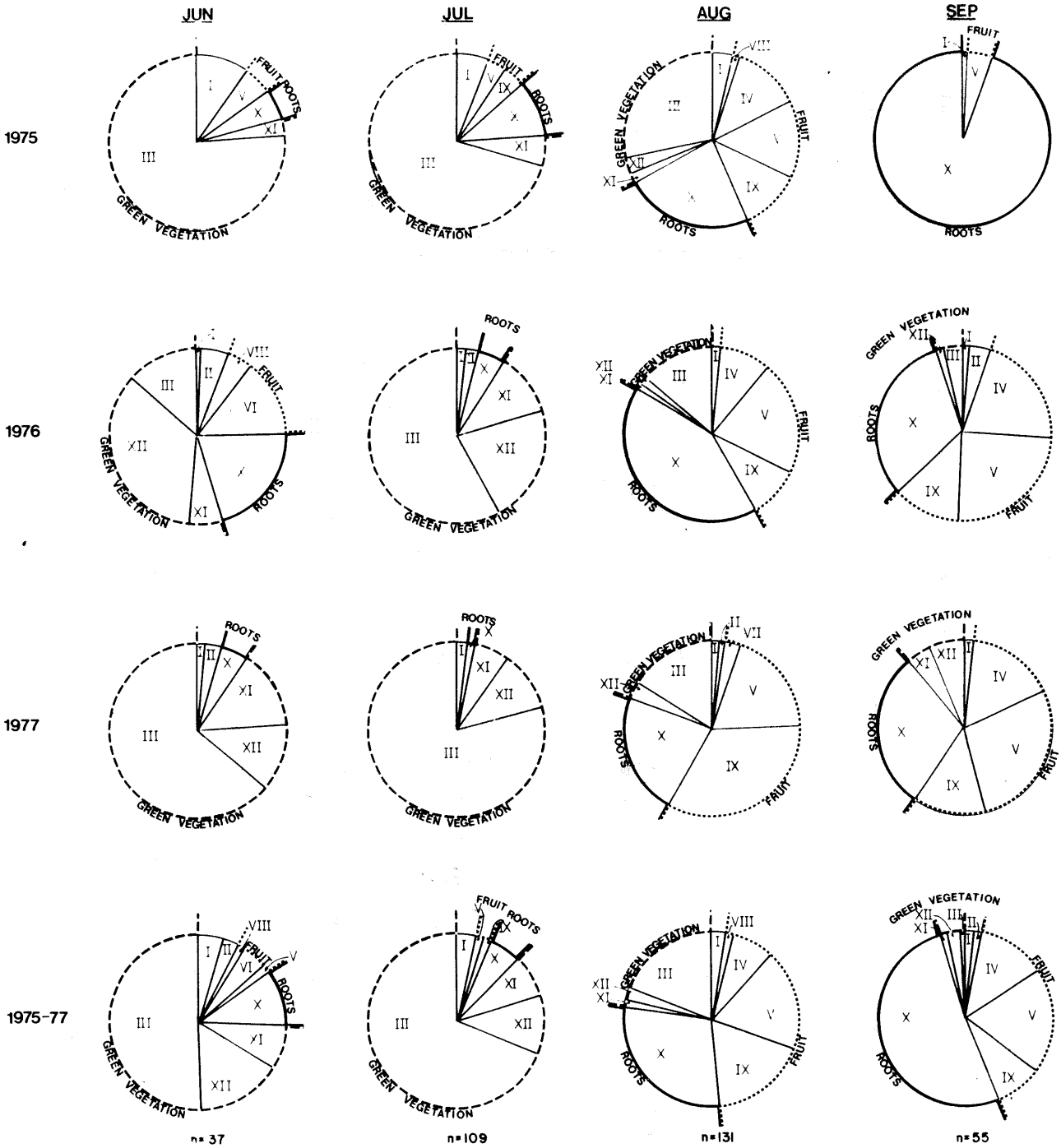

Figure 7. Grizzly bear food habits as determined from scats collected from 1975 through 1977 in the Mackenzie Mountains, N.W.T.

1977 and 1978 (Fig. 7). As a result of the prostrate growth form of the crowberry, it may be affected by frost later than other berries.

By September, scats were void of horsetails and consisted of roots (52%) and berries (42%). As September progressed bears moved higher into subalpine areas to feed on roots of Hedysarum along the alluvial fans of the numerous small creeks and on late developing patches of blueberries and crowberries (Fig. 7). The predominance of roots in 1975 likely reflects a berry crop failure. Normally however, bears continue to feed on roots and berries until denning time in October.

Our results are most similar to the findings of Nagy et al. (1977) for grizzlies in the area of Tuktoyaktuk, N.W.T. They found that horsetail, (Equisetum spp.), grasses, (Graminae spp.), and sedges (Carex spp.) comprised a major portion of a bear's diet following green-up in mid-June until mid-August. From then until September the bears fed almost exclusively on berries and arctic ground squirrels (Spermophilus parryii).

Predatory Behaviour

Scat analyses suggested that animal matter was relatively unimportant in bears' diets and indicated that grizzlies in the Mackenzie Mountains are not active predators. On two occasions however, adult male bears were observed feeding on fresh carcasses. Those observations occurred in the fall and involved a calf moose and an adult caribou.

Two bears were observed stalking ungulates. An adult female (2391) was seen in the subalpine stalking a full grown male moose

which was unaware of her presence only 30 m away. Despite the helicopter hovering 80 m above her, the bear was reluctant to discontinue her stalk and ran off only after the moose bolted at our presence. In contrast, a subadult female (2388) stalking a small group of caribou in the alpine, quickly abandoned her stalk and stood on her hind legs when our helicopter approached. We received other reports from pilots of bears chasing caribou in the alpine, but no kills were reported.

We did not find as did Nagy et al. (1977) that bears actively sought arctic ground squirrels. Areas where bears seemed to have dug for squirrels were noted, but there was not enough evidence to indicate that a major food item was missed in our scat collection.

Habitat Selection

Knowing the seasonal habitat preferences of bears is important in management of the species. Critical habitat can be protected from excessive human disturbance and bear-man conflicts can be reduced. Use of habitat types included within 13 home ranges of bears (Appendix XV) varied significantly during the months of June ($P<0.01$), July ($P<0.01$), August ($P<0.05$), September ($P<0.06$), and October ($P<0.05$) from the intensity of use expected if all types were used proportionally to their occurrence (Table 10).

The utilization of alpine habitat during June and July is possibly based on the availability of major food species, horsetails, grasses, sedges, and Hedysarum alpinum roots which make up 86% of bear diets (Fig. 7). In August, a significant decrease in the use of alpine occurred ($P<0.05$) and bears showed a preference for subalpine

Table 10. Habitat selection based on 13 grizzly bear home ranges in the Mackenzie Mountains, N.W.T.

Habitat	June			July			August			September			October		
type	O	E	X^2	O	E	X^2	O	E	X^2	O	E	X^2	O	E	X^2
Forest	5	7.5	0.83	6	15.2	5.56	15	12.1	0.72	3	9.6	4.51	0	2.1	2.08
Subalpine	10	18.6	3.96	23	37.7	5.71	36	29.9	1.23	27	23.7	0.45	9	5.2	2.86
Alpine	21	9.9	12.45	44	20.1	27.59	7	16.0	5.02	16	12.6	0.89	1	2.8	1.11
Total	36		17.24	73		38.85	58		6.97	46		5.85	10		6.05

O = Number of bear observations
E = Expected number of observations (% habitat cover x total bear observations)

areas (Table 10). By September, bears showed equal preference for alpine and subalpine areas, utilizing an area proportionately to its occurrence (Table 10). Forested areas appeared to be selected against at this time. Bears utilize the higher elevation habitat types as winter approaches and continue to do so until they den for the winter in October (Fig. 8).

Seasonal habitat selection of bears is related to changes in plant phenology. In the spring bears frequent the snow-free areas at low elevations and then follow the emergence of green vegetation as it progresses to higher elevations. With the ripening of the berry crops and the increase of root biomass in August, there is a movement of bears to lower elevations where berry and root production is highest. In late fall berries continue to ripen at higher elevations and bears increase their activity in these areas prior to denning.

Dens

Twenty-three dens were located during the study (Fig. 9). All were winter dens except one which appeared to be a day bed. Dens were located on slopes ranging from 31^{o} to 38^{o} with a predominantly southeast orientation (Fig. 10). The mean elevation was at 1619 m and ranged from 1402 m to 1829 m (Fig. 11). Soil type was described for 15 of the winter dens and all but three had dark, warm chernozemic soils; one was in forest podzolic soil and two in poorly developed colluvial soil. Nine of the dens had collapsed when located.

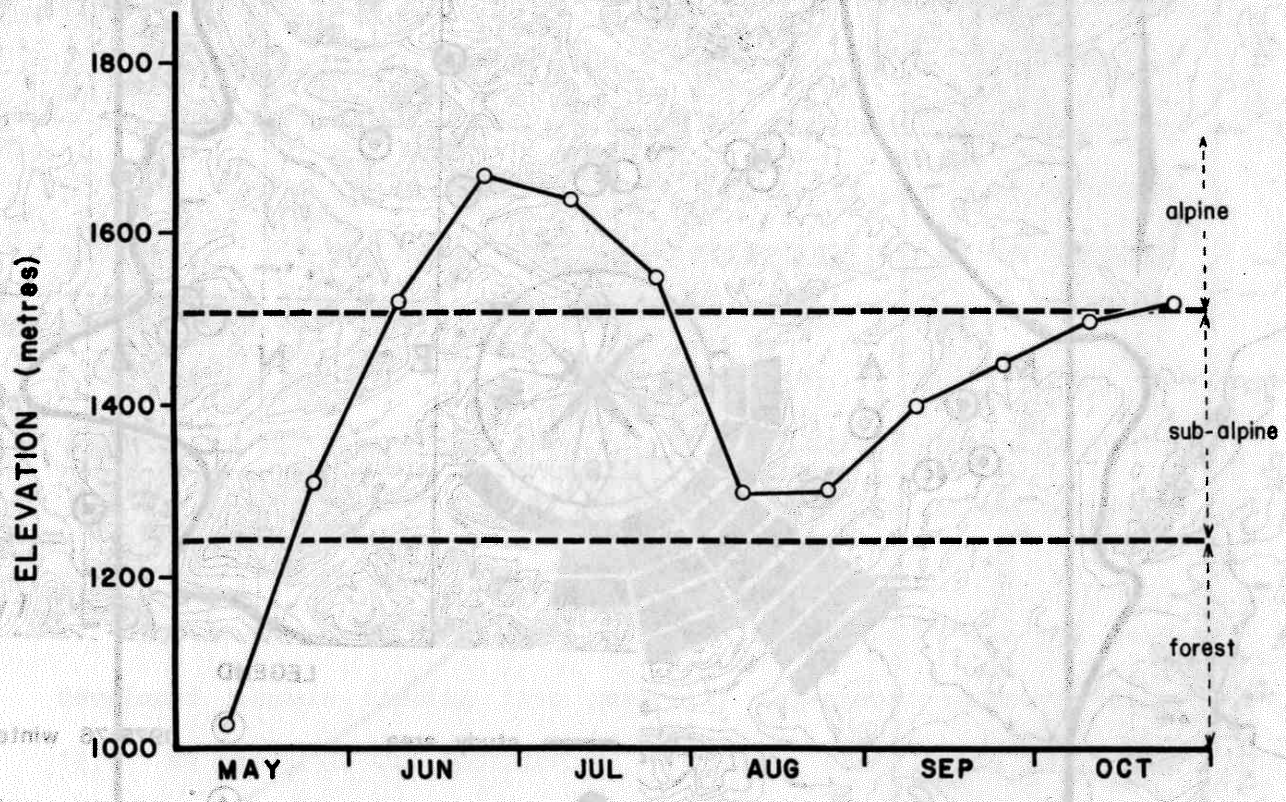

Figure 8. The mean elevational distribution of four adult female bears (>6 years) in the Mackenzie Mountains, N.W.T. based on 156 observations (1973-1977).

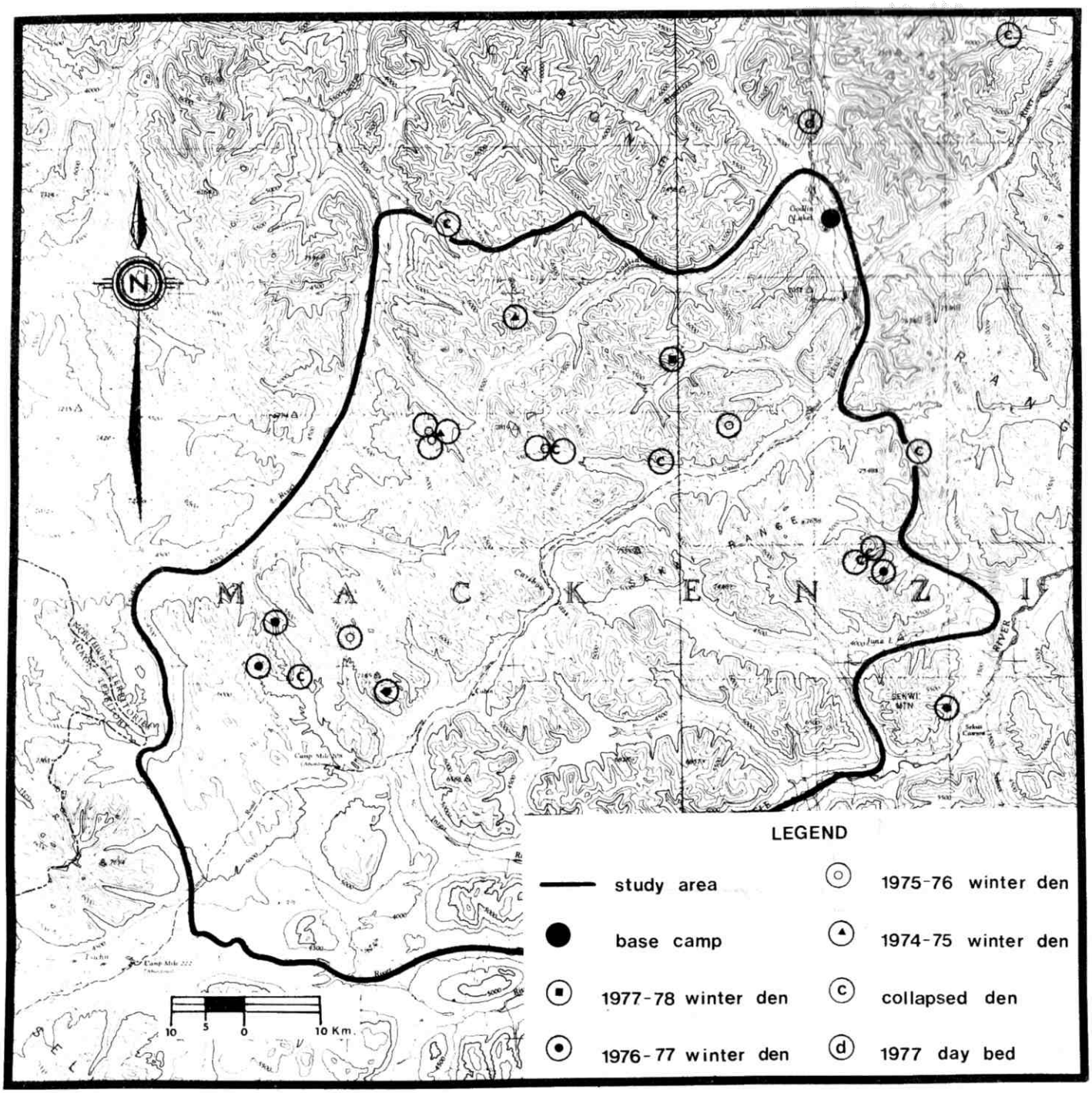

Figure 9. Dens located within the study area or near its boundaries Mackenzie Mountains, N.W.T.

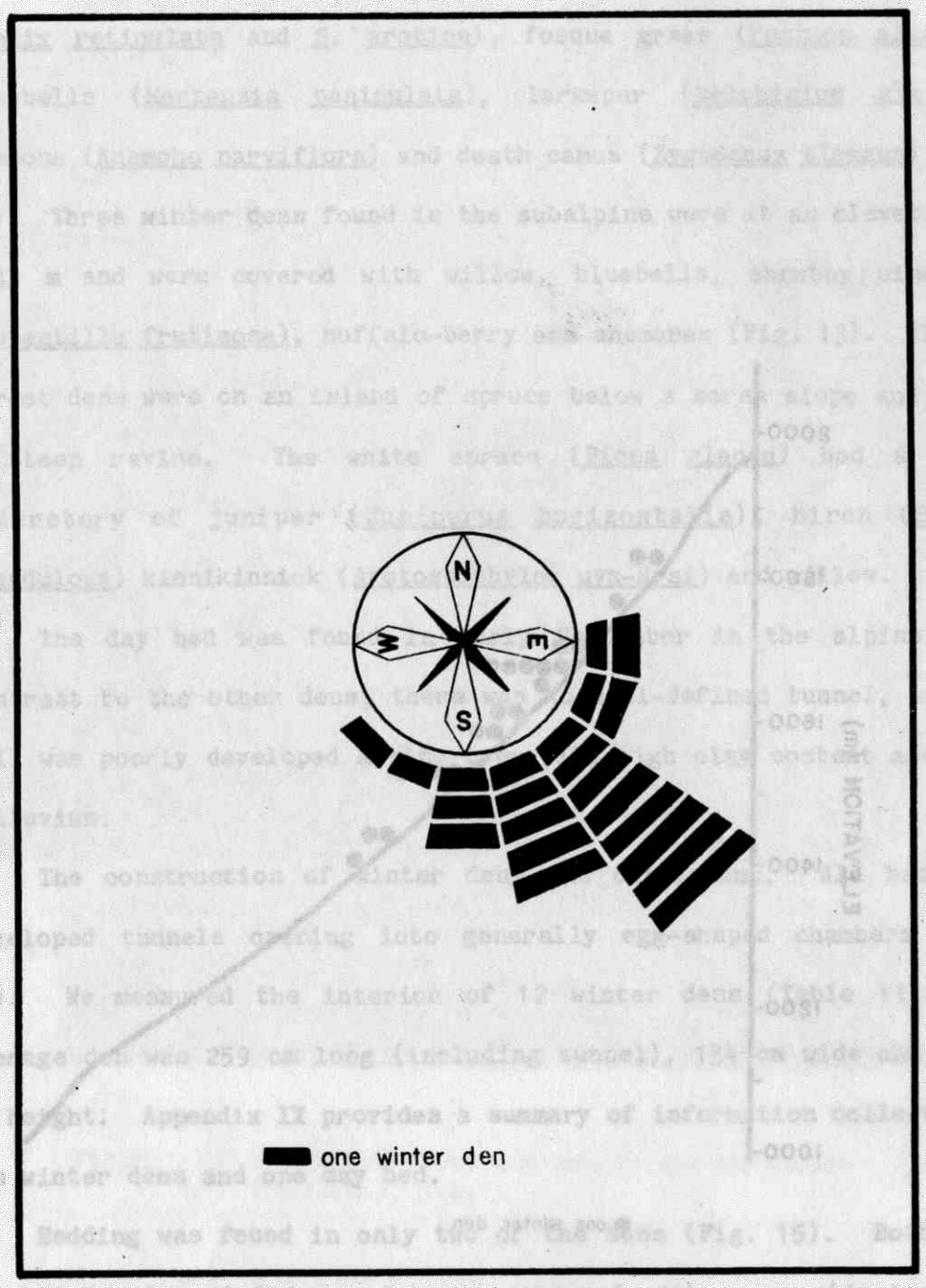

Figure 10. Aspect of 22 grizzly bear winter dens located within the study area, Mackenzie Mountains, N.W.T.

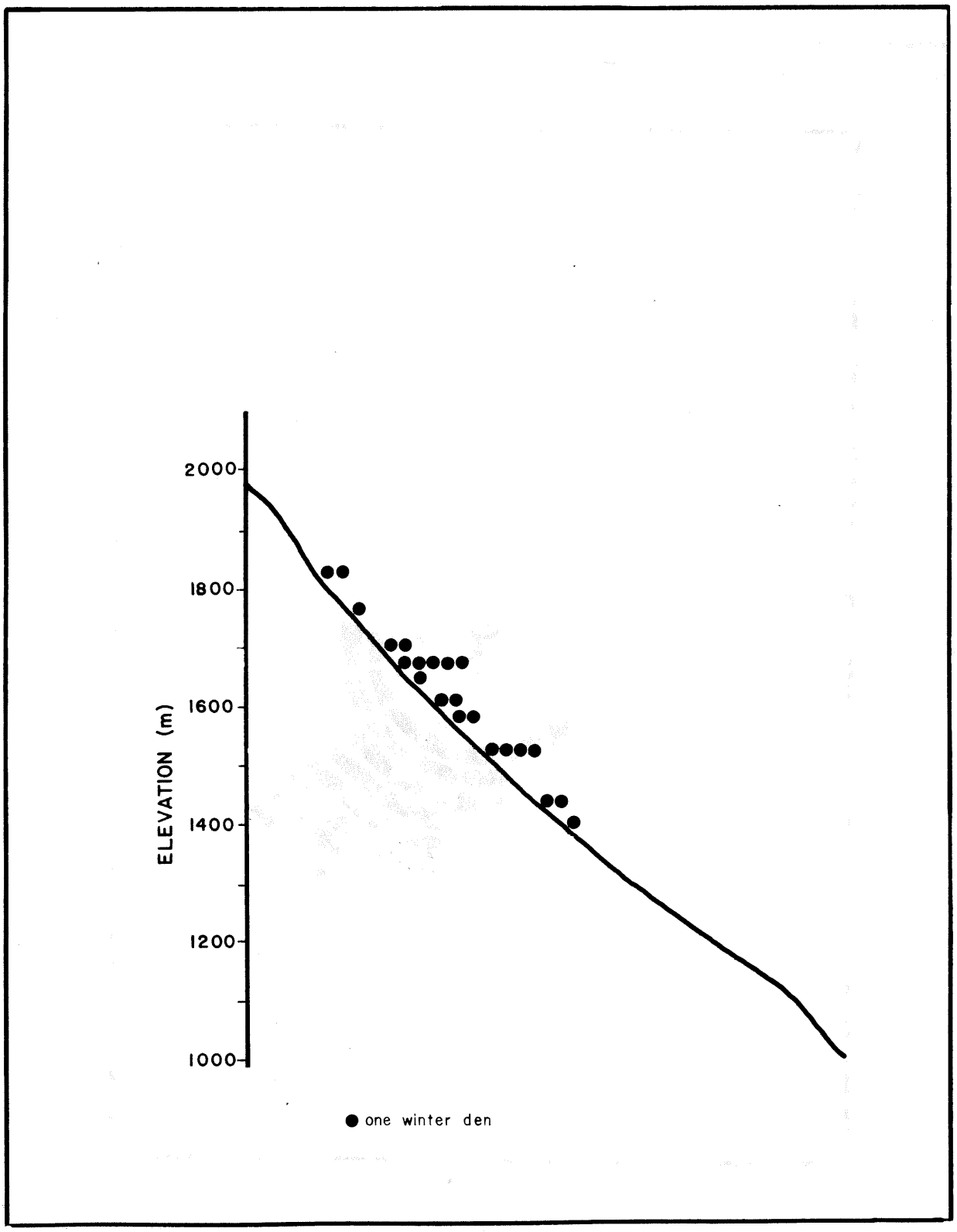

Figure 11. Elevational distribution of 22 grizzly bear winter dens.

Den Characteristics

Seventeen of the 22 winter dens were found in alpine habitat at elevations above 1520 m (Fig. 11). Habitat was typically willows (Salix reticulata and S. arctica), fescue grass (Festuca altaica), bluebells (Mertensia paniculata), larkspur (Delphinium glaucum), anemone (Anemone parviflora) and death camus (Zygadenus elegans) (Fig. 12). Three winter dens found in the subalpine were at an elevation of 1433 m and were covered with willow, bluebells, shrubby cinqefoil (Potentilla fruticosa), buffalo-berry and anemones (Fig. 13). The two forest dens were on an island of spruce below a scree slope and above a steep ravine. The white spruce (Picea glauca) had a thick understory of juniper (Juniperus horizontalis), birch (Betula glandulosa) kinnikinnick (Arctostaphylos uva-ursi) and willow.

The day bed was found in early September in the alpine. In contrast to the other dens, there was no well-defined tunnel, and the soil was poorly developed alpine type with high clay content and much colluvium.

The construction of winter dens was consistent. All had well developed tunnels opening into generally egg-shaped chambers (Fig. 14). We measured the interior of 12 winter dens (Table 11). An average den was 259 cm long (including tunnel), 134 cm wide and 94 cm in height. Appendix IX provides a summary of information collected on the winter dens and one day bed.

Bedding was found in only two of the dens (Fig. 15). Both were located in the subalpine and were cushioned with grass clippings and willow branches to a depth of 10 cm and covering an area of 1 m^2. The willow branches were about 1 cm in diameter and 25 cm long.

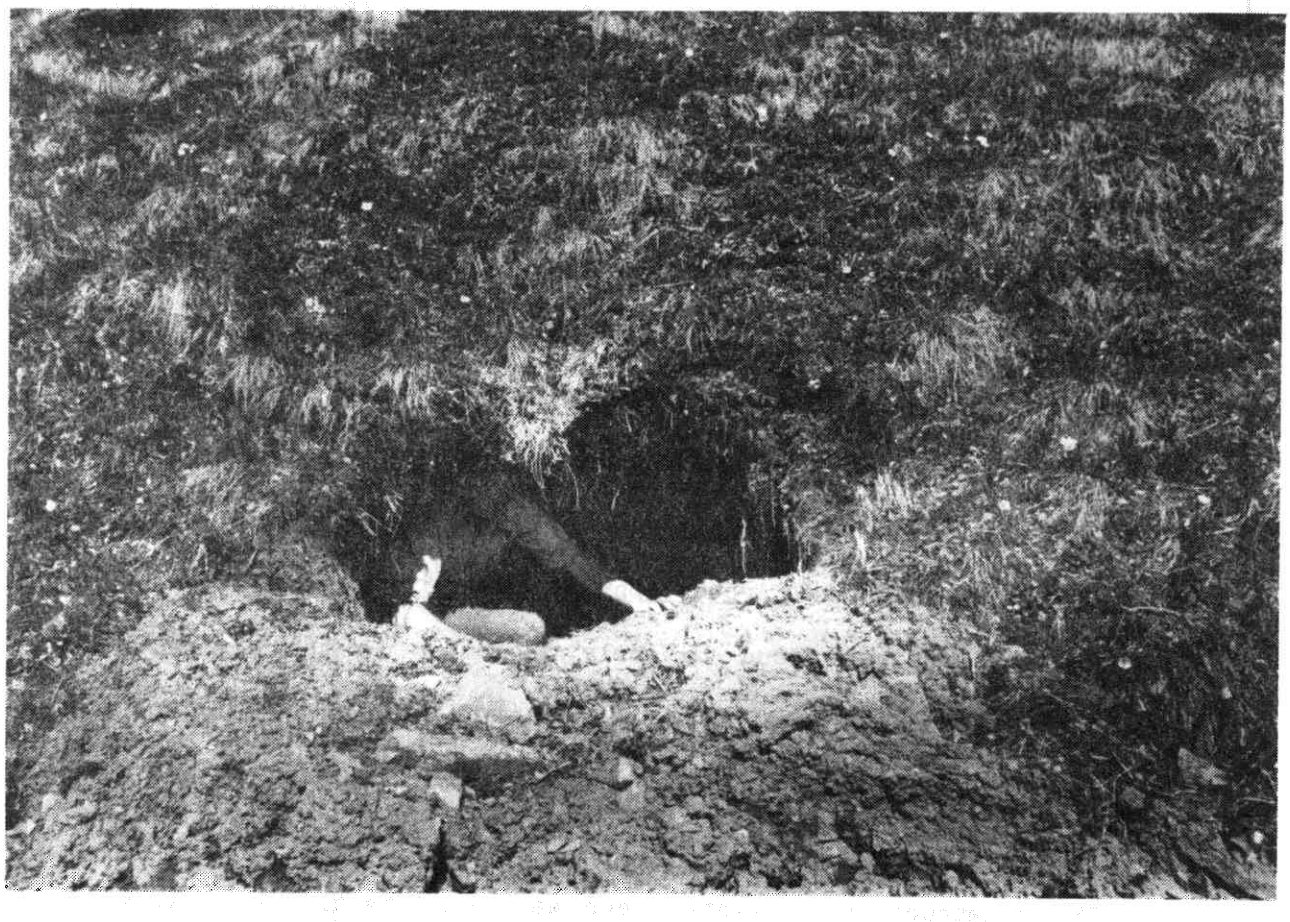

Figure 12. A typical alpine den in the Mackenzie Mountains, N.W.T.

Figure 13. A typical subalpine den in the Mackenzie Mountains, N.W.T.

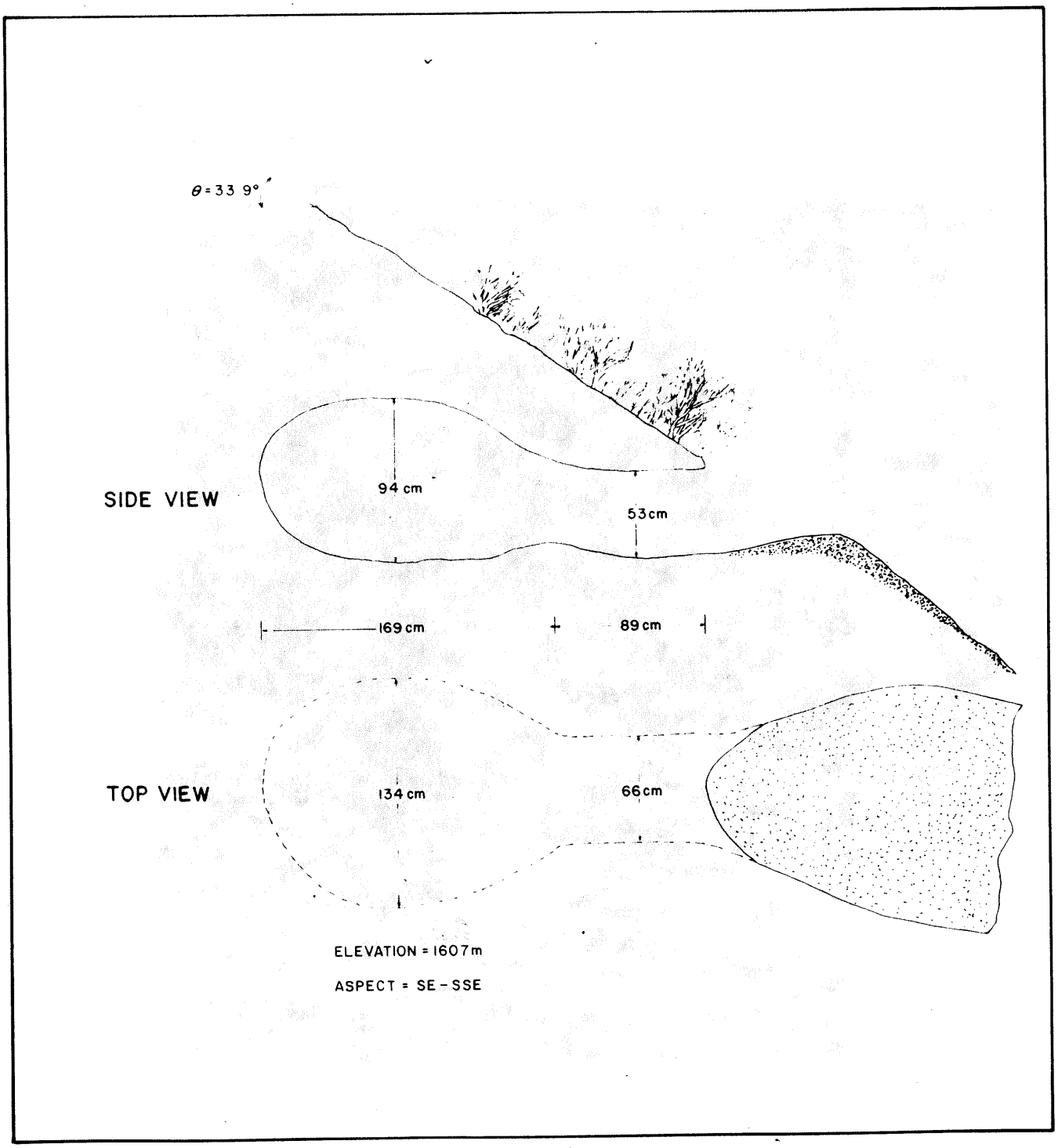

Figure 14. Diagram of a typical grizzly bear winter den in the Mackenzie Mountains, N.W.T.

Table 11. Size of 12 grizzly bear dens in the Mackenzie Mountains, N.W.T.

Measurement		Mean dimension (cm)	Range (cm)
Chamber:	length	169	130-230
	width	134	92-200
	height	94	60-130
Entrance:	length	89	41-158
	width	67	45- 92
	height	53	40- 72
Slope length		92	70-135
Total den length		259	177-366

ure 15. The inside of a grizzly bear den showing the bedding.

Emergence and Den-up

Although no exact emergence times of bears from dens were noted during the study, bears were observed in increasing numbers from the first week of May through the first week of June. Some observations could have been the result of bears moving from forested areas to alpine areas. All bears did not emerge from dens at the same time, and females with cubs were not observed before 15 May. This is similar to the findings of Pearson (1975) for the southeastern Yukon, although he observed adult males in late April. The latest emergence was between 8 and 12 June 1977 in a known denning area in the alpine.

Females with cubs appeared to den first although it is likely that there was considerable overlap in denning between sex and age groups. In 1975, two marked females with cubs were in dens by 1 and 7 October respectively, and in 1977, two other females with cubs were denned by 1 October. Single female bears were observed to be active on 8 October 1973 and 1 October 1975. Our latest sighting of a bear in the fall was on 15 October.

Mortality and Fecundity

It is not possible in a relatively short study of a long lived species to directly measure mortality rates. In general, these rates must be inferred from the age and sex structure of the population. The traditional approach uses the observed age structure to develop a life table which in turn is used to estimate survivorship and thus mortality.

Age Distribution

The age distribution of the study population was determined by cumulating the sex-specific age distribution of all bears 2 years old and older observed by random encounters in the study area from 1973 to 1977. A total of 109 random bear observations was made from 38 individual marked bears between 1973 and 1977 (Tables 12 and 13).

Throughout this analysis we use the concept of "cumulative random encounters". For example, in this section we consider the total number of observations of an age class within a year. From Table 12, in 1976 there were five observations of 7 year old males. All observations were initiated from the air without the aid of telemetry equipment and some may have been duplicate sightings. The point of totaling all observations and including the same individual a number of times in the sample is not to arbitrarily increase the sample size but rather to generate a representation of the average age distribution in the study area. Bears that reside totally within the study area will be encountered more frequently than transients or

Table 12. Random encounter[1] of male[2] grizzly bears in the study area of the Mackenzie Mountains by age and year.

Age	Year					Total
	1973	1974	1975	1976	1977	
2	2	1	1	1		5
3				4		4
4	1			1		2
5		1	1	1	2	5
6			1	2		3
7	1			5	1	7
8					1	1
9			1			1
10				2		2
11					2	2
12				1		1
13			1			1
14				2		2
15		1			2	3
16	1					1
17				1		1
18			3			3
19				3		3
20	1					1
21				1		1
22						0
23	1					1
24						0
Total	7	3	8	24	8	50
Subadult (2-6 years)	3	2	3	9	2	19
Adult (7+ Years)	4	1	5	15	6	31

1 Random encounters included bears observed from helicopter and fixed-wing flights.

2 Does not include offspring (cubs of the year and yearlings) accompanied by an adult female.

Table 13. Random encounter[1] of female[2] grizzly bears in the study area of the Mackenzie Mountains by age and year.

Age	Year					Total
	1973	1974	1975	1976	1977	
2						
3	1					1
4	1			1	2	4
5			4	2		6
6		1		4		5
7					2	2
8	1				2	3
9						
10	1					1
11		1				1
12		1	2			3
13		1	4	3		8
14				11	1	12
15				1	7	8
16			1			1
17						
18						
19						
20						
21			2		1	3
22				1		1
Total	4	4	13	23	15	59
Subadult (2-6 years)	2	1	4	7	2	16
Adult (7+ years)	2	3	9	16	13	43

1 Random encounters included bears observed from helicopter and fixed-wing flights.

2 Does not include offspring (cubs of the year and yearlings) accompanied by an adult female.

individuals with home ranges which have minor overlap with the study area. The use of "cumulative random encounters" ensures that the resident individuals provide a proportionately larger contribution to the estimate for the study area.

Our study is too small, relative to the longevity of grizzly bears, to develop a complete life table. Instead, we have considered the proportion of bears in each of three age classes; juveniles are animals in the care of their mothers, subadults are animals on their own but not yet reproductively active, and adults are reproductively active animals. For our study we assumed age ranges of 0 and 1 for juveniles, 2-6 for subadults, and 7 and older for adults.

Table 14 is a comparison of the Mackenzie Mountains grizzly bear age structure with age structures of other North American grizzly bear populations. These age structures can be used to estimate mortality or survivorship rates.

Cub Mortality

Cub survivorship was estimated as the proportion of yearlings to cubs in the population. From 1973 to 1977, a total of eight yearlings and 11 cubs of the year were observed. This gave a survivorship estimate of 73% or a mortality rate of 27%. Craighead and Craighead (1967) observed a first year mortality in Yellowstone National Park of 39% and Glenn et al. (1976) reported a 38% mortality rate at McNeil Falls. In a review of six North

Table 14. Age-sex structure of seven North American grizzly populations.

Author	Study area	Percent of population				
		Cubs	Yrlg	Subadult	Adult males	Adult females
This study	Mackenzie Mtns, N.W.T.	14.3	10.4	24.2	21.4	29.7
Pearson (1975)	S.W. Yukon	7.3	17.1	31.7	24.2	19.5
Craighead et al. (1974)	Yellowstone	17.5	12.6	24.5	21.1	24.5
Troyer & Hensel (1964)	Kodiak Island, Alaska	25.8	22.1	27.0	5.5	19.6
Glenn et al. (1976)	McNeil River, Alaska	15.0	9.0	13.5	27.4	34.7
Glenn (1975)	Chigmuk-Black Lake, Alaska	25.0	15.0	30.2	4.1	25.6
Reynolds (1976)	Easter Brooks Range, Alaska		32.3		33.3	34.3

American grizzly populations by Bunnell and Tait (1981), a 35% mortality rate for cubs of the year was estimated. Our figure of 27% appears low but it may be a result of the small sample size.

Subadult Mortality

Our estimate of subadult mortality is based on the following equation:

$$P_s (1-S) = P_1 (S - S^6)$$

where P_s = subadult proportion of population

S = subadult yearly survivorship rate

P_1 = yearling proportion of population.

This equation was derived by assuming that the proportion of 2 year olds is equal to the proportion of surviving 1 year olds, $P_1 \times S$, the proportion of 3 year olds from the surviving 2 year olds, $P_1 \times S \times S$, and so on up to the proportion of 6 year olds. This assumes that the subadult survivorship is equal for all subadult age classes. Solving the equation for S, (by substituting in a range of values for S), with a value of P_s of 24.2 and a value of P_1 of 10.4 gives a subadult survivorship of 75.5% or a yearly mortality of 24.5%.

This estimate is suspect for two reasons. The first inconsistency is the age distributions in Tables 12 and 13. A 25% mortality rate per year for a period of 5 years would generate a noticeable decline in the total number of animals aged 2 to 6. From Tables 12 and 13 the age distributions are flat or possibly increasing over this age range.

The second inconsistency is the very low number of 7 year olds that would be recruited to the population. There would only be 1.5 surviving 7 year olds from an original eight yearlings after 6 years of 24.5% mortality per year. It is impossible for the adult proportion of the population with a recruitment rate of 1.5 adults per year to account for 51.1% of the population. Even with no adult mortality, at a recruitment rate of 1.5 per year and 20 adult age classes, adults would represent only 43% of the population.

There are two 'explanations' for these inconsistencies. The first is to note that the estimate is dependent on P_1, the proportion of yearlings in the population. Small fluctuations in P_1 will result in large fluctuations in the estimated survivorship rate. The second explanation is that the population is not closed. The observed high proportion of adults may result from a net recruitment through immigration of animals, around age 7, into the population.

Adult Mortality

Average adult mortality rates were assumed to be sex-specific but consistent over age classes 7 years and older. Using the data given in Tables 15 and 16, the adult male mortality rate was calculated from the following equation. This estimate uses the Chapman-Robson equation as transformed in Bunnell and Tait (1981):

$$q_x = (1 - 1/n) / (1 + \bar{x} - a - 1/n)$$

where q_x = the average annual adult mortality rate

n = the number of observations in the sample

$\bar{x}$ = the average age of animals over age "a"

a = the minimum age used in the estimate

The average annual adult mortality rate (q_x) is a measure of the relative decrease in numbers of animals with increasing age. It provides a convenient description of the shape of the adult age distribution. If the age distribution is stationary, then q_x represents the average mortality in the population. As such it can be incorporated in simulation models to estimate the relative productivity of the population. A stationary age distribution implies that the age distribution is the same from year to year and the population is neither growing nor declining. If the population is growing or declining, but still retains a stable age distribution, then q_x will be biased. In a growing population q_x will overestimate the actual mortality rate. In a declining population, q_x will underestimate the actual mortality rate. The argument is identical to that presented in Caughley and Birch (1971) and Tait and Bunnell (1980). The estimated average adult male mortality rate is 13.2%, adult females 12.8% and when pooled, the adult mortality rate is 13.1%. In reviews of other grizzly populations, Bunnell and Tait (1981) found female mortality rates to be consistently lower than those of males. However, the difference between sexes in our sample population appears to be insignificant.

Age at First Reproduction

The earliest known age of litter production in the study area from 32 females observed was 8 years of age (Bear 2461, Table 15). Eleven observations of females without litters were of bears 7 years of age or less. Puberty was assumed to have occurred one year prior (in 7 years of age). Bunnell and Tait (1981) estimated a mean age of 7.8 at

Table 15. Random encounter of grizzly bear sightings in the study area by year.

Bear tag #	Name	Sex	Age[1]	Number of observations by year					Total obs.
				1973	1974	1975	1976	1977	
1 2461	Sally	F	4	1				2	3
2 2468	Playmate	F	3	1		2			3
3 2469	Killer	F	10	1	1	2	3	1	8
4 2470	Brother John	M	2	1			1		2
5 2471	Brother	M	2	1					1
6 2472	Fangs	M	23	1					1
7 2473	Watergirl	M	8	1					1
8 2474	Gentle-Ben	M	16	1		1			2
9 2477	Y.U.C.	M	7	1			2	2	5
10 2478	Pepper	M	20	1					1
11 2479	Choker	M	4	1			1		2
12 2751	Rugby	M	5		1	1	4	1	7
13 2752	Low I.Q.	M	1			1			1
14 2753	Sleezy	M	1						
15 2754	Easy	F	12		1	1	1		3
16 2755	Debarker	M	15		1		1		2
17 2758	Tooth	M	2		1				1
18 2759	No-Name	M	1						
19 2760	Speed	F	13		1		1		2
20 2761	One-Eye	F	6		1				1
21 2376	Snaggle-Tooth	F	21			2	1		3
22 2377	White Claw	M	13			1		1	2
23 2378	Tease	F	5			2	3	2	7
24 2379	Express	F	13			3	5	3	11
25 2380	Teddy	M	18			2	3		5
26 2381	Wayne	M	9			1			1
27 2382	Pink-O	F	16			1			1
28 2383	Rugs	M	5			1	2	1	4
29 2388	Moosey	F	5				2		2
30 2390	Brute	M	21				1		1
31 2391	Rico Sally	F	6				1		1
32 2392	Campion	M	2				1		1
33 2393	Afro	M	3				4		4
34 2394	Tramp	F	4				1		1
35 2395	Jaws	F	14				5	4	9
36 2396	Cubby	M	0						
37 2397	Church	M	12				1		1
38 2398	Mash	M	14				2	1	3
39 2399	Rotor	M	4				1	2	3
40 4990	Ursula	F	21					1	1
41 4991	Eva	F	4					2	2
				11	7	21	47	23	109

[1] Age at capture.

first production for southwestern Yukon using data from Pearson (1972 and 1975). They also estimated a high mean age of 9.9 for the bears of interior Alaska using data from Reynolds (1976).

Mean Litter Size

From 1973 to 1977, a total of 11 cubs of the year, accompanied by six individual adult females, were observed in the study area. The mean litter size was calculated to be 1.83 cubs per female. Ideally, litter sizes should be measured over at least 2 times the length of the inter-litter interval and on a large number of females but the study was too short (5 years). From research conducted in North America, litter sizes varied from 1.70 in Glacier park, Montana (Martinka 1974) and in southwestern Yukon (Pearson 1975), to 2.23 on Kodiak Island, Alaska (Troyer and Hensel 1964).

Inter-litter Interval

The time between the birth of one litter and the birth of the next is a function of the age at which the cubs are dissociated from the females and the capability of the female to conceive and produce young.

The inter-litter interval has been estimated by assuming that 11 individual observations of adult females with litters correspond on average to 5.5 litter productions. This assumes that each observed litter has a 50/50 chance of being seen in its first or second year. Litters in their third year are not included. A production rate of 5.5 litters per 21 adult female years (21 adult females were observed during the study) corresponds to an average inter-litter interval of

21/5.5 or 3.8 years. This figure should be considered to be the minimum number of years for the inter-litter period for bears in the Mackenzies. A female dissociating from cubs during their third spring of life (age 2.5 years) would have at least 3 years between birth of that and the next litter. Craighead et al. (1974) found an inter-litter interval of 3.4 years in Yellowstone National Park and Stringham (1980) estimated 4 years in his analysis of Reynolds (1976) data. Pearson's (1975) data were reviewed by Bunnell and Tait (1981) and an inter-litter period of 3.1 years or greater was estimated. Our result of 3.8 is high in comparison to six grizzly populations reviewed by Bunnell and Tait (1981). They ranged from a low of 2.8 years in Glacier Park, Canada to 3.6 years in McNeil River, Alaska. Rogers (1976) found that litter production was strongly related to nutrition. This is consistent with the findings by Beecham (1980), Pearson (1975) and the summary by Bunnell and Tait (1981). The bears in the Mackenzie Mountains also appear to respond to available nutrition as is reflected in their small body weights and other reproductive rate functions, in litter size, and age of first reproduction.

Natality

Natality was calculated as the number of cubs produced per adult female per year. The calculation includes the mean litter size divided by the inter-litter interval which gives an estimate of 0.48 cubs per female per year. This rate is not much different than the rate estimated by Pearson (1975) for northeastern Yukon (0.49), and Pearson (1976) for Barn Mountains, Yukon (0.45) and Reynolds (1976) estimate of Brooks Range, Alaska (0.43).

Distribution, Density and Abundance

Capture-Recapture

From 1973 to 1977, 38 individual bears were marked and subsequently recaptured or observed within the study area (Table 15). The number of marked bears recaptured in relation to the total number observed each year increased from 14.29% in 1974 to 91.30% in 1977 (Table 16).

Table 16. The numbers of grizzly bears observed and captured in the study area from 1973 - 1977.

	1973	1974	1975	1976	1977
Total bears observed	11	7	21	47	23
Previously marked bears	0	1	12	37	21
Percent recapture	0	14.29	57.14	78.72	91.30

Due to the high percentage of marked bears being recaptured in 1977, we feel that most of the bears occupying the study area during the 5 year study had been marked.

Movements and Home Ranges

During the study, radio-transmitters were attached to eight adult females and three immatures, and three adult males and one immature. Information on bear movements was provided by 245 relocations as determined by telemetry and observation of free roaming marked bears. Adult female home range sizes were calculated from 189 of the relocations. The data collected are not sufficient to definitely describe a minimum home range size for males or immature females although evidence suggests large home range sizes for all sex and age groups.

We found, as did Pearson (1975), that adult males were the most mobile of the sex and age groups. They often disappeared after being collared, only to be located a few kilometres away a year later. For example, a 23 year old male (2472, Fangs) was first captured and collared on 3 September 1973. We resighted him 10 km away on 7 September. A hunter shot him 720 days later 15 km from the last observation point; however we never observed him during the time lapse. Other examples included a 15 year old male (2755, Debarker) who was first captured on 7 August 1974. Although Debarker was collared, he was not seen again until he was recaptured in a foot snare 57 km away 358 days later. He was subsequently shot on 20 September 1976 (385 days later) in the Yukon, 94 km from the last capture location. The longest recorded movement of any bear was that of a 16 year old male (2474, Gentle Ben) who was first captured on 3 September 1973. He was later observed on 7 September, 2 km away but was not seen again until 7 August 1975 (700 days later) only 55 km from the last location. He was last seen by us 30 days later having moved 60 km. On 18 September 1978 (407 days later) Gentle Ben was shot in the Yukon. He had moved a distance of 155 km. Other males tagged but not observed again were a 9 year old (2381) captured on 30 July 1975 and a 12 year old (2397) captured on 9 August 1976. Since resightings of tagged and collared adult males were few, we suspect most of their activities occurred outside the study area.

The movements of immature males also support large movement patterns since they were seldom observed after being captured in the study area. As an example, a 2 year old (2758) was captured on 26 August 1974 and was never observed again. Bear 2752 was first captured as a 1 year old with his mother (2754) in 1974 and was

subsequently recaptured as a single 2 year old on 27 July 1975. He was never observed again. This second capture was outside the normal home range of his mother. Although our data are limited, we did not find, as did Pearson (1975) for southwestern Yukon, any evidence that young males remained in the maternal home ranges after being weaned. Another example of bears disappearing is that of a 2 year old (2471) captured with his brother (2470) on 2 September 1973. Bear 2471 was shot 1 week after being captured, but 2470 was not resighted until he was recaptured 1,093 days later only 16 km from the original capture location. The straight line distances between resightings of immature males were greater than any other sex and age groups except for adult males. As an example, Bear 2383, a 5 year old, was first captured on 4 September 1975. He was not seen again until he was recaptured 294 days later 8 km away. He was subsequently observed 2 days later having moved 37 km. A 3 year old bear (2393) was captured 19 July 1976 and tagged. Nine days later he was spotted 13 km from the capture location. Five days passed and he was again observed 18 km further away. On 26 August 1976 (24 days later) he was last seen 30 km further away.

The average minimum home range size of six adult females was estimated to be 265 km^2. This is larger than what has been reported elsewhere. Berns et al. (1978) calculated a mean size of 14.3 km^2 for females in Alaska, Craighead (1976) found a size of 85.7 km^2 in Wyoming, Pearson (1975) found 86 km^2 in southwestern Yukon, and Pearson (1976) reported 73 km^2 in northern Yukon; and Nagy and Russell (1978) found a size of 188.6 km^2 in Alberta. We found, as did Pearson (1975), that home ranges of individual females varied in size from year to year but found no indications as he did, that reproductive

status influenced sizes. For example, an 11 year old bear (2469, Killer) is of particular interest as she was the only bear to have a home range entirely within the study area during the 5 years (Figs. 16 and 17). In 1974, Killer was accompanied by two cubs of the year and had a home range size of 136.1 km^2. In 1975 her home range was only 67.7 km^2. The decrease in size occurred during a year when few berries were available and bears switched to a diet of predominately roots in the fall. As a single bear in 1976, Killer increased her home range size to 137.9 km^2. It is noteworthy that her 1976 home range did not overlap any portion of her 1975 home range (Fig. 16). During 1977, Killer emerged from the den with two cubs of the year and occupied a home range calculated to be 265 km^2 which overlapped all previous home ranges. These differences in home range sizes cannot be explained with the information gathered during this study. When the extreme peripheral points of Killer's five home ranges are joined together, the size becomes 456.9 km^2 which is considerably larger than the estimated average (Fig. 17). Large home ranges were also calculated for the other two females on which we had 2 years or more of movement information. A 13 year old bear (2379, Express) with a 2 year old cub had a home range size of 136.6 km^2 in 1975 (Fig. 16) and in 1976 her home range increased in size to 226.5 km^2. Accompanied by two cubs of the year in 1977, her home range decreased slightly to 217.1 km^2. Combining Express' extreme peripheral points, her home range size becomes 560.1 km^2 (Fig. 17). The other bear, (2395, Jaws) was 14 years of age with one cub of the year in 1976. Her home range was 216 km^2. In 1977 this increased to 345.2 km^2 and her combined home range size was 408.9 km^2 (Fig. 17).

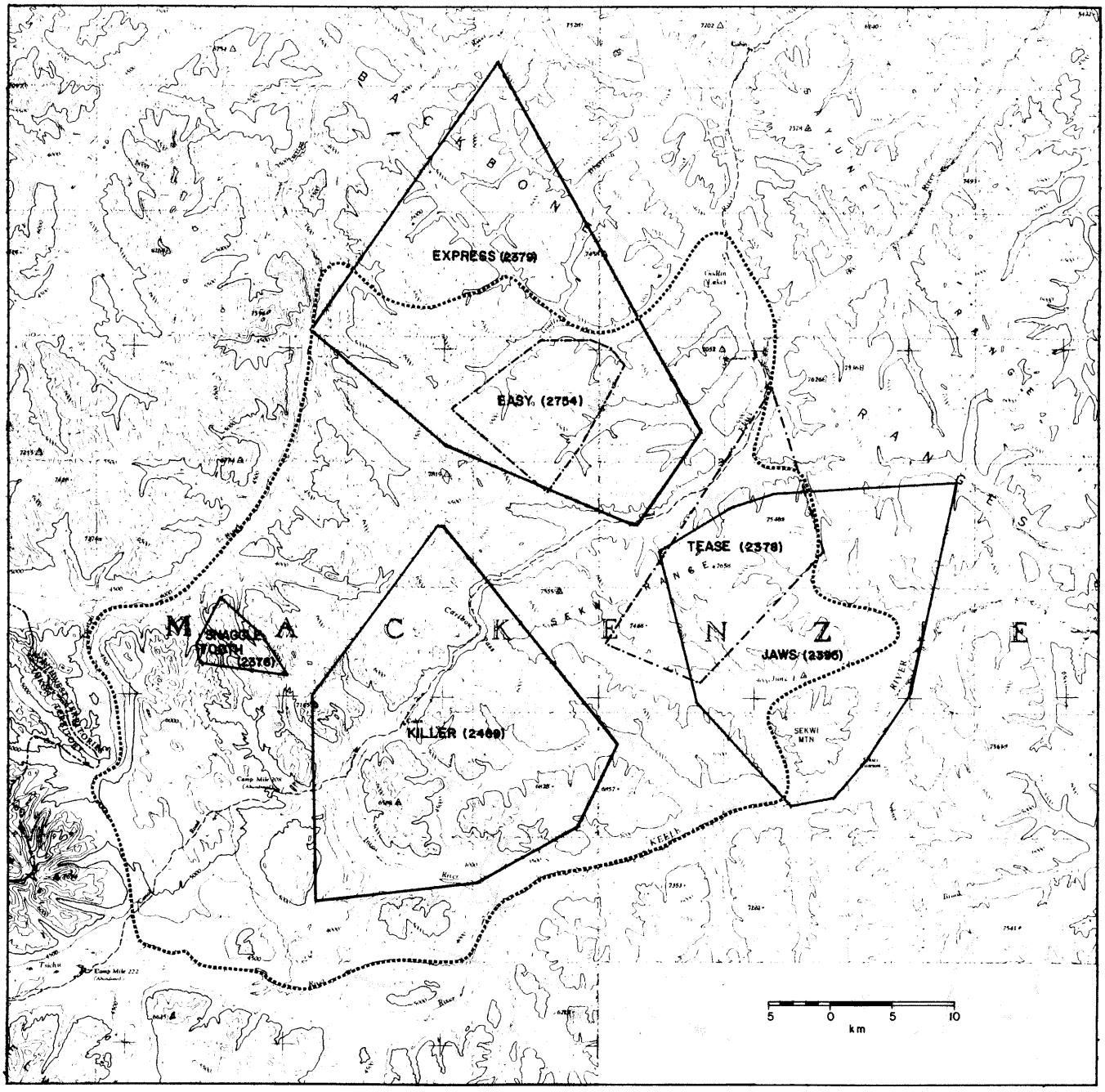

Figure 16. Minimum home range polygons for adult female grizzly bears in the Mackenzie Mountains, N.W.T.

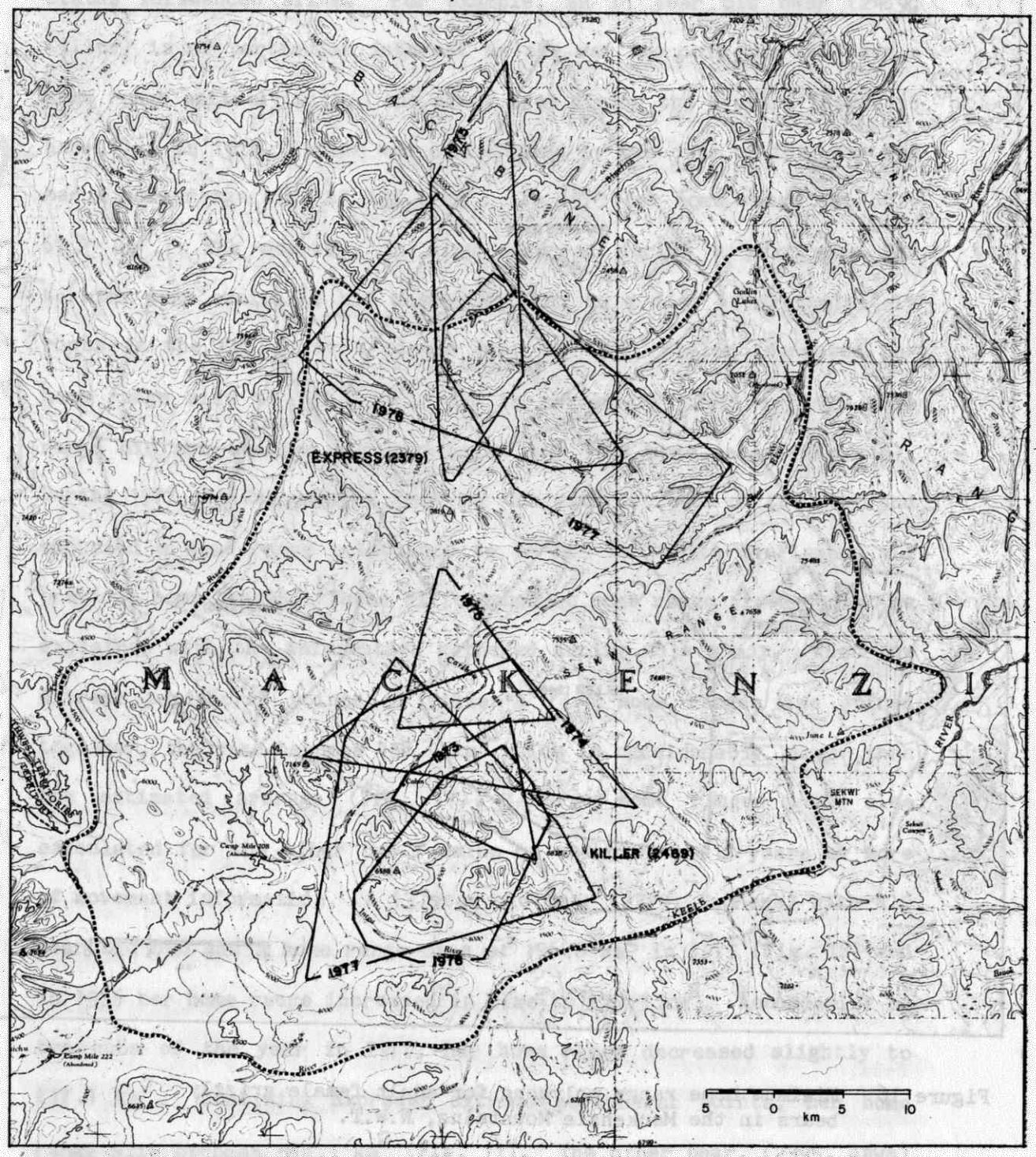

Figure 17. Yearly minimum home range polygons for the adult female grizzly bears, Killer (2469) and Express (2379).

The longest recorded movement by an adult female (Killer) occurred between 5-10 August 1977. The distance between the two monitoring locations during the time was 30.6 km.

No minimum home ranges were calculated for immature females and the fact that they were also difficult to relocate after being captured and collared suggests long distance movements. Examples include a 4 year old female (2394) captured on 27 July 1976. She was not observed again. Sally (2461) was a 4 year old when first captured and collared on 14 August 1973. She was resighted on 21 August but was not seen again until she was recaptured on 12 June 1977 (1397 days later). Bear 2468 was first captured and collared as a 3 year old on 2 September 1973. Her movements were monitored until 8 October when she disappeared. She was recaptured on 4 September 1975 but not observed again during the study. Bear 2391 was captured as a 6 year old and collared on 1 July 1976. Her movements were monitored between 1 July and 17 August when she disappeared and was not seen again during the study.

Density

The 5 year study treated an open population as bears moved randomly in and out of the study area. As a result, attributes of the bear population such as the number of bears in the area vary over time. In this study we are considering parameters such as the "average density" where the average is over time. This is equivalent to considering the overlap between the study area and the bear's home range. A bear that spent all its time entirely within the study area is treated as a "whole" bear. A bear that spent 50% of its time in

the study area is counted as half a bear. As a result, a parameter such as the density of bears in the study area would be simply the number of bears or "part" bears in the study area. Ideally this approach would require accurate home range descriptions for all bears that have some overlap with the study area. For some estimates, we have simply assumed that the chance of spotting a bear during a random search is proportional to the amount of time that the bear is in the study area. This assumes that, on average, bears of different ages or sex are all equally observable. Within these assumptions, the relative encounter frequency of an individual bear is a measure of the overlap of the bear's home range with the study area.

This approach may be used for estimating relative densities such as the sex ratio or proportionate age classes. However, it cannot be used to estimate absolute densities without some estimate of the probability of encountering a bear on a search. As a result we have used the total number of individual adult female bears observed in the study area to estimate absolute density. The high percent recapture (Table 16) suggests that this represents a complete census.

This introduces a futher complication in that a relatively small proportion of the home range of some females will be in the study area. Or alternatively, our sampling area is larger than the study area.

Caughley (1977) addresses this problem in estimating population size by adding one home range radius around the sampled area. We felt that this approach would increase our sampled area by too large an area. Based on our understanding of the sampling flights, the distance to be added to the radius of the study area was calculated using 10% of the radius of the average female home range. We assumed

that this would be more representative of the area from which adult female bears were actually being sampled. The new area would be 3180.76 km^2. This gives a 94% probability that all females with 44% or more of their home range within the study area would be observed during one of five surveys. We are assuming that we captured all adult females in the area. Table 16 supports this assumption in that of 23 bears observed in 1977, 21 were previously marked. Within the study area, a total of 11 individual adult females were identified during the 5 year study (Table 15) for a density of one adult female per 289.16 km^2. Our estimate of adult male density is based on the observed sex ratio in the population.

Sex Ratio

We have used the relative encounter frequency of males and females (Tables 12 and 13) to estimate the sex ratio in the population. Of 109 random encounters, 54% were females and 46% were males (Table 17). Craighead et al. (1974) found a higher proportion of males in the first four age classes and a higher proportion of females among adults but they assessed a 1:1 sex ratio. The Mackenzie Mountains data suggest the same phenomenon of a possible male bias in the younger age classes. According to Fisher (1930), there is a good theoretical explanation for a preponderance of males. He suggested that given a differential mortality of one sex before the end of parental care, there would be less total investment in that sex with greater mortality. Natural selection then should favor a shift in sex ratio at conception to the sex with greater mortality (McCulloch in press).

Table 17. The proportion of male to female grizzly bears by age class observed in the study area through random encounter, 1973 - 1977.

	Male		Female	
	N	%	N	%
Total	50	45.87	59	54.13
Adults	31	41.89	43	58.11
Subadults	19	54.29	16	45.71

It is more likely during random flying that we would encounter a female bear. If we consider the number of individuals (2 years or older) over the course of the study, females appear to be more numerous than males (59 to 50 respectively). This is expected because females have smaller home ranges than males and would spend more time within the study area. As a result the same individual female would be encountered frequently over the course of the study. Males have relatively larger home ranges and most males would spend a proportion of their time outside the study area. Repeat encounters would be less frequent for individual males than for females. But the larger male home range also implies that the male bears encountered in the area have been "drawn" from a much larger area than females. We have assumed that the relative encounter rate of males and females is the better estimate of the population sex ratio while the larger number of observed individual males is an artifact of the sampling approach and the movements of male and female bears. A density of 11 adult females in the sampled area would thus correspond to a density of 7.9 adult males based on the proportion of males to females (31:43, Table 17).

The total adult population of the sampled area would be 18.9 bears. Using the proportion of subadults to adults (35:74) contained in Table 17, we would expect 8.9 subadults or a population of 27.8 bears 2 years of age or older in the 3,180.76 km^2 area. This gives an average density of one bear per 114 km^2. A total population of bears for the sampled area can be determined using the natality rate of 0.48 and the yearling to cub ratio of 0.73. This would give a bear population of 7.9 adult males (21.4%), 11 adult females (29.7%) 8.9 subadults (24.2%), 5.3 cubs of the year (14.3%), and 3.8 yearlings (10.4%) or a total of 37 bears for the sampled area.

Although our estimate of male density using the adult sex ratio gives 7.9 for the sampled area, we actually captured 14 individual adult males during the study (Table 15). This suggests that a larger area than the one sampled provided the 14 males. If the ratio of random encounters of females to males (43:31) is multiplied by the ratio of individual males to females (14:11) an estimate of this size difference can be derived. This gives a difference of 1.77 or a sampling area of 5629 km^2 for adult males.

Hunter Kill Analysis

Bear harvest regulations have changed little since 1965. Every hunter with a non-resident license is entitled to one bear of either sex unaccompanied by cubs. Bear baiting has always been prohibited. From 1965 to 1970 the season opened 1 August and closed 30 November. From 1971 to 1978 the season was from 15 July through 15 November. In 1979 the season was from 15 August to 31 October. There has never been a spring season because of the inaccessability of the Mackenzie Mountains during April and May. A $250 trophy fee was levied in 1979. Until 1981 there was no quota on the number of bears that could be taken by each outfitter.

Non-resident hunter harvest data from the eight outfitting areas (Fig. 18) have been provided in some form since 1965. Every licensed hunter in the Mackenzie Mountains has been asked to provide the bear skull along with the date of kill, location of kill, sex, and hide length. Unfortunately some information has been lost or inadequately recorded. No age data are available prior to 1972 and the sex and kill location data are incomplete.

Total Kill

From 1965 to 1978, 397 bears, an average of 28 bears per year, has been shot in Game Management Zones 12 and 19 (currently Wildlife Management Zone E-1) by non-resident hunters. A peak in 1969, possibly reflecting an unusually high take of caribou and moose which create bear feeding sites, was followed by a steady decline in the number of bears killed to 1976 (Fig. 19). It increased in the next 2 years. The number of bears killed since 1968 was regressed against

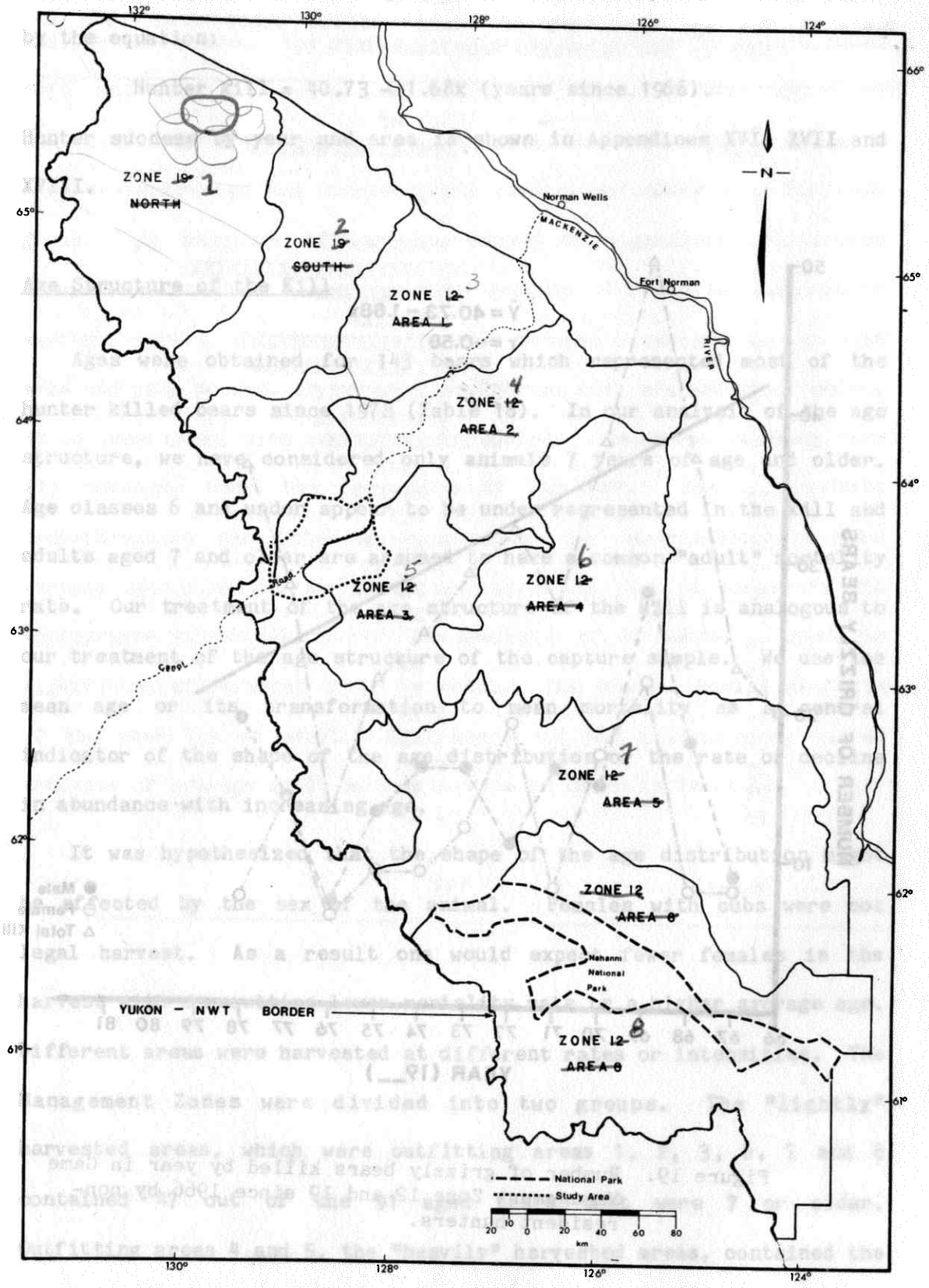

Figure 18. Delineated outfitter areas in Game Management Zones 12 and 19 (currently Wildlife Management Zone E-1, Areas 1-8) of the Mackenzie Mountains, N.W.T.

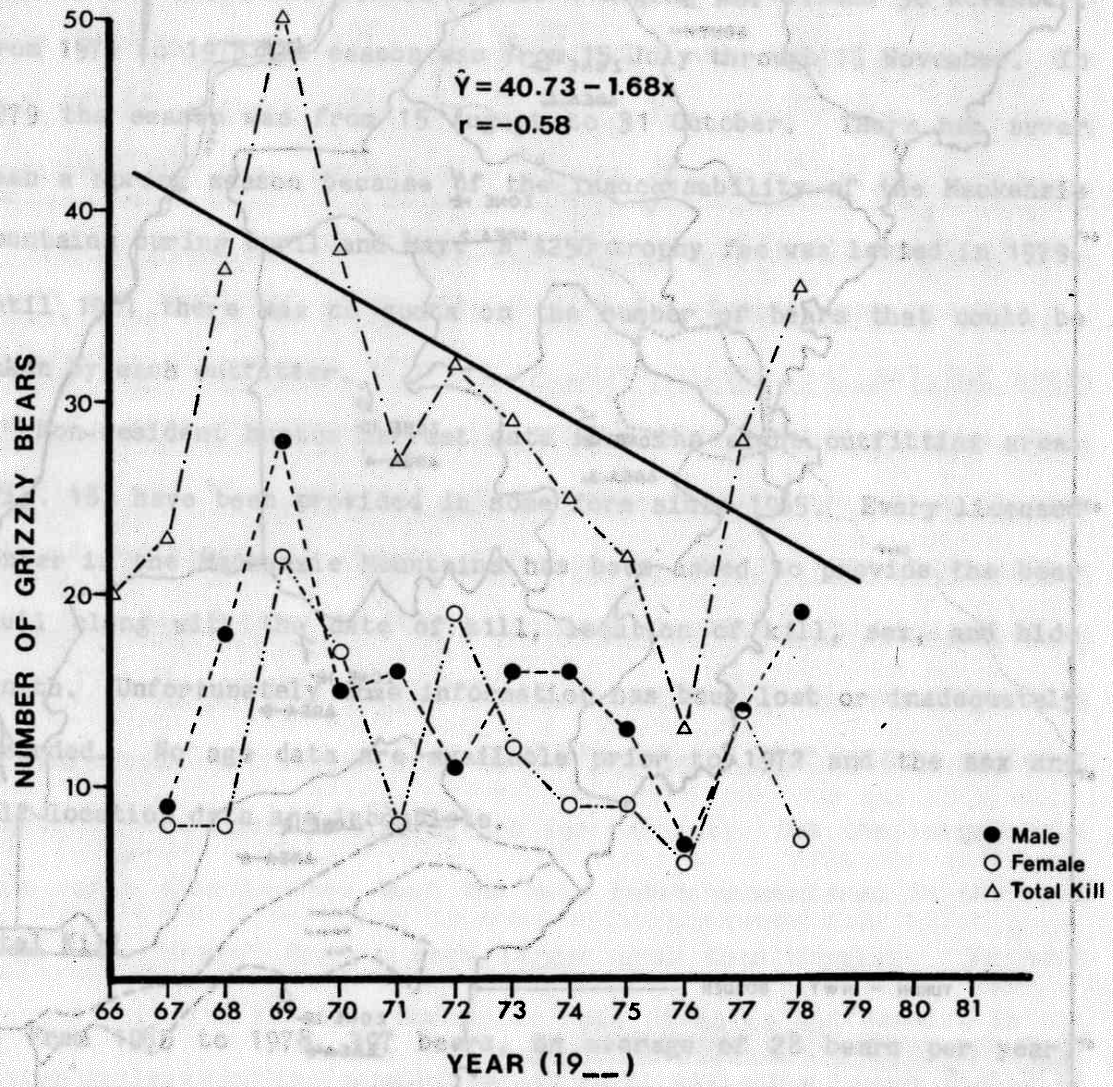

Figure 19. Number of grizzly bears killed by year in Game Management Zone 12 and 19 since 1966 by non-resident hunters.

year and found to be declining by about two bears per year ($r = 0.58$) by the equation:

Hunter kill = 40.73 - 1.68x (years since 1966).

Hunter success by year and area is shown in Appendices XVI, XVII and XVIII.

Age Structure of the Kill

Ages were obtained for 143 bears which represented most of the hunter killed bears since 1972 (Table 18). In our analysis of the age structure, we have considered only animals 7 years of age and older. Age classes 6 and under appear to be under represented in the kill and adults aged 7 and older are assumed to have a common "adult" mortality rate. Our treatment of the age structure of the kill is analogous to our treatment of the age structure of the capture sample. We use the mean age or its transformation to mean mortality as a general indicator of the shape of the age distribution or the rate of decline in abundance with increasing age.

It was hypothesized that the shape of the age distribution might be affected by the sex of the animal. Females with cubs were not legal harvest. As a result one would expect fewer females in the harvest with a resulting lower mortality rate or a higher average age. Different areas were harvested at different rates or intensities. The Management Zones were divided into two groups. The "lightly" harvested areas, which were outfitting areas 1, 2, 3, 6, 7 and 8 contained 47 out of the 91 aged bears that were 7 or older. Outfitting areas 4 and 5, the "heavily" harvested areas, contained the remaining 44 bears. If the age distribution were not stable, one

Table 18. The age structure of hunter killed bears from 1972 to 1978 in the Mackenzie Mountains, N.W.T.

Age in years	No. of bears (Each X= 1)
0	1 X
1	0
2	9 XXXXXXXXX
3	19 XXXXXXXXXXXXXXXXXX
4	9 XXXXXXXXX
5	6 XXXXXX
6	13 XXXXXXXXXXXXX
7	14 XXXXXXXXXXXXXX
8	9 XXXXXXXXX
9	9 XXXXXXXXX
10	8 XXXXXXXX
11	6 XXXXXX
12	6 XXXXXX
13	3 XXX
14	5 XXXXX
15	5 XXXXX
16	6 XXXXXX
17	4 XXXX
18	0
19	2 XX
20	1 X
21	2 XX
22	3 XXX
23	0
24	1 X
25	2 XX
Total	143

would expect differences in the age structure between the early years and the late years. The sample was divided between bears shot between 1972 and 1975 inclusive and bears shot between 1976 and 1978 inclusive. Table 19 summarizes the above breakdown with an estimate of the average age and corresponding average mortality rate for each group. An analysis of variance showed no significant difference between the means of the above eight groups. Nor did an analysis of variance show a significant difference between mean ages by sex with area and year pooled, or between year groups with sex and area pooled, or between areas with sex and year pooled. The above analyses were all repeated with the logarithm of the age. The logarithmic transformation was intended to reshape the distribution to more closely approximate a normal distribution and thus be closer to the appropriate distribution for an analysis of variance. Again no significant differences could be found. The overall pooled estimate of the mean age of adult killed bears and the corresponding pooled estimate of average adult mortality rate is shown in Table 19.

Table 19. The age structure between "lightly" and "heavily" harvested outfitting areas in Game Management Zones 12 and 19.

	Average age	Sample size	Standard error	Average mortality
Heavily hunted				
72-75				
Male	13.0	18	0.99	0.134
Female	11.1	12	0.87	0.177
76-78				
Male	10.1	8	1.23	0.206
Female	12.5	6	2.45	0.125
Lightly hunted				
72-75				
Male	12.8	12	1.2	0.132
Female	11.3	15	1.26	0.175
76-78				
Male	16.4	12	2.02	0.087
Female	11.2	8	1.32	0.163
Overall	12.3	91	0.52	0.153

MANAGEMENT IMPLICATIONS

The population simulation model developed by Bunnell and Tait (1981) was used to explore the implications of the calculated fecundity and mortality patterns. Their model projects an age distribution through time by applying constant age-specific survivorship rates to the distribution. We used the model to establish potential growth rates or minimum survivorship rates required to maintain a stable population. Those rates or estimates provide bounds or limits on the sustainable harvest of the population.

The low observed natality rates, the late age of first reproduction and the long inter-litter period, together severely limit the growth potential of this population. As an illustration, consider a hypothetical population with an average natality rate of 0.240 female cubs/adult female per year. This natality rate corresponds to an average litter size of 1.83 cubs with a sex ratio of 50/50 in the litter and an inter-litter interval of 3.82 years. The natality rate is to be applied only to females age 8 and older. Assume no mortality in the population until age 22, the assumed longevity for this population. This is not a biologically reasonable assumption but it does generate an upper or maximum potential growth rate for the population. The growth rate corresponds to the maximum average mortality rate that could be tolerated by a stable population, a population with no growth or decline. This assumes that the mortality rate is applied to all age classes. If we include the estimated cub mortality rate of 27% per year as a further constraint on our hypothetical or simulated population and retain a zero mortality rate for all other age classes, the population grows at a rate of 7% per

year. A stable population with the above reproduction rate and cub mortality rate would require an average mortality rate of 7% per year for all the remaining age classes. Any higher average mortality rate in those age classes would cause the population to decline. The lowest average mortality rate recorded by Bunnell and Tait in their 1981 review was 10% per year for the Yellowstone population.

Our final simulation uses the observed estimated natality rate, the estimated cub mortality rate, and the estimated adult mortality rate of 13% per year for animals 8 and older. A stable population requires that there be no mortality for age classes 2 - 7 inclusive.

We conclude from these simulations that the Mackenzie Mountains grizzly bear population is marginal. The natality data alone place severe limitations on the ability of this population to grow or even sustain itself at the present level of harvest. When the observed mortality rates are included in the simulations the result is a declining population. This conclusion has repercussions on the estimates. As Caughley and Birch (1971) point out, in a "closed" declining or increasing population, mortality estimates based on a sample of the population are biased. For a completely closed population with no emigration or immigration the bias is sufficient to be of the same magnitude as the rate of growth or decline. For example, a 5% rate of growth in the population would result in a 5% increase in the estimated % mortality rate. If the population is declining as suggested by the above simulations, then the estimated mortality rates are too low.

If the population is closed, the biases should be sufficient to totally confound the results of the above simulations. As Caughley and Birch (1971) point out, the simulations using the estimated

mortality rates from a sample of the age distribution should result in a simulated population showing no growth or decline regardless of the actual growth or decline in the population.

We conclude that our populations are not closed. We hypothesize that there is net immigration of animals into the harvested areas. With constant net recruitment the estimated mortality rates should be representative of the true mortality rates. If net recruitment is slowly declining with time, then again there will be a bias in the estimated mortality rates. The conclusion however is unchanged. The population is locally overharvested resulting in a net drain on the surrounding population base.

In summary, we hypothesize that the Mackenzie Mountains grizzly bear population is marginal. Current harvest rates are excessive and result in local over-exploitation of the population with a resulting net immigration into the harvested areas. The net result could be a slow decline in the overall population density of the entire area. This hypothesis is consistent with our observations. The very low reproductive potential alone is indicative of a marginal population. This evidence suggests that the ability of the Mackenzie Mountains grizzly bear population to sustain a harvest is limited. The high estimated mortality rates of both the capture and harvest data, as well as the declining catch per unit effort and the low reproductive rates would result in a declining population. The inadequate degree of bias in the mortality estimates indicates that there is a local net immigration of bears into the area, but this immigration may be declining. The area does not contain a sustainable bear population at current levels of harvest.

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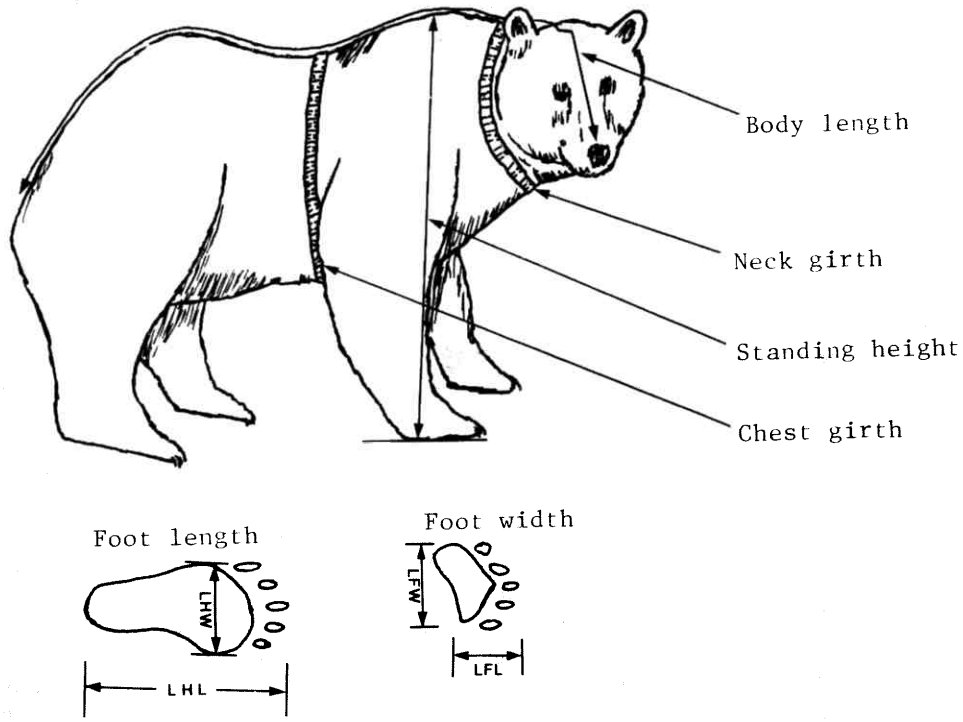
Appendix I. Diagram and definitions of measurements taken on captured grizzly bears.



Total body length (cm):	From the tip of the nose to the tip of the tail following the contours along the shoulders, back and rump.
Standing height (cm):	From the apex of the shoulder to the pad of the front foot.
Chest girth (cm):	Circumference of the body directly behind the shoulder.
Neck girth (cm):	Neck circumference.
Foot length (cm):	Measured from the tip of the most forward toe pad to the midpoint at the back of the foot pad.
Foot width (cm):	The widest measurement across the foot pad, perpendicular to the foot length.
Weight (kg):	Weight in kilograms from a spring scale attached to a tripod from which an immobilized bear was suspended.

Appendix II. Information collected from female grizzly bears captured and tagged in the Mackenzie Mountains, N.W.T. 1973 to 1977.

Tag #	Date	Age	A	B	C	D	E	F	G	H	I	J	Offspring
2461	14 Aug./73	4	101	85	104	62	18.0	19.0	-	-	113.0	-	-
2464	30 Aug./73	6	-	-	100	68	-	-	-	-	102.9	-	-
2466	30 Aug./73	17	173	-	103	68	-	16.0	-	-	110.4	-	-
2468	2 Sept/73	3	146	-	93	52	-	9.5	-	-	85.3	-	-
2469	2 Sept/73	10	154	-	98	57	-	-	-	-	97.9	-	-
2473	3 Sept/73	8	160	-	112	64	17.0	11.0	-	-	133.1	-	-
2475	4 Sept/73	3	140	-	86	48	17.0	10.0	-	-	67.6	-	-
2476	4 Sept/73	17	150	-	135	-	20.0	12.0	-	-	191.0	-	-
2469	24 July/74	11	162	80	94	54	-	-	-	-	87.9	81.3	2 COY
2754	28 July/74	12	165	-	103	64	-	-	-	-	111.4	109.8	2 YRLG
2756	13 Aug./74	13	174	-	112	65	-	-	-	-	133.1	127.0	-
2757	25 Aug./74	-	-	-	-	-	-	-	-	-	-	-	-
2760	26 Aug./74	13	152	-	106	61	-	-	-	-	118.0	129.6	1 YRLG
2761	4 Sept/74	6	185	-	107	66	-	-	-	-	121.4	129.6	-
2376	27 June/75	21	159	70	101	62	19.0	-	11.0	-	106.3	106.7	2 YRLG
2378	28 June/75	5	161	-	101	57	17.5	10.0	10.5	12.0	106.3	91.4	-
2469	28 June/75	12	165	-	102	-	17.0	11.0	11.0	12.0	107.9	-	2 YRLG
2379	30 June/75	13	169	66	104	62	19.5	11.0	11.5	12.0	113.0	104.2	1 2 YR.OLD
2754	1 July/75	13	162	-	98	65	19.0	10.0	11.0	11.5	97.9	106.7	-
2382	Aug./75	16	-	-	98	-	-	-	-	-	97.9	-	-
2468	4 Sept/75	5	163	66	104	56	18.0	10.0	11.0	11.5	113.0	-	-
2388	14 June/76	5	177	74	104	64	19.0	10.0	13.0	13.0	113.0	-	-
2754	21 June/76	14	-	-	-	-	-	-	-	-	-	-	-
2391	1 July/76	6	151	65	99	58	17.0	10.0	10.0	12.0	101.3	103.1	-
2379	4 July/76	14	173	92	117	63	22.0	13.0	12.5	13.0	146.6	147.3	-
2394	27 July/76	4	140	63	97	55	19.0	12.0	13.0	14.0	96.3	91.4	-
2395	28 July/76	14	163	80	101	60	18.0	12.0	12.5	13.0	106.3	106.7	-
2469	30 July/76	13	-	-	-	-	-	-	-	-	102.7	110.7	-
2378	30 July/76	6	-	-	-	-	-	-	-	-	97.1	96.5	-
2378	22 Aug./76	6	-	-	-	-	-	-	-	-	84.8	-	-
4990	11 June/77	19	153	71	102	55	19.0	13.0	12.0	14.0	107.9	-	-
4991	11 June/77	4	144	52	85	49	18.0	13.0	11.0	12.0	65.1	-	-
2395	12 June/77	15	173	72	102	55	18.0	12.0	12.5	13.0	107.9	-	1 YRLG
2461	12 June/77	8	161	65	106	55	18.0	12.0	13.0	13.0	118.0	-	2 COY
2469	14 June/77	14	165	80	105	-	17.0	11.0	11.0	12.0	115.5	-	2 COY
2379	15 June.77	15	173	92	104	57	22.0	13.0	12.5	13.0	113.0	-	2 COY

A = Total body length in centimetres
B = Standing height in centimetres
C = Chest girth in centimetres
D = Neck girth in centimetres
E = Left hind foot length in centimetres
F = Left front foot length in centimetres
G = Left hind foot width in centimetres
H = Left front foot width in centimetres
I = Estimated weight from chest girth in kilograms
J = Actual weight (spring scale) in kilograms
COY = Cub of the year

For definitions and diagram of measurement taken, see Appendix III.

Appendix III. Information collected from male grizzly bears captured and tagged in the Mackenzie Mountains, N.W.T. 1973 to 1977.

Tag. #	Date	Age	A	B	C	D	E	F	G	H	I	J
2462	18 Aug./73	2	150	97	114	62	-	-	-	-	138.1	-
2463	20 Aug./73	18	204	108	145	81	28.0	19.5	-	-	216.2	-
2467	30 Aug./73	0	112	-	73	48	-	9.0	-	-	34.9	-
2470	2 Sept/73	2	154	-	98	57	-	-	-	-	97.9	-
2471	2 Sept/73	2	144	-	103	59	-	-	-	-	110.4	-
2472	3 Sept/73	23	178	-	130	71	23.0	-	-	-	178.1	-
2474	3 Sept/73	16	170	-	141	88	21.0	10.0	-	-	206.1	-
2477	7 Sept/73	5	172	92	107	61	23.0	10.5	-	-	120.5	-
2478	7 Sept/73	20	174	84	117	79	24.0	14.0	-	-	145.7	-
2479	7 Sept/73	4	161	67	102	65	20.0	11.0	-	-	107.9	-
2751	5 July/74	5	165	-	95	57	21.0	19.0	-	-	91.2	88.9
2752	28 July/74	1	138	-	85	47	-	-	-	-	66.0	58.5
2753	28 July/74	1	150	-	81	48	-	-	-	-	56.0	64.1
2755	7 Aug./74	15	179	-	133	80	-	-	-	-	186.0	-
2758	26 Aug./74	2	145	-	93	48	-	-	-	-	86.2	83.8
2759	26 Aug./74	1	122	-	83	47	-	-	-	-	61.0	66.1
2377	28 June/75	13	191	89	128	80	24.0	13.0	14.0	15.0	173.4	-
2380	30 June/75	18	178	69	112	68	22.0	12.0	13.0	14.5	133.1	-
2752	27 July/75	2	154	76	94	56	18.5	13.0	14.5	15.0	87.9	82.3
2752	29 July/75	2	-	-	-	-	-	-	-	-	-	-
2381	30 July/75	9	166	77	102	62	21.0	12.5	12.0	13.0	107.9	-
2381	4 Sept/75	5	160	65	104	62	21.0	11.0	12.5	12.0	113.0	119.8
2389	6 June/76	7	175	73	104	62	23.0	11.0	14.0	14.0	113.0	-
2380	15 June/76	19	166	90	119	72	24.0	13.5	14.5	17.0	150.7	-
2383	25 June/76	6	182	94	104	85	23.0	13.0	14.0	14.0	113.0	-
2390	26 June/76	21	186	-	144	78	25.0	17.0	16.0	18.0	213.7	-
2392	16 July/76	2	150	-	90	55	17.0	9.0	12.0	12.0	77.7	76.1
2477	16 July/76	8	175	-	107	57	20.0	12.0	13.0	13.0	121.4	122.0
2393	19 July/76	3	155	67	100	52	20.0	12.0	11.5	11.0	102.9	99.1
2383	27 July/76	6	-	-	-	-	-	-	-	-	-	116.8
2396	28 July/76	0	105	-	62	35	14.0	8.0	9.0	10.0	-	25.4
2397	9 Aug./76	12	-	-	113	-	-	-	-	-	135.6	-
2398	26 Aug./76	14	181	95	135	83	23.0	16.0	16.0	16.0	191.0	-
2470	31 Aug./76	5	166	82	114	82	23.0	13.0	14.0	15.0	138.1	-
2399	8 Sept/76	4	174	75	104	65	19.0	12.0	14.5	14.0	113.0	-

A = Total body length in centimetres
B = Standing height in centimetres
C = Chest girth in centimetres
D = Neck girth in centimetres
E = Left hind foot length in centimetres
F = Left front foot length in centimetres
G = Left hind foot width in centimetres
H = Left front foot width in centimetres
I = Estimated weight from chest girth in kilograms
J = Actual weight (spring scale) in kilograms

For definitions and diagram of measurements taken, see Appendix III.

Appendix IV. Specifications of the Davidson Model "W" Receiver and the Dav-Tron Model 'MS-1' Reciever, both used for the tracking of transmitter-collared grizzly bears.

Characteristics	Specifications	
	Davidson Model "W"	Dav-Tron Model 'MS-1'
Type	solid state with integrated circuitory crystal construction	
Frequency	150 mhz	150 mhz
Band width	2 KC	2 KC
Sensitivity	0.05 mv	0.05 mv
Battery type	nickel-cadmium	nickel-cadmium
Battery life	10 hours between charges	10 hours between charges
Dimensions	20x11x18 cm	20x11x18 cm
Weight	1.13 kg	0.68 kg

Appendix V. Transmitter-collar characteristics used in tracking grizzly bears in the Mackenzie Mountains, N.W.T.

Characteristics	Specifications
Frequency	150 mhz
Output power	2 Milliwatts
Pulse width	0.2-0.1 per second
Pulse repetition rate	120-200 per minute
Antenna type	Whip antenna; 45.7 cm long
Antena impedence	50 ohms
Direct current input power	5 milliwatts
Battery type	Mercury cells
Total weight	0.76 Kilograms
Operating life-time	12 months

Appendix VI. Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1975.

APPENDIX VI. Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1975.

SCAT NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Period of defecation*	8	8	6	8	8	7	6	6	6	7	7	7	?	8	7	8	7	7	7	7	7	7	8	7	7	7	8	8	7	6
Location**	163	162	162	163	163	174	170	170	165	161	c.v.	162	162	162	174	157	162	157	170	173	173	162	162	174	170	192	162	157	160	169
Vegetation type***	F	F	F	F	F	F	F	F	F	F	?	F	F	F	F	F	F	F	F	F	F	F	F	F	F	SA	F	F	F	F
Percentage Sampled	25	22	17	22	11	10	8	31	20	13	20	50	15	19	14	42	17	71	42	16	12	14	23	33	42	15	29	33	10	29
Species diversity	7	4	6	3	7	4	3	8	5	5	4	6	3	9	6	7	8	9	7	4	8	5	8	6	10	7	10	9	8	4

Food Item — Percentage composition of Food Items in Grizzly Bear Scats

1. *Picea glauca*	tr	tr	tr									tr		tr		1	tr	tr			tr		tr							
2. *Betula glandulosa*																tr														
3. *Salix spp.*	tr				tr												tr	tr				tr				tr	tr	tr		tr
4. *Shepherdia canadensis*					24							45		1					tr		tr				tr		tr	25	35	
fruit					(22)							(5)		(1)							(tr)				(tr)		(tr)	(22)	(25)	
leaves					(2)							(40)							(tr)									(3)	(10)	
5. *Vaccinium uliginosum*	55		15	tr	5	2		tr	5	tr		1		7	5	3	tr	45	4	4	7	2	40		60	tr	5	6	20	
fruit	(30)		(tr)		(tr)	(tr)		(tr)	(4)	(tr)		(1)		(4)	(4)	(2)	(tr)	(3)	(4)	(4)	(2)	(1)	(3)		(15)	(tr)	(2)	(3)	(10)	
leaves	(25)		(15)	(tr)	(5)	(2)			(1)			(tr)		(3)	(1)	(1)		(42)	(tr)	(tr)	(5)	(1)	(37)		(45)	(tr)	(3)	(3)	(10)	
6. *Vaccinium vitis-idaea*	tr							tr						tr	tr	tr		tr					tr		tr		tr			
fruit																														
leaves	(tr)							(tr)						(tr)	(tr)	(tr)		(tr)					(tr)		(tr)		(tr)			
7. *Empetrum nigrum*	37	tr	15		20		tr					30		15	1	57		45	tr		tr	tr	60		2	tr	tr	3	tr	
fruit	(30)		(15)		(20)		(tr)					(30)		(15)	(1)	(56)		(42)			(tr)	(tr)	(50)		(2)	(tr)	(tr)	(3)	(tr)	
leaves	(7)	(tr)	(tr)		(tr)							(tr)		(tr)		(2)		(3)	(tr)		(tr)		(10)		(tr)			(tr)	(tr)	
8. *Arctostaphylos rubra*																														
fruit																														
leaves																														
9. *Ledum palustris*								tr								tr							tr		tr	tr	tr		tr	
10. *Hedysarum*	3	55	54	45	30	9	80	87	1	65	tr	5	55	75	2	37	95	tr	1	tr	1	95		35	25	28	3	3	tr	85
roots and bark	(3)	(55)	(54)	(45)	(30)	(9)	(80)	(87)	(1)	(65)	(tr)	(5)	(55)	(75)	(2)	(37)	(95)	(tr)	(1)	(tr)	(1)	(95)		(1)	(25)	(28)	(3)	(3)	(tr)	(85)
leaves			(tr)					(tr)											(tr)				(34)							
11. *Graminae spp.*						tr			2	1	tr	85			1			tr	-	-	tr	-	tr	tr	-	-	tr	tr	-	-
12. *Carex spp.*			tr				3		3	3	tr	tr	-	1	1	2	-	tr	tr	4	8	3	-	-	3	-	tr	tr	tr	tr	tr
13. *Equisetum spp.*		40	15	55	15	85	20	7	90	35	15	17	44	tr	90	-	3	-	88	85	85	-	-	62	tr	70	90	60	40	14
14. *Lichens*																			tr											
15. *Moss*																							tr							
16. *Insect matter*																	tr	tr							tr					
17. *Animal matter*								tr																						
Bone & Meat								(tr)																						
Hair																														
18. *Dryas integrifolia*																														
19. *Dryas drummondii*																									tr					
20. *Arctostaphulos uva-ursi*																											tr			
21. *Cruciferae*																								tr						
22. *Unidentified*								1									tr					tr	tr	tr	tr				tr	
23. *Unidentified*																														
24. *Unidentified*																														
25. *Unidentified*																														

* Periods of defecation:

1 — 1 - 15 May 2 — 16 - 31 May 3 — 1 - 15 June 4 — 16 - 30 June 5 — 1 - 15 July 6 — 16 - 31 July 7 — 1 - 15 Aug.
8 — 16 - 31 Aug. 9 — 1 - 15 Sept.

** Location — Numbers refer to mileage posts on the Canol Road, CV refers to Claudia Valley, JL refers to June Lake, CL refers to Cirque Lake and the remaining letters refer to the identification of bears where we located scats at the point of capture. P = X2468, W = X2381. See Appendix for map of name places.

*** Vegetation type — F = forest, SA = subalpine and A = alpine.

APPENDIX VI. Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1975.

SCAT NUMBER	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	56	47	48	49	50	51	52	53	54	55	56	57	59	58	60
Period of defecation*	6	6	6	6	6	6	-	6	6	8	6	6	6	6	6	6	6	-	8	6	6	7	8	9	6	7	8	8	8	4
Location**	165	169	170	180	180	180	174	170	180	174	165	164	180	174	170	177	169	170	162	165	165	170	163	P	W	171	162	162	157	212
Vegetation type***	F	F	F	SA	SA	SA	F	F	SA	F	F	F	SA	F	F	F	F	F	F	F	F	F	F	A	SA	F	F	F	F	A
Percentage Sampled	11	9	12	71	100	19	50	71	100	33	9	21	50	17	29	19	25	50	56	19	8	50	50	20	91	42	71	12	22	50
Species diversity	6	2	6	5	5	8	6	7	6	5	5	9	7	9	16	3	14	8	8	5	7	7	10	3	7	8	9	13	6	5

Food Item	Percentage composition of Food Items in Grizzly Bear Scats
1. Picea glauca	tr tr - - - tr tr - tr tr - tr tr
2. Betula glandulosa	
3. Salix spp.	tr - - tr tr tr - tr - tr - tr
4. Shepherdia canadensis	- - 3 tr 5 - 22 tr 3 - 18 tr 3 85 - 75 90 - - 6 85 - - - 7 - tr tr
fruit	(3) (tr) (5) (20) (tr) (3) (15) (tr) (3) (60) (52) (60) - - (3) (65) (7) (tr)
leaves	(tr) (tr) (2) (tr) (tr) (3) (tr) (25) (23) (30) - - (3) (20) (tr) (tr) (tr)
5. Vaccinium uliginosum	6 - 18 98 2 - - 1 1 2 - tr 3 tr 2 - 8 tr 30 - tr tr 77 - tr 75 40 80 2
fruit	(3) - (8) (78) (tr) - - (tr) (tr) (2) (tr) (3) (tr) (2) - (5) (tr) (2) (tr) (tr) (37) - (65) (15) (40) (2)
leaves	(3) - (10) (20) (2) - - (tr) (tr) (tr) (tr) (tr) (tr) (3) (28) (40) (tr) (10) (25) (40) -
6. Vaccinium vitis-idaea	tr tr tr tr t tr
fruit	
leaves	(tr) tr
7. Empetrum nigrum	tr - - - - - tr tr - - tr - 1 - tr - 70 17 - - 1 40 15 tr
fruit	(tr) (tr) (tr) (tr) (1) - (68) (15) (1) (30) (2) (tr)
leaves	- - (tr) (2) (2) (tr) (10) - (tr)
8. Arctostaphylos rubra	35 tr - - - tr tr 2 tr
fruit	(35) (tr) - - - (tr) (2)
leaves	(tr) (tr) (tr) (tr)
9. Ledum palustris	tr - tr - - tr tr tr - tr
10. Hedysarum	6 95 - - tr 2 10 25 tr 13 4 tr 1 70 2 5 2 1 tr 1 10 8 3 99 3 15 7 2 90 3
roots and bark	(6) (95) - - (tr) (2) (10) (25) (tr) (13) (4) (tr) (1) (70) (2) (2) (2) (1) (tr) (1) (8) (99) (3) (15) - (2) (90) (3)
leaves	(3)
11. Graminae spp.	tr tr tr tr tr tr tr tr tr tr 1 tr tr
12. Carex spp.	tr tr tr tr 3 2 1 tr 3 1 tr tr 5 tr 1 tr tr 2 tr 4 tr tr tr 3
13. Equisetum spp.	87 5 75 90 80 70 95 90 77 88 25 2 90 15 tr tr 97 80 7 93 tr 95
14. Lichens	2 1 tr tr tr tr tr
15. Moss	tr tr tr 2 tr tr
16. Insect matter	tr tr tr
17. Animal matter	tr tr 1
Bone & Meat	(tr) (tr) (tr)
Hair	(tr)
18. Dryas integrifolia	
19. Dryas drummondii	
20. Arctostaphylos uva-ursi	50 tr tr tr tr tr
21. Cruciferae	tr tr tr
22. Unidentified	tr tr tr tr tr tr tr tr tr
23. Rosa spp.	tr tr tr
24. Linnaea borealis	tr
25. Fish	tr

* Periods of defecation:

1 — 1 - 15 May 2 — 16 - 31 May 3 — 1 - 15 June 4 — 16 - 30 June 5 — 1 - 15 July 6 — 16 - 31 July 7 — 1 - 15 Aug.
8 —16 - 31 Aug. 9 — 1 - 15 Sept

** Location -- Numbers refer to mileage posts on the Canol Road, CV refers to Claudia Valley, JL refers to June Lake, CL refers to Cirque Lake and the remaining letters refer to the identification of bears where we located scats at the point of capture. P = X2468, W = X2381.

*** Vegetation type — F = forest, SA = subalpine and A = alpine.

APPENDIX VI. Information of grizzly bear scats collected and analyzed from the Mcakenzie Mountains, N.W.T. in 1975.

SCAT NUMBER	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Period of defecation*	8	8	8	7	8	7	3	7	7	8	8	7	-	8	8	3	4	4	8	8	8	7	7	7	9	7	5	6	7	8
Location**	162	160	163	165	158	CV	216	165	170	161	162	170	210	JL	161	216	167	212	157	172	JL	164	170	171	164	CL	211	177	171	157
Vegetation type***	F	F	F	F	F		A	F	F	F	F	F	A	SA	F	A	F	A	F	F	SA	F	F	F	F	A	A	F	F	F
Percentage Sampled	12	15	83	17	24	25	59	100	8	100	16	20	17	91	30	9	17	15	22	10	90	36	20	15	19	33	17	14	10	10
Species diversity	7	9	8	15	7	6	3	6	14	8	8	8	7	8	11	7	14	8	8	5	7	8	8	8	12	7	5	10	10	6

Food Item — Percentage composition of Food Items in Grizzly Bear Scats

1. Picea glauca	-	-	tr	tr	-	-	-	tr	tr													tr								
2. Betula glandulosa																									tr					
3. Salix spp.				tr											tr			tr	tr	tr					tr	tr				
4. Shepherdia canadensis	tr	tr	-	35	tr	-	-	40	7	22	15	48					5		25	4		50	17	2				tr	tr	14
fruit	(tr)	(tr)		(15)	(tr)			(75)	(6)	(2)	(15)	(45)					(3)		(13)	(4)		(25)	(12)	(2)				(tr)	(tr)	(14)
leaves	(tr)			(20)				(15)	(1)	(20)	(tr)											(25)	(5)	(tr)				(tr)	(tr)	
5. Vaccinium uliginosum	1	tr	98	tr	tr	-	-	tr	10	2	3	35			40		32		tr			tr	tr	4	15				5	2
fruit	(tr)	-	(63)	(tr)				(tr)	(8)	(tr)	(3)	(30)			(2)		(20)							(4)	(15)				(tr)	
leaves	(tr)	(tr)	(35)	(tr)	(tr)				(2)	(2)	(tr)	(5)			(38)		(12)								(tr)				(5)	(2)
6. Vaccinium vitis-idaea	tr								tr	tr															tr				tr	
fruit																														
leaves	(tr)								(tr)	(tr)															(tr)				(tr)	
7. Empetrum nigrum	75	-		3	47				75	75	tr	tr			55		5	tr	tr			47			tr				5	5
fruit	(65)		(2)	(5)					(75)	(73)					(50)		(5)					(45)							(5)	(5)
leaves	(10)		(1)	(2)					(3)	(2)					(5)		(tr)					(2)			(tr)					
8. Arctostaphylos rubra		tr																tr										tr	tr	
fruit		(tr)																(tr)												
leaves		(tr)																											(tr)	(tr)
9. Ledum palustris	tr	-	-	tr	-	-	-	-	tr	tr		tr			tr		tr		tr					tr	tr				tr	
10. Hedysarum	15	4	-	5	6	3	-	5	tr	3	75	12	5	5	3	3	25	2	55	92	3	tr	25	20	85	tr	tr	7	20	33
roots and bark	(15)	(4)	-	(5)	(6)	(3)	-	(5)	(tr)	(3)	(75)	(12)	(5)	(5)	(3)	(3)	(15)	(2)	(55)	(92)	(3)	(tr)	(25)	(20)	(85)	(tr)	(tr)	(7)	(20)	(33)
leaves																	(10)		(tr)									(tr)		
11. Graminae spp.	tr	tr			tr	tr			tr		tr		tr			3	tr				35									
12. Carex spp.		tr	tr	tr	tr	2	5	tr	tr			tr	tr	5	8	tr	3	3	2		7		8	10	tr	3	10	tr	tr	tr
13. Equisetum spp.		95		tr	93	70	95	5		tr	7	3	90	75	3	90	23	60	20	tr	55		50	60	tr	43	80	80	70	40
14. Lichens									5							tr						1								
15. Moss				tr	2		tr															tr			tr					
16. Insect matter		tr	tr	tr				tr		tr					tr			tr			tr	tr			tr					
17. Animal matter				tr					1				tr											tr						
Bone & Meat				(tr)					(tr)															(tr)						
Hair									(tr)				(tr)																	
18. Juneperus horizontallis																													tr	
19. Saxifraga spp.				tr																										
20. Arctostaphylos uva-ursi				tr					tr						tr															
21. Cruciferae																			tr									tr		
22. Oxycoccus					tr																									
23. Fungi					5																									
24. Unidentified		tr		tr	tr	25				tr	tr	tr	tr	9	1	1	8	39	tr	tr	4		5	2		55	10	10		
25. Unidentified									.																					

* Periods of defecation:

1 — 1 - 15 May 2 — 16 - 31 May 3 — 1 - 15 June 4 — 16 - 30 June 5 — 1 - 15 July 6 — 16 - 31 July
7 — 1 - 15 Aug. 8 — 16 - 31 Aug. 9 — 1 - 15 Sept.

** Location — Numbers refer to mileage posts on the Canol Road, CV refers to Claudia Valley, JL refers to June Lake, CL refers to Cirque Lake and the remaining letters refers to the identification of bears where we located scats at the point of capture. P = X2468, W = X2381.

*** Vegetation type — F = forest, SA = subalpine and A = alpine.

APPENDIX VI. Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1975.

SCAT NUMBER	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108
Period of defecation*	7	7	8	7	7	9	7	7	7	7	7	7	8	8	7	7	7	6
Location**	157	170	170	170	CL	171	170	157	170	170	161	160	160	160	170	170	170	171
Vegetation type***	F	F	F	F	A	F	F	F	F	F	F	F	F	F	F	F	F	F
Percentage Sampled	50	31	11	24	22	12	40	13	14	16	38	100	17	15	91	100	29	10
Species diversity	5	8	5	7	8	1	13	6	7	11	5	8	5	7	7	9	8	6

Food Item	Percentage composition of Food Items in Grizzly Bear Scats
1. Picea glauca	tr
2. Betula glandulosa	
3. Salix spp.	tr tr tr tr
4. Shepherdia canadensis	3 81 23 23 3 25 3 tr 92 2 20 tr 38 15
fruit	(3) (75) (18) (3) (22) (3) (tr) (47) (2) (18) (tr) (27) (13)
leaves	(tr) (6) (5) (tr) (3) (45) (tr) (2) (11) (2)
5. Vaccinium uliginosum	66 1 tr 69 1 3 5 tr 1 10 1 tr 52
fruit	(41) (tr) (65) (tr) (2) (tr) (5) (tr) (tr) (34)
leaves	(25) (1) (4) (1) (3) (3) (tr) (tr) (5) (1) (18)
6. Vaccinium vitis-idaea	tr tr tr tr
fruit	
leaves	(tr) (tr) (tr) (tr)
7. Empetrum nigrum	tr 32 tr 1 1 tr tr 5 1
fruit	(27 (tr) (1) (1) (tr) (tr) (5) (1)
leaves	(tr) (5) (tr)
8. Arctostaphylos rubra	tr tr 2
fruit	(tr) (tr) (2)
leaves	
9. Ledum palustris	tr tr tr tr tr tr tr
10. Hedysarum	93 99 4 3 100 4 23 19 21 98 tr 85 19 9 58 24 5
roots and bark	(93) (99) (4) (3)(100) (4) (23) (19) (21) (98) (tr) (85) (19) (9) (58) (24) (5)
leaves	(tr) (tr) (tr) (tr) (tr) (tr) (tr) (tr)
11. Graminae spp.	tr 85 tr 12 tr tr
12. Carex spp.	tr tr 10 tr 16 1 1 4 2 1 5 tr
13. Equisetum spp.	3 13 3 5 56 51 40 56 77 2 3 93
14. Lichens	tr
15. Moss	tr tr tr tr tr tr
16. Insect matter	tr tr tr tr tr tr tr
17. Animal matter	tr tr 7 tr
Bone & Meat	(tr) (tr)
Hair	(7) (tr)
18. Dryas integrifolia	
20. Cornus canadensis	
21. Arctostaphulos uva-ursi	tr
22. Unidentified	tr tr 2 22
23. Unidentified	
24. Unidentified	
25. Unidentified	

* Periods of defecation:

1 — 1 - 15 May 2 — 16 - 31 May 3 — 1 - 15 June 4 — 16 - 30 June 5 — 1 - 15 July 6 — 16 - 31 July
7 — 1 - 15 Aug. 8 — 16 - 31 Aug. 9 — 1 - 15 Sept.

** Location — Numbers refer to mileage posts on the Canol Road, CV refers to Claudia Valley, JL refers to June Lake, CL refers to Cirque Lake and the remaining letters refer to the identification of bears where we located scats at the point of caputre. P = X2468, W = X2381.

*** Vegetation type — F = forest, SA = subalpine and A = alpine.

Appendix VII. Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1976.

APPENDIX VII. Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1976

SCAT NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Period of defecation*	9	8	9	9	6	10	8	8	9	5	8	9	9	6	3	9	3	9	9	5	9	8	4	7	9	10	7	8	9	6
Location**	171	165	166	165	165	167	204	166	164	MV	204	167		165	GR	166	154	165	163	MV	LE	150	177	185	153	152	153	152	167	213
Vegetation type***	F	F	F	F	F	F	SA	F	F	A	SA	F	A	F	F	F	F	F	F	A	SA	F	F	SA	F	F	F	F	F	A
Percentage Sampled	12	8	12	12	11	7	50	7	12	6	12	5	30	20	6	25	5	12	7	7	10	7	12	80	12	12	7	15	12	5
Species diversity	3	10	6	4	3	8	10	7	8	3		6	3	3	3	1	7	1	5	7	3	4	6	4	8	6	8	4	1	3

Food Item	Percentage composition of Food Items in Grizzly Bear Scats
1. *Picea glauca*	tr tr tr tr tr tr tr
2. *Betula glandulosa*	tr tr tr tr
3. *Salix spp.*	tr tr 3 1 tr tr tr tr tr tr 3 tr tr
4. *Shepherdia canadensis*	2 tr 46 1 tr 25 tr 1 8 17 tr tr - 100
fruit	(1) (0) (17) (1) (tr) (12) (-) (tr) (8) (14) (tr) - (tr) (22)
leaves	(1) (tr) (29) (0) (tr) (13) (tr) (1) (tr) (3) (tr) (78)
5. *Vaccinium uliginosum*	62 97 91 36 33 49 46 43 85 85 45 1 34 20 86
fruit	(23) (30) (25) (7) (15) (36) (25) (29) (10) (47) (40) (1) (9) (19) (56)
leaves	(39) (67) (66) (29) (18) (13) (21) (14) (75) (38) (5) (tr) (25) (1) (30)
6. *Vaccinium vitis-idaea*	tr 70 tr 1
fruit	(0) (58) - -
leaves	(tr) (12) (tr) (1)
7. *Empetrum nigrum*	36 1 16 48 tr 11 80 71 82 62 4
fruit	(18) (0) (15) (44) (tr) (11) (66) (53) (67) (57) (4)
leaves	(18) (1) (1) (4) (0) (-) (14) (18) (15) (5)
8. *Arctostaphylos rubra*	
fruit	
leaves	
9. *Ledum palustris*	tr tr tr tr
10. *Hedysarum*	98 tr 2 5 8 41 2 7 46 13 100 100 4 21 82 10 51 15 75
roots and bark	(98) (tr) (2) (5) (8) (41) (7) (46) (13) (100) (100) (4) (21) (74) (10) (51) (15) (75)
leaves	(tr) (tr) (8) (tr) (-)
11. *Graminae spp.*	tr tr tr 19 tr 99 9 47 tr 79
12. *Carex spp.*	tr tr 3 2 tr - 10 tr 1 10 1 4 1
13. *Equisetum spp.*	97 7 3 81 90 10 74 tr 41 tr 14 20
14. *Lichens*	tr 1 tr
15. *Moss*	1 tr 1 1
16. *Insect matter*	tr tr tr tr
17. *Animal matter*	20 20 7 1
Bone & Meat	(3) - (1)
Hair	(20) (17) (7)
18. *Dryas integrifolia*	tr tr tr tr tr tr
19. *Dryas drummondii*	
20. *Garbage*	1 tr
21. *Plastic bag*	1
22. *Banana peel*	tr
23. *Arctostaphylos ura ursi*	27
fruit	22
leaves	5

* Periods of defecation:

1 — 1 - 15 May 2 — 16 - 31 May 3 — 1 - 15 June 4 — 16 - 30 June 5 — 1 - 15 July 6 — 16 - 31 July
7 — 1 - 15 Aug. 8 — 16 - 31 Aug. 9 — 1 - 15 Sept.

** Location — Numbers refer to mileage posts on the Canol Road, TV refers to Trophy Valley, GV refers to Godlin Valley, WV refers to Wayne Valley, MV refers to Mud Valley, ER refers to Ekwi River, C refers to Caribou Pass, and the remaining letters refer to the identification of bears where we located scat at point of capture. U = X4990, EV = X4991, E = X2379, K = X2469.

*** Vegetation type — F = forest, SA = subalpine and A = alpine.

APPENDIX VII. Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1976

SCAT NUMBER	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Period of defecation*	9	9	8	8	6	6	5	7	9	6	5		9	9	4	5	6	9	9	8	8	9	6	9	5	9	6	10	5	9
Location**	151	152	159	GV	WV	153	MV	151	167	214	MV		ER	181	192	RS	C	148	171	GR	M	ER	SV	ER	MV	ER	WY	163	182	167
Vegetation type***	F	F	F	SA	A	F	A	F	F	A	A		F	SA	A	A	A	F	F	SA	SA	F	A	F	A	F	A	F	SA	F
Percentage Sampled	7	5	12	100	62	8	6	7	7	7	6		6	3	20	67	50	5	5	100	5	7	7	10	7	10	33	4	20	4
Species diversity	7	5	6	8	6	2	6	5	2	6	5		5	12	6	6	3	4	6	1	4	7	5	7	4	5	3	6	3	5

Food Item — Percentage composition of Food Items in Grizzly Bear Scats

1. *Picea glauca*				tr				tr	tr										tr					tr		tr		tr		
2. *Betula glandulosa*								tr																						
3. *Salix spp.*	tr	tr			1										tr	1		1			tr	tr	tr				tr			
4. *Shepherdia canadensis*	1								100										1			5		17		23		32		1
fruit	(1)								(18)										(1)			(3)		(17)		(18)		* (21)		(1)
leaves	-								(82)										(tr)			(2)		(tr)		(5)		(11)		(tr)
5. *Vaccinium uliginosum*	8		tr	5				3					tr	35				tr				4		1		15		67		1
fruit	(6)		(tr)	(5)				(3)					(tr)	(5)				(tr)				(2)		(1)		(7)		(47)		(tr)
leaves	(2)			(-)				(-)					(-)	(30)				(tr)				(2)		(tr)		(8)		(20)		(1)
6. *Vaccinium vitis-idaea*			tr	tr									tr					tr						tr						
fruit				-									-					-						-						
leaves			(tr)	(tr)									(tr)					(tr)						(tr)						
7. *Empetrum nigrum*		42		53				3					98					65		100	99	18		50		14		tr		
fruit		(36)		(48)				(3)					(83)					(57)		(88)	(89)	(14)		(36)		(12)		(tr)		
leaves		(6)		(5)				(tr)					(15)					(8)		(12)	(10)	(4)		(14)		(2)				
8. *Arctostaphylos rubra*																			tr											
fruit																			-											
leaves																			(tr)											
9. *Ledum palustris*																														
10. *Hedysarum*	14	57	99	32				94					2	65				34	98			73		32		48		tr		98
roots and bark	(14)	(57)	(99)	(32)				(94)					(2)	(65)				(98)				(73)		(32)		(48)		(tr)		(98)
leaves		(tr)																												
11. *Graminae spp.*	3		tr	tr	tr	tr	38		14	30				35	79	25					tr		4		35		3		
12. *Carex spp.*	tr	1			tr		25		58	31				10	14	75						tr	2		30		3		2
13. *Equisetum spp.*	75				96	100	23		17	15				4	2	tr							94		35		94		98
14. *Lichens*			tr		1		tr																							
15. *Moss*					tr		tr		tr				tr									tr							tr	
16. *Insect matter*		tr		tr					tr	tr		tr			2				1				tr	tr	tr					tr
17. *Animal matter*			tr	10			14		10	24				51	2															
Bone & Meat			-	-			-		-	(4)				(6)	-															
Hair			(tr)	(10)			(14)		(10)	(20)				(45)	(2)															
18. *Dryas integrifolia*																					tr									tr
19. *Dryas drummondii*																														
20. *Cornus canadensis*																														
21. *Cassiope spp.*															tr															
22. *Unidentified*																														
23. *Unidentified*																														
24. *Unidentified*																														
25. *Unidentified*																														

* Periods of defecation:

1 -- 1 - 15 May 2 -- 16 - 31 May 3 -- 1 - 15 June 4 -- 16 - 30 June 5 -- 1 - 15 July 6 -- 16 - 31 July
7 -- 1 - 15 Aug. 8 -- 16 - 31 Aug. 9 -- 1 - 15 Sept.

** Location -- Numbers refer to mileage posts on the Canol Road, TV refers to Trophy Valley, GV refers to Godlin Valley, WV refers to Wayne Valley, ER refers to Ekwi River, C refers to Caribou Pass, and the remaining letters refer to the identification of bears where we located scat at point of capture. MV refers to Mud Valley. U = X4990, EV = X4991, E = X2379, K = X2469.

*** Vegetation type -- F = forest, SA = subalpine and A = alpine.

APPENDIX VII. Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1976

SCAT NUMBER	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	84	83	82	85	86	87	88	89	90
Period of defecation*	8	9	9	5	8	6	9	6	8	9	8	9	10	8	9	9	6	7	5	3	7	6	7	8	7	9	9	9	4	9
Location**	152	167	GV	MV	173	153	162	157	173	162	159	165	161	152	163	165	165	175	184	GV	152	165	178	174	175	174	185	179	170	167
Vegetation type***	F	F	F	A	F	F	F	F	F	F	F	F	F	F	F	F	F	F	SA	F	F	F	F	F	F	F	SA	F	F	F
Percentage Sampled	5	5	12	12	4	6	8	67	10	13	50	13	6	6	6	13	13	10	33	5	17	13	17	10	8	6	100	17	25	12
Species diversity	8	12	7	5	7	5	3	3	5	7	1	9	5	7	9	4	3	4	4	3	4	4	5	5	3	6	7	2	6	9

Food Item — Percentage composition of Food Items in Grizzly Bear Scats

1.	*Picea glauca*		tr			tr																				tr	tr			
2.	*Betula glandulosa*																										tr		tr	
3.	*Salix spp.*				tr	tr						1	11														3		tr	
4.	*Shepherdia canadensis*	tr	58	9		41		99		39	32		3	21	10	2	32		tr				tr	80	40	tr	tr			1
	fruit	(tr)	(24)	(3)		(31)		(90)		(19)	(15)		(1)	(6)	(10)	(1)	(11)		(tr)				(tr)	(70)	(36)	-	-			(tr)
	leaves		(34)	(6)		(10)		(9)		(20)	(17)		(2)	(15)	(tr)	(1)	(21)		(tr)					(10)	(4)	(tr)	(tr)			(1)
5.	*Vaccinium uliginosum*	1	37	37		14	tr			2	36		6	62	17	21			27				72	tr	tr	tr	5	55		18
	fruit	(1)	(13)	(14)		(7)	(-)			(1)	(14)		(4)	(12)	(12)	(9)			(19)				(56)	(tr)		-	-		(41)	(12)
	leaves		(24)	(23)		(7)	(tr)			(1)	(22)		(2)	(50)	(5)	(12)			(8)				(16)	(tr)	(tr)	(tr)	(5)	(14)		(6)
6.	*Vaccininun vitis-idaea*		tr										tr																1	
	fruit		(-)										(-)																(tr)	
	leaves		(tr)										(tr)																(1)	
7.	*Empetrum nigrum*	1	1	1		12				2	1		87	1	tr	tr			2					tr		20	92			80
	fruit	(1)	(1)	(1)		(10)				(2)	(1)		(77)	(1)	(tr)	(tr)			(2)					(tr)		(19)	(87)			(71)
	leaves	(-)	(-)	(-)		(2)				(tr)	(tr)		(10)	(-)					(tr)					(-)		(1)	(5)			(9)
8.	*Arctostaphylos Rubra*																													
	fruit																													
	leaves																													
9.	*Ledum palustris*		tr	tr									tr		tr								tr							tr
10.	*Hedysarum*	20	3	52	tr	31	7	tr	4	57	tr	100	2	5	59	16	3		71		10	10		18	60	80		45	45	
	roots and bark	(20)	(3)	(52)	(tr)	(31)	(7)	(tr)	(4)	(57)	(tr)	(100)	(2)	(5)	(59)	(16)	(3)		(71)		(10)	(10)		(18)	(60)	(80)		(45)	(45)	
	leaves																							(tr)						
11.	*Graminae spp.*	tr			29					tr					tr	50			1	62	1	tr	tr	1					5	
12.	*Carex spp.*	10	tr		15		5		7		1		1		1	tr	15	4	1	28	9	1							10	
13.	*Equisetum spp.*	68			55		88		89						13	61		96	95		80	99	28						40	
14.	*Lichens*		tr	tr																										1
15.	*Moss*		tr	tr																						tr	tr			tr
16.	*Insect matter*	tr	tr			tr	tr	tr								tr		tr				tr								
17.	*Animal matter*										29								3											
	Bone & Meat										(1)								(-)											
	Hair										(28)								(3)											
18.	*Dryas integrifolia*										tr		tr																	
19.	*Dryas drummondii*																													
20.	*Cornus canadensis*																													
21.	*Wood splinters*		tr																											
22.	*Fish*														tr															
23.	*Arcto uva-ursi*																													
24.	*Unidentified*																													
25.	*Unidentified*																													

* Periods of defecation:

1 — 1 - 15 May 2 — 16 - 31 May 3 — 1 - 15 June 4 — 16 - 30 June 5 — 1 - 15 July 6 — 16 - 31 July 7 — 1 - 15 Aug.
8 — 16 - 31 Aug 9 — 1 - 15 Sept.

** Location — Numbers refer to mileage posts on the Canol Road, TV refers to Trophy Valley, GV refers to Godlin Valley, WV refers to Wayne Valley, MV refers to Mud Valley, ER refers to Ekwi River, C refers to Caribou Pass, and the remaining letters refer to the identification of bears where we located scat at point of capture. U = X4990, EV = X4991, E = X2379, K = X2469.

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APPENDIX VII Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1976.

SCAT NUMBER	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Period of defecation*	3	9	8	8	8	7	4	9	6	6	9	4	9		10	9	9	9	6	10	7	5	9	3	6	5	9	7	4	7
Location**	162	178	160	175	180	188	171	180	T	A	174	193	165	164	175	174	175	167	SP	183	204	MV	175	176	WV	174	167	176	169	179
Vegetation type***	F	F	F	F	SA	SA	F	SA		A	F	A	F	F	F	F	F	F	A	SA	SA	A	F	F	A	F	F	F	F	F
Percentage Sampled	10	17	33	10	17	20	13	17	13	8	11		12	10	25	11	14	9	10	50	50	10	6	6	17	12	10	10	8	25
Species diversity	5	3	5	4	1	3	4	3	4	3	9	5	3	7	7	7	7	5	4	4	4	3	7	11	3	5	5	8	3	5

Food Item	Percentage composition of Food Items in Grizzly Bear Scats
1. *Picea glauca*	tr tr tr t
2. *Betula glandulosa*	tr tr
3. *Salix spp.*	tr tr tr tr tr tr tr tr tr tr tr t
4. *Shepherdia canadensis*	75 tr 8 1 48 2 tr 10 tr tr 9 3 5
fruit	(65) (tr) (7) (tr) (11) (2) (-) (1) (4) (tr) (tr) (9) 2 5
leaves	(10) (1) (tr) (37) (tr) (tr) (-) (6) (tr) (-) (t) 1
5. *Vaccinium uliginosum*	76 22 12 1 65 62 44 65 tr 54 89 tr 59 27 13 55
fruit	(34) (15) (10) (1) (15) (10) (5) (18) (-) (14) (51) (-) (19) 22 8 50
leaves	(42) (7) (2) (-) (50) (52) (39) (47) (tr) (40) (38) (tr) (40) 5 5 5
6. *Vaccinium vitis-idaea*	15 65
fruit	(13) (54)
leaves	(2) (11)
7. *Empetrum nigrum*	tr 1 2 tr tr 40 tr 1 99 tr tr 63 t
fruit	(tr) (1) (2) (tr) (tr) (38) (tr) (tr) (93) (tr) (tr) 59 t
leaves	- (tr) (tr) (tr) (-) (2) (-) (-) (6) (tr) (tr) 4
8. *Arctostaphylos rubra*	
fruit	
leaves	
9. *Ledum palustris*	tr tr tr tr tr tr t t
10. *Hedysarum*	41 24 5 78 100 80 98 35 85 4 100 8 3 60 20 52 14 tr 3 1 t 80 5
roots and bark	(41) (24) (5) (78) (100) (80) (98) (35) (85) (4) (100) (8) (60) (20) (52) (14) (tr) 3 1 t 80 5
leaves	-
11. *Graminae spp.*	10 tr 70 15 95 12 30 98 10 5
12. *Carex spp.*	20 tr tr 1 5 tr tr 10 9 5
13. *Equisetum spp.*	44 10 10 29 87 13 2 5 90 82 75 15 35
14. *Lichens*	tr
15. *Moss*	tr tr
16. *Insect matter*	tr tr tr tr tr t
17. *Animal matter*	31 5 25 tr 27 10 tr
Bone & Meat	(1) (tr) (-) (-) (-) (-) (-)
Hair	(30) (5) (25) (tr) (27) (10) (tr)
18. *Dryas integrifolia*	tr tr
19. *Arctostaphylos uva-ursi*	19
fruit	(17)
leaves	(2)
20. *Unidentified*	
21. *Unidentified*	
22. *Unidentified*	
23. *Unidentified*	

* Periods of defecation:

1 — 1 - 15 May 2 -- 16 - 31 May 3 -- 1 - 15 June 4 -- 16 - 30 June 5 -- 1 - 15 July 6 -- 16 - 31 July 7 -- 1 - 15 Aug.
8 —16 - 31 Aug. 9 -- 1 - 15 Sept.

** Location — Numbers refer to mileage posts on the Canol Road. TV refers to Trophy Valley, GV refers to Godlin Valley, WV refers to Wayne Valley, MV refers to Mud Valley, ER refers to Ekwi River, C refers to Caribou Pass, and the remaining letters refer to the identification of bears where we located scat at point of capture. U = X4990, EV = X4991, E = X2379, K = X2469.

*** Vegetation type -- F = forest, SA = subalpine and A = alpine.

Appendix VIII. Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1977.

APPENDIX VIII. Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1977.

SCAT NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Period of defecation*	2	5	5	3	5	3	4	3	8	8	8	8	8	8	8	8	8	8	8	7	4	4	8	8	8	8	7	7	7	8
Location**	155	165	165	E	166	K	177	166	180	181	205	180	181	180	172	183	180	181	182	205	190	178	182	181	185	200	176	181	180	211
Vegetation type***	F	F	F	A	F	A	F	F	SA	SA	SA	SA	SA	SA	F	SA	SA	SA	SA	SA	A-SA	F	SA	F	SA	SA	SA-F	SA	SA	A-SA
Percentage Sampled	5	8	8	12	10	30	12	12	6	3	6	12	33	25	4	13	8	4	6	7	8	13	6	17	6	63	10	10	8	6
Species diversity	9	7	2	3	7	11	6	5	5	6	4	3	6	4	3	4	4	2	9	5	4	7	6	9	7	3	5	11	7	2

Foot Item — Percentage composition of Food Items in Grizzly Bear Scats

1. *Picea glauca*						tr				tr						tr	tr					tr		tr				tr		
2. *Betula glandulosa*	tr				tr																									
3. *Salix spp.*	tr	tr		tr	tr			1	tr		tr	tr		tr	tr					tr	tr	tr	tr	tr		tr		tr		
4. *Shepherdia canadensis*								81	34	87	98	89	18	80	25	99	40	22					15	12	52	100	2	86	4	47
fruit								(70)	(20)	(69)	(45)	(53)	(10)	(60)	(15)	(59)	(20)	(11)					(7)	(5)	(42)	(77)	(2)	(72)	(3)	(42)
leaves								(11)	(14)	(18)	(53)	(36)	(8)	(20)	(10)	(40)	(20)	(11)					(8)	(7)	(10)	(23)	(tr)	(14)	(1)	(5)
5. *Vaccinium uliginosum*						tr		16	1			tr	77					21					tr	77	2		42	12	94	
fruit						tr		(13)	(1)				(71)					(12)						(20)	(1)		(24)	(2)	(51)	
leaves					tr			(3)	(tr)			(tr)	(6)					(9)					(tr)	(57)	(1)		(18)	(10)	(40)	
6. *Vaccinium vitis-idaea*	4						tr																							
fruit	(3)																													
leaves	(1)						(tr)																							
7. *Empetrum nigrum*	89							1	1		1		tr			1		tr						tr	7		1	1	1	
fruit	(85)							(1)	(1)		(1)		(tr)			(1)		(tr)						(tr)	(5)		(tr)	(1)	(tr)	
leaves	(4)							(-)	(-)		(-)													(tr)	(2)		(tr)		(tr)	
8. *Arctostaphylos rubra*																														
fruit																														
leaves																														
9. *Ledum palustris*									tr																		tr	tr	tr	
10. *Hedysarum*	7	tr						1	63	10		10	5	20	75		60	41					84	2	14	tr	55	tr	tr	
roots and bark	(7)							(1)	(63)	(10)		(10)	(5)	(20)	(75)		(60)	(41)					(84)	(2)	(14)	(tr)	(55)	(tr)	(tr)	
leaves									(tr)			(tr)	(tr)		(tr)										(tr)		(tr)			
11. *Graminae spp.*					tr	tr	14	tr					tr			tr		tr	tr		tr	tr	tr	23			tr		53
12. *Carex spp.*						tr	70	1	1				tr					tr	tr	13	tr	tr	tr	2				tr	
13. *Equisetum spp.*		99	100	100	99		97	98			3							1	99	87	99		7	tr			tr		
14. *Lichens*																														
15. *Moss*	tr					tr												1										tr		
16. *Insect matter*	tr	tr		tr	tr	tr	tr	tr											tr	tr	tr									
17. *Animal matter*																														
Bone & Meat						tr												10												
Hair						13												4										tr		
18. *Dryas integrifolia*	tr																					tr								
19. *Dryas drummondii*																														
20. *Cornus canadensis*																														
21. *Wood splinters*	tr																													
22. *Unidentified*																														
23. *Unidentified*																														
24. *Unidentified*																														
25. *Unidentified*																														

* Periods of defecation:

1 — 1 - 15 May 2 — 16 - 31 May 3 — 1 - 15 June 4 — 16 - 30 June 5 — 1 - 15 July 6 — 16 - 31 July
7 — 1 - 15 Aug. 8 — 16 - 31 Aug. 9 — 1 - 15 Sept.

** Location:

Numbers refer to mileage posts on the Canol Road, TV refers to Trophy Valley, and the remaining letters refer to the identification of bears where we located scat at point of capture. U = X4990, EV = X4991, E = X2379, K = X2469.

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APPENDIX VIII. Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1977.

SCAT NUMBER	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
Period of defecation*	7	7	7	7	7	7	7	7	7	6	6	6	6	6	6	6	9	9	9	9	9	6	9	9	9	9	5	5	4	6
Location**	174	200	179	182	173	173	179	206	178	193	179	203	197	193	TV	TV	182	164	181	182	200	193	175	166	182	178	165	185	179	207
Vegetation type***	F	SA	SA	SA	F	SA	SA	SA	SA	A	A	A	A	A	A	A	SA	F	SA	SA	SA	A	F	F	SA	F	F	SA	SA	SA
Percentage Sampled	13	7	5	6	10	13	10	10	10	9	5	5	13	5	8	13	4	6	4	5	6	8	17	3	10	3	7	7	10	7
Species diversity	9	8	3	4	6	6	8	4	13	5	6	3	2	3	4	3	10	4	5	3	3	4	10	10	7	6	5	3	5	2

Food Item	Percentage composition of Food Items in Grizzly Bear Scats
1. *Picea glauca*	tr tr
2. *Betula glandulosa*	tr tr tr
3. *Salix spp.*	tr tr tr tr tr tr tr tr tr
4. *Shepherdia canadensis*	6 2 31 5 tr 2 8 6 5 70 30 tr 12
fruit	(6) (tr) (25) (4) (tr) (2) (8) (6) (2) (31) (21) (tr) (10)
leaves	(tr) (tr) (6) (1) (tr) (tr) (3) (39) (9) (2)
5. *Vaccinium uliginosum*	76 5 83 24 30 9 3 28 85 65 22 tr 62
fruit	(42) (3) (50) (10) (10) (3) (8) (35) (55) (8) - (12)
leaves	(34) (2) (33) (14) (20) (tr) (20) (50) (10) (14) (tr) (50)
6. *Vaccinium vitis-idaea*	tr tr tr
fruit	(-) (tr)
leaves	(tr) (tr) (-)
7. *Empetrum nigrum*	tr tr tr tr tr 65 1 45 1 37 tr
fruit	(tr) (tr) (tr) (tr) (61) (1) (40) (1) (27) (tr)
leaves	(4) (tr) (5) (-) (10) (-)
8. *Arctostaphylos rubra*	91
fruit	(77)
leaves	(14)
9. *Ledum palustris*	tr tr tr tr tr 1 tr tr tr tr
10. *Hedysarum*	17 8 98 64 12 tr 17 tr 14 27 70 5 tr 29 32 86
roots and bark	(17) (8) (98) (64) (12) (tr) (17) (tr) (14) (27) (70) (5) (-) (29) (32) (86)
leaves	(tr) (tr) (tr) (tr) (tr) (tr) (-) (-) (-) (tr)
11. *Graminae spp.*	tr tr tr tr tr 2 61 1 2 1 tr tr 1 59 8 tr tr tr 6 -
12. *Carex spp.*	tr tr tr 1 1 tr 17 12 1 tr 1 tr 2 36 4 tr tr tr 9 8
13. *Equisetum spp.*	tr tr tr 75 68 99 28 25 89 83 97 99 99 99 88 99 99 85 92
14. *Lichens*	tr
15. *Moss*	tr 1 tr
16. *Insect matter*	tr tr tr tr
17. *Animal matter*	
Bone & Meat	4 tr tr
Hair	31 13
18. *Dryas integrifolia*	tr
19. *Dryas drummondii*	tr
20. *Cornus canadensis*	
21. *Wood splinters*	
22. *Unidentified* Fungus	tr tr
23. *Unidentified* Round Worm	tr
24. *Unidentified* Worm	tr
25. *Unidentified* Unid aa	tr

* **Periods of defecation:** 1 — 1 - 15 May 2 — 16 - 31 May 3 — 1 - 15 June 4 — 16 - 30 June 5 — 1 - 15 July 6 —16 - 31 July 7 — 1 - 15 Aug. 8 —16 - 31 Aug. 9 — 1 - 15 Sept.

** **Location:** Numbers refer to mileage posts on the Canol Road, TV refers to Trophy Valley, and the remaining letters refer to the identification of bears where we located scat at point of capture. U = X4990, EV = X4991, E = X2379, K = X2469.

*** **Vegetation type:** F = forest, SA = subalpine and A = alpine.

APPENDIX VIII. Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1977.

SCAT NUMBER	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90
Period of defecation*	3	3	8	5	3	5	3	6	4	5	3	6	6	3	5	5	6	5	5	6	6	5	4	5	6	4	5	5	3	6
Location**	185	178	179	205	180	TV	EV	194	TV	198	194	TV	167	E	190	192	205	173	180	TV	205	205	168	173	207	204	185	181	180	204
Vegetation type***	SA	SA	SA	SA	SA	A	SA	A	A	A	A	A	F	F	A	A	SA	F	SA	A	SA	SA	F	F	SA	SA	SA	SA	SA	SA
Percentage Sampled	8	10	100	8	8	9	13	7	13	10	10	5	13	25	13	10	13	8	13	11	13	7	10	8	13	7	8	10	17	10
Species diversity	6	3	5	2	3	3	1	4	3	3	3	4	2	3	2	4	2	2	3	3	3	2	5	2	3	3	3	3	4	6

Food Item — Percentage composition of Food Items in Grizzly Bear Scats

1. *Picea glauca*																							tr							
2. *Betula glandulosa*																														
3. *Salix spp.*	tr		12																											
4. *Shepherdia canadensis*			82																											
fruit			(52)																											
leaves			(30)																											
5. *Vaccinium uliginosum*																														
fruit																														
leaves																														
6. *Vaccinium vitis-idaea*																														
fruit																														
leaves																														
7. *Empetrum nigrum*			tr																											
fruit			(tr)																											
leaves																														
8. *Arctostaphylos rubra*																														
fruit																														
leaves																														
9. *Ledum palustris*																														
10. *Hedysarum*	46		6				100	tr																						2
roots and bark	(45)		(6)				(100)	(tr)																						(2)
leaves	(1)		(-)				(-)																							(-)
11. *Graminae spp.*	1	1		tr	16	tr		3	64	15	73	tr		37	93	74			66	1	1		tr		2	37	39	tr	1	8
12. *Carex spp.*	11	40	tr		12	tr		5	24	27	9	tr	tr	17	-	2	9	tr	7	tr	3	tr	1	1	4	37	5	7	16	2
13. *Equisetum spp.*	tr	59		100	72	99		92	12	58	18	99	100	46	7	24	91	100	27	99	96	99	96	99	94	26	56	93	82	72
14. *Lichens*																														
15. *Moss*																tr														
16. *Insect matter*																														tr
17. *Animal matter*																														
Bone & Meat																														15
Hair	42																													
18. *Dryas integrifolia*																														
19. *Dryas drummondii*																					3								1	
20. *Cornus canadensis*												tr																		
21. *Wood splinters*																														
22. *Unidentified*																														
23. *Unidentified*																														
24. *Unidentified*																														
25. *Unidentified*																														

* Periods of defecation:

1 — 1 - 15 May 2 — 16 - 31 May 3 — 1 - 15 June 4 — 16 - 30 June 5 — 1 - 15 July 6 — 16 - 31 July
7 — 1 - 15 Aug. 8 — 16 - 31 Aug. 9 — 1 - 15 Sept.

** Location:

Numbers refer to mileage posts on the Canol Road, TV refers to Trophy Valley, and the remaining letters refer to the identification of bears where we located scat at point of capture. U = X4990, EV = X4991, E = X2379, K = X2469.

*** Vegetation type:

F = forest, SA = subalpine and A = alpine.

APPENDIX VIII. Information of grizzly bear scats collected and analyzed from the Mackenzie Mountains, N.W.T. in 1977.

SCAT NUMBER	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114
Period of defecation*	6	5	6	5	5	5	5	5	3	3	5	6	5	6	5	6	5	5	6	5	6	3	5	6
Location**	164	199	167	171	TV	198	211	178	184	181	179	TV	TV	181	187	TV	201	189	TV	171	180	U	TV	TV
Vegetation type***	F	A	F	F	A	A	SA	F	SA	SA	SA	A	A	SA	SA	A	SA	A	A	F	SA	A	A	A
Percentage Sampled	17	17	13	10	17	10	13	13	10	17	13	13	25	50	17	17	17	17	13	13	25	100	17	50
Species diversity	1	2	3	4	3	3	5	3	7	6	3	3	4	3	4	6	1	4	4	2	7	2	3	3

Food Item	Percentage composition of Food Items in Grizzly Bear Scats
1. *Picea glauca*	
2. *Betula glandulosa*	
3. *Salix spp.*	tr tr tr tr
4. *Shepherdia canadensis*	12
fruit	(10)
leaves	(2)
5. *Vaccinium uliginosum*	33
fruit	
leaves	
6. *Vaccinium vitis-idaea*	1
fruit	(-)
leaves	(1)
7. *Empetrum nigrum*	6 2 tr
fruit	(6) (2) (tr)
leaves	(-) (-)
8. *Arctostaphylos rubra*	
fruit	
leaves	
9. *Ledum palustris*	tr
10. *Hedysarum*	15 42
roots and bark	(15) (42)
leaves	(-) (-)
11. *Graminae spp.*	20 tr 30 53 21 17 14 10 4 tr tr 25 8 47 1 3 10
12. *Carex spp.*	tr 1 44 37 35 1 5 1 55 15 2 tr tr 22 1 tr 1 2 4 30
13. *Equisetum spp.*	100 80 99 84 26 10 38 99 41 82 35 81 97 99 72 70 100 42 99 99 9 98 93 60
14. *Lichens*	tr
15. *Moss*	
16. *Insect matter*	tr tr tr tr
17. *Animal matter*	
Bone & Meat	6 31 3 10
Hair	
18. *Dryas integrifolia*	
19. *Dryas drummondii*	
20. *Cornus canadensis*	
21. *Wood splinters*	
22. *Unidentified* Forb(ee)	4
23. *Unidentified* Forb(99)	
24. *Unidentified* Corus Canad	tr
25. *Unidentified* Wood	tr

* Periods of defecation:

1 -- 1 - 15 May 2 -- 16 - 31 May 3 -- 1 - 15 June 4 -- 16 - 30 June 5 -- 1 - 15 July 6 -- 16 - 31 July
7 -- 1 - 15 Aug. 8 -- 16 - 31 Aug. 9 -- 1 - 15 Sept.

** Location:

Numbers refer to mileage posts on the Canol Road, TV refers to Trophy Valley, and the remaining letters refer to the identification of bears where we located scat at point of capture. U = X4990, EV = X4991, E = X2379, K = X2469.

*** Vegetation type:

F = forest, SA = subalpine and A = alpine.

Appendix IX. Summary of grizzly bear den information from the Mackenzie Mountains, N.W.T.

Den Number	1	2	3	4	5	6
Den type	winter	winter	winter	winter	winter	winter
Location	64°3½' 128°19'	63°38' 129°1½'	63°38½' 129°12'	63°38½' 129°12'	63°31' 129°29'	63°39½' 129°17½'
Date of Location	1973, 1976	1973	1973, 1976	22 June 1976	1 July 1976	19 July 1976
Elevation (meters)	1524 meters	1677	1677	1677	1829	1585
Aspect	SE	SSE	SSE	SSE	SSE	E
Slope (degrees)	33	-	35	35	31	33
Soils	poorly developed, coarse, gravel soil	-	loam	loam	dark loam	dark loam
Habitat type	subalpine	alpine	alpine	alpine	alpine	alpine
Major plant assoc.	*Juniperus-Potentilla*	-	-	-	*Salix-Festuca-Mertensia*	*Festuca-Artemisia-Salix-Mertensia*
Overstory canopy hgt. (cm)	20	-	-	-	-	35
Den construction	dug	dug	dug	dug	dug	dug
Den condition	good	collapsed	good	good	good	collapsed
Den lining	spruce branches	-	-	-	-	-
Year of last use	1972-73	unknown	unknown	1975-76	1976-76	1974-75
Measurements: (cm)						
Chamber: length;	151				168	200
width;	144				130	178
height;	78				100	130
Entrance: length;	80	Not Measured	Not Measured	Not Measured	106	84
width;	71				92	78
height;	47				60	70
slope len.	86				75	122
Total den length;	231				274	284
Comments:	Used by female and two cubs in 1972-73. Measured in 1976.					

APPENDIX IX. (continued)

Den Number	7	8	9	10	11	12
Den type	winter	winter	winter	winter	winter	winter
Location	69°39½' 129°17½'	63°39½' 129°17½'	63°44' 129°15'	63°47½' 129°21'	63°39½' 128°55'	63°55' 128°28½'
Date of Location	19 July 1976	19 July 1976	20 July 1976	21 July 1976	19 August 1976	11 September 1976
Elevation (meters)	1585	1829	1768	1646	1677	1524
Aspect	E	SE	ESE	SE	SE	SSW
Slope (degrees)	33	31	35	-	33	33
Soils	dark loam	dark loam	dark loam	-	loam	poorly-developed, much colluvium
Habitat type	alpine	alpine	alpine	alpine	alpine	forest
Major plant assoc.	*Festuca-Artemesia-Mertensia*	*Salix-Mertensia Festuca*	*Salix-Artemesia-Festuca-Myosotis*	-	*Salix-Astragalus*	*Juniperus-Arctostaphylos*
Overstory canopy hgt. (cm)	35	35	-	-	30	30
Den construction	dug	dug	dug	dug	dug	dug
Den condition	good	good	collapsed	collapsed	good	collapsed
Den lining	-	-	-	-	-	-
Year of last use	1975-76	1975-76	1974-75	unknown	1975-76	unknown
Measurements: (cm)						
Chamber: length;	230	151	163		130	
width;	200	135	150		92	
height;	84	112	95		88	
Entrance: length;	136	58	117	Not Measured	158	Not Measured
width;	78	58	75		50	
height;	40	72	40		43	
slope len.	70	135	70		79	
Total den length;	366	209	280		288	
Comments:						Constructed at base of tree, den collapsed but opening supported by roots.

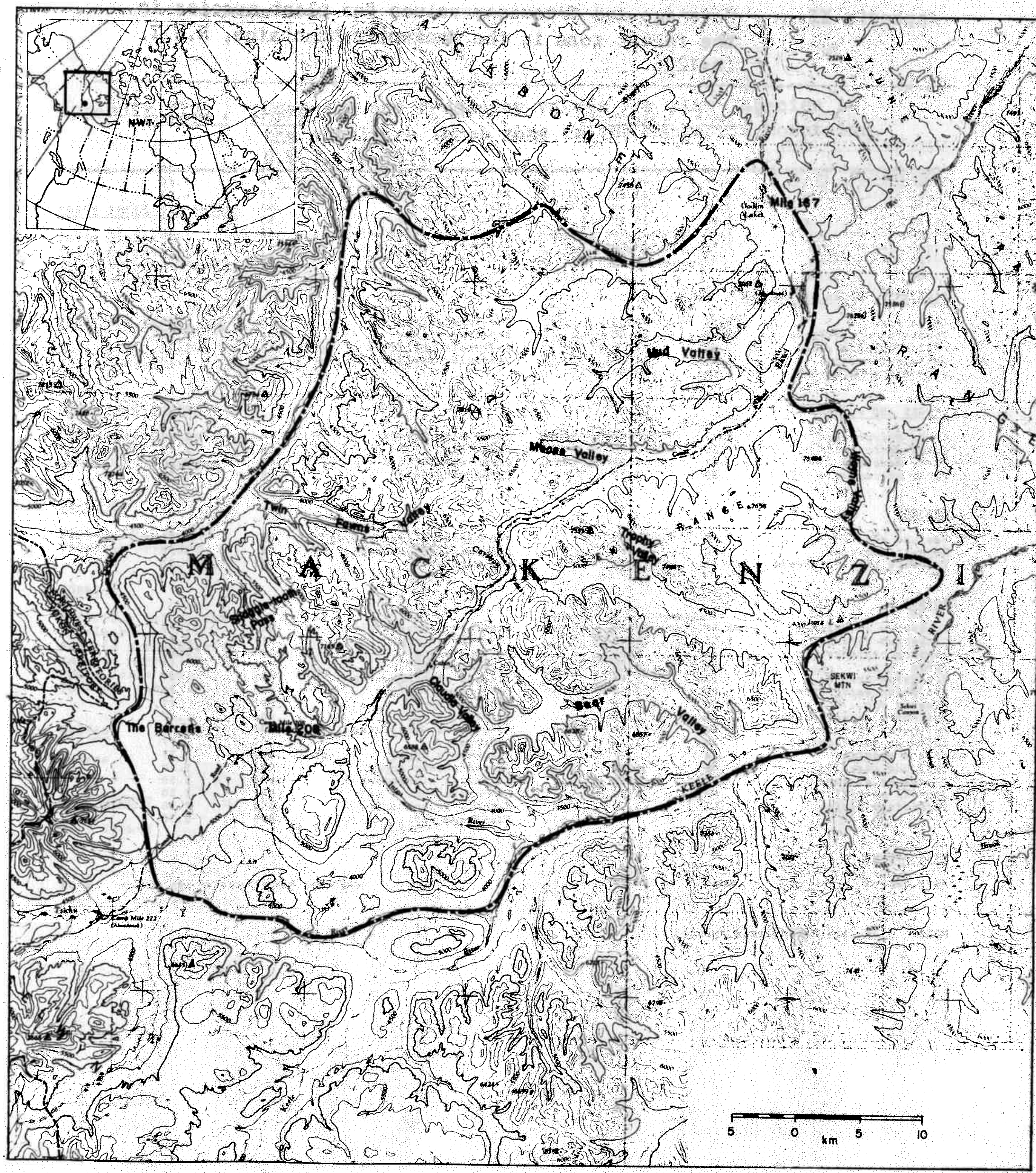
APPENDIX IX. (continued)

Den number	13	14	15	16	17	18	19
Den type	winter	winter	winter	winter	winter	winter	winter
Location	63°32' 129°36½'	63°30' 129°38½'	63°29½' 129°33'	63°28½' 129°26'	63°27½' 128°37'	63°38' 128°38'	63°33½' 128°41'
Date of Location	12 June 1977	14 June 1977	14 June 1977	14 June 1977	14 June 1977	16 June 1977	18 June 1977
Elevation (meters)	1433	1676	1524	1524	1402	1707	1433
Aspect	ESE	S	SW	SE	S	S	SSE
Slope (degrees)	37	34	35	35	35	-	31
Soils	loam	black-loam	-	black-loam	stony-forest soil	-	black-loam with colluvium
Habitat type	subalpine	alpine	alpine	alpine	forest	alpine	subalpine
Major plant assoc.	*Salix*	*Salix-Festuca*	-	*Salix-Mertensia*	*Juniperus-Betula Salix-Arctostaphylos*	-	*Salix-Mertensia*
Overstory canopy hgt. (cm)	183	30	-	61	244	-	213
Den construction	dug	dug	dug	dug	dug	dug	dug
Den condition	good	good	collapsed	good	very good	collapsed	very good
Den lining	-	-	-	-	twigs and branches (*Picea* and *Salix*)	-	*Salix* and *Festuca*
Year of last use	1976-77	1976-77	-	1976-77	1976-77	-	1976-77
Measurements: (cm)							
Chamber: length;	200	136		148	180		171
width;	102	115		105	123		135
height;	68	85		82	96		110
Entrance: length;	50	41		72	118		53
width;	49	45		82	52		73
height;	58	44		54	53		55
slope len.	90	82		85	82		123
Total den length	250	177		220	298		226
Comments					used by female and yearlin		

APPENDIX IX. (continued)

Den number	20	21	22	23
Den type	winter	winter	day-bed	winter
Location	63°34' 128°42½'	63°34' 128°43'	63°52' 128°47½'	63°42' 129°½'
Date of Location	18 June 1977	18 June 1977	10 September 1977	1 October 1977
Elevation (meters)	1607	1607	1676	1707
Aspect	SE	SE	SE	SE
Slope (degrees)	-	-	38	-
Soils	-	-	clay-rich, poorly developed. Much colluvium	-
Habitat type	alpine	alpine	alpine	alpine
Major plant assoc.	-	-	*Vaccinium-Arctostaphylos Juniperus-Festuca*	-
Overstory canopy hgt. (cm)	-	-	25	-
Den construction	dug	dug	dug	dug
Den condition	collapsed	collapsed	good	good
Den lining	-	-	-	-
Year of last use	-	-	summer 1977	1977-78
Measurements: (cm)				
Chamber: length;			52	
width;			31	
height;			37	
Entrance: length;			no tunnel	
width;			25	
height;			36	
slope len.			35	
Total den length			52	
Comments			appeared to be a day-bed	den dug for winter of 1977-78 by a radio collared bear.

Appendix X. Map showing place names within the Study Area.



Appendix XI. Coverage and frequency values for plant species in the forest zone in the Mackenzie Mountains, N.W.T. (n=129)

	% COVER	% FREQUENCY		% COVER	% FREQUENCY
ERECT TREES AND SHRUBS					
Betula glandulosa	15.12	55.80	*Salix myrtilloides*	.78	6.20
Salix pulchra	5.40	46.90	*Salix spp.*	.76	5.40
Vaccinium alpinum	3.46	23.90	*Rhododendron lapponicum*	.69	6.90
Salix glauca	3.35	16.90	*Salix pulchra**	.64	6.20
Potentilla fruticosa	1.94	30.80	*Salix alaxensis*	.63	3.90
Shepherdia canadensis	1.73	9.20	*Salix arbusculoides**	.42	1.50
Picea glauca	1.62	10.80	*Juniperus communis*	.12	3.10
Salix barrattiana	.83	6.90	*Populus balsamifera*	.003	1.50
PROSTRATE SHRUBS AND HEATHS					
Dryas spp.	9.94	46.20	*Cassiope tetragona*	.64	5.40
Vaccinium vitis-idaea	3.02	38.50	*Empetrum nigrum*	.56	8.50
Arctostaphylos rubra	2.05	28.70	*Andromeda polifolia*	.18	6.20
Salix reticulata	1.84	14.60	*Geocaulin lividum*	.02	1.50
Arctostaphylos uva-ursi	1.29	10.00			
SEDGES AND RUSHES					
Carex scirpoidea	8.32	46.90	*Carex capillaris*	.16	2.30
Carex membranacea	.59	2.30	*Carex spp.*	.16	.77
Carex concinna	.41	1.50	*Carex aurea*	.14	3.90
Carex atrasquanma	.39	3.10	*Carex podocoopa*	.002	.77
GRASSES					
Festuca altaica	1.29	16.90	*Arctogrostis arundinacea*	.09	.77
Elymus innovatus	.30	4.60	*Unidentified grasses*	.04	3.90
Kobresia simpliciuscula	.27	3.10	*Poa alpina*	.002	.77
FORBS					
Equisetum scirpoides	1.51	12.30	*Saussurea angustifolia*	.01	1.50
Hedysarum alpinus	1.08	25.40	*Pedicularis spp.*	.01	3.90
Lupinus arcticus	.43	6.90	*Oxytropis spp.*	.01	4.60
Pyrola spp.	.26	6.20	*Taraxacum spp.*	.002	.77
Equisetum arvense	.13	3.10	*Senecio atropurpureus*	.002	.77
Epilobium latifolium	.09	2.30	*Petasites frigidus*	.002	.77
Senecio spp.	.06	5.40	*Gentiana spp.*	.002	.77
Epilobium angustifolium	.04	1.50	*Astragalus spp.*	.002	.77
Polygonum viviparum	.04	12.30	*Astragalus umbellatus*	.002	.77
Solidago multiradiata	.04	3.10	*Aster spp.*	.002	.77
Silene acaulis	.04	.77	*Antennaria spp.*	.002	.77
Tofielda pusilla	.04	3.90	*Chrysanthemum spp.*	.004	1.50
Zygadenus elegans	.02	2.30	*Oxytropis nigrescens*	.004	1.50
Anemone parviflora	.02	6.20	*Parnassia spp.*	.004	1.50
Thalictrum alpina	.01	3.90	*Senecio triangularis*	.006	2.30
			Saxifraga spp.	.006	2.30
BARE GROUND					
Bare ground	6.26	26.40			

NOTE: * denotes unconfirmed species

Appendix XII. Coverage and frequency values for plant species in the subalpine shrub zone in the Mackenzie Mountains, N.W.T. (n=167)

	% COVER	% FREQUENCY		% COVER	% FREQUENCY
ERECT TREES AND SHRUBS					
Salix alaxensis	5.41	26.50	*Populus balsamifera*	.77	2.90
Salix barrattiana	1.97	8.80	*Salix arbusculoides**	.61	5.90
Shepherdia canadensis	1.14	5.90	*Betertilla fruticosa*	.06	5.90
Salix myrtilifolia	.77	2.90	*Salix pulchra**	.007	2.90
PROSTRATE SHRUBS AND HEATHS					
Arctostaphlos rubra	3.74	14.70			
Salix reticulata	1.25	14.70			
SEDGES AND RUSHES					
Carex membranacea	.92	2.90	*Carex Physocarpa*	.007	2.90
Carex capillaris	.38	14.70	*Carex scirpoidea*	.007	2.90
Unidentified Sedges	.156	2.90	*Carex aurea*	.007	2.90
GRASSES					
Elymus innovatus	.007	2.90			
Trisetum spicatum	.007	2.90			
FORBS					
Epilobium latifolium	.52	17.60	*Senecio atropurpureus*	.007	2.90
Pyrola spp.	.218	8.80	*Saxifraga aizoides*	.007	2.90
Senecio triangularis	.02	5.90	*Polygonum viviparum*	.007	2.90
Anemone parviflora	.02	5.90	*Loratogonium rotatum*	.007	2.90
Pedicularis spp.	.02	8.80	*Anemone richarsonii*	.007	2.90
Tofielda pussilla	.01	5.90	*Equisetum arvense*	.007	2.90
MOSSES					
Mosses	3.85	23.50			
BARE GROUND					
Bare Ground	71.97	82.40			

NOTE: * denotes unconfirmed species

Appendix XIII. Coverage and frequency values for plant species in the alpine heath-meadow zone in the Mackenzie Mountains, N.W.T. (n=200)

	% COVER	% FREQUENCY		% COVER	% FREQUENCY
ERECT TREES AND SHRUBS					
Betula glandulosa	13.73	49.70	*Salix arbusculoides**	1.11	5.40
Salix barrattiana	6.46	29.90	*Potentilla fruticosa*	.82	11.40
Salix glauca	3.83	12.60	*Rhododendron lapponicum*	.46	8.40
Vaccinium uliginosum	2.52	21.00	*Picea glauca*	.39	1.80
*Salix barclayi**	1.51	5.40	*Salix alaxensis*	.31	2.40
*Salix pulchra**	1.51	6.00	*Salix spp.*	.27	2.40
Betula pulustre Var. *decumbens*	1.41	13.80	*Shepherdia canadensis*	.09	1.20
PROSTRATE SHRUBS AND HEATHS					
Salix reticulata	7.88	46.10	*Empetrum nigrum*	.37	5.40
Dryas spp.	5.86	27.00	*Salix arctica*	.23	9.00
Vaccinium vitis-idaea	2.32	16.80	*Arctostaphylos uva-ursi*	.17	1.20
Arctostaphylos rubra	1.62	21.60	*Andromeda polifolia*	.004	1.20
Cassiope tetragona	.94	11.40	*Oxycoccus microcarpus*	.002	.60
SEDGES					
Carex membranacea	5.25	16.80	*Eriophorum vaginatum*	.12	2.40
Carex scirpoidea	4.14	44.90	*Eriophorum angustifolium*	.06	1.20
Carex podocarpa	.60	9.60	*Carex physocarpa*	.03	.60
GRASSES					
Festuca altaica	2.83	33.00	*Poa alpina*	.06	.60
Kobresia simpliciuscula	.17	4.80	*Agropyron spp.**	.05	1.20
Arctogrostis arundinacea	.10	7.80	*Trisetum spicatum**	.004	1.20
Unidentified Grasses	.10	3.00			
FORBS					
Equisetum arvense	1.92	13.80	*Anemone richardsonii*	.03	8.90
Lupinus arcticus	.70	10.30	*Epilobium angustifolium*	.03	.60
Equisetum scirpoides	.53	8.40	*Pedicularis spp.*	.03	14.40
Petasites frigidus	.45	10.20	*Polygonum viviparum*	.03	9.60
Mertensia paniculata	.39	12.00	*Parnassia spp.*	.02	3.00
Epilobium latifolium	.37	3.60	*Saxifraga spp.*	.02	2.40
Artemisia arctica	.32	9.60	*Tofielda pusilla*	.02	2.40
Saussurea angustifolia	.25	9.60	*Lloydia serotina*	.01	4.20
Anemone narcissiflora	.18	6.60	*Aconitum delphinifolium*	.008	3.00
Hedysarum alpina	.14	8.40	*Draba spp.*	.008	3.00
Polemonium acutiflorum	.13	16.20	*Myosotis alpestris*	.008	1.20
Senecio spp.	.11	5.40	*Senecio triangularis*	.007	.60
Thalictrum alpina	.08	4.80	*Arnica spp.*	.005	1.80
Geum rossii	.07	1.80	*Pyrola spp.*	.005	1.80
Rubus spp.	.07	3.00	*Stellaria spp.*	.004	1.20
Silene acaulis	.07	4.80	*Rubus chaemamorus*	.004	1.20
Solidago multiradiata	.07	8.40	*Linnaea borealis*	.002	1.20
Anemone parviflora	.04	13.80	*Chrysanthemum spp.*	.001	1.20
Astragalus umbellatus	.04	4.80	*Claytonia tuberosa*	.001	.60
Unidentifed forbs	.03	1.20	*Senecio atropurpureus*	.001	.60
			Valeriana capitata	.001	.60
MOSSES					
Mosses	7.88	62.30			
LICHENS					
Lichens	12.63	62.90			
BARE GROUND					
Bare ground	5.35	13.20			

NOTE: * indicates unconfirmed species

Appendix XIV. Coverage and frequency values for plant species in gravel river beds in the Mackenzie Mountains, N.W.T. (n=31)

	% COVER	% FREQUENCY		% COVER	% FREQUENCY
ERECT TREES AND SHRUBS					
Salix barrattiana	1.35	6.00	*Salix barclayii*	.05	.50
Betula glandulosa	.97	3.50	Unidentified Willows	.05	.50
Salix glauca	.36	1.50	*Leum palustre*	.02	2.00
Potentilla fruticosa	.11	4.00	*Rhododendron lapponicum*	.02	1.00
Vaccinium uliginosum	.11	2.00			
PROSTRATE SHRUBS AND HEATHS					
Salix reticulata	13.31	49.00	*Cassiope tetragona*	.09	8.50
Salix arctica	7.28	49.00	*Vaccinium vitis-idaea*	.006	2.50
Dryan spp.	6.34	28.50	*Andromeda polifolia*	.001	.50
Arctostaphylos rubra	.40	2.50			
SEDGES AND RUSHES					
Carex podocarpa	2.60	25.00	*Juncus spp.*	.05	.50
Carex scirpoidea	2.29	20.00	*Eriophorum brachantherum*	.01	1.50
Carex membranacea	1.12	3.00	*Carex aurea*	.003	.50
Carex spp.	.56	4.50	*Carex physocarpa*	.003	.50
*Carex petricosa**	.20	5.00	*Eriophorum angustifolium*	.001	.50
GRASSES					
Unidentified Grasses	2.60	22.00	*Trisetum spicatum**	.22	15.00
Festuca altaica	1.77	12.50	*Kobresia simpliciuscula*	.13	2.50
Arctogrostis arundinacea	1.25	14.00	*Agropyron spp.**	.08	2.00
Poa spp.	.44	15.50	*Poa spp.*	.03	2.00
Luzula spp.	.35	10.50	*Alopecurus spp.**	.003	.50
FORBS					
Artemesia arctica	4.06	38.50	*Polygonum viviparum*	.08	11.50
Petasites frigidus	1.66	18.00	*Gentiana spp.*	.06	9.00
Geum rossii	1.56	22.00	*Parnassia spp.*	.06	5.50
Equisetum arvense	1.14	9.00	*Lupinus arcticus*	.04	1.00
Mertensia paniculata	1.04	14.50	*Saussurea angustifolia*	.04	2.50
Polemonium acutiflorum	.87	24.00	*Veronica spp.*	.04	8.00
Valeriana capitata	.86	4.00	*Myosotis alpestris*	.03	6.50
Artnemesia tilesii	.80	4.00	*Potentilla biflora*	.03	2.50
Epilobium latifolium	.67	24.00	*Pyrola spp.*	.03	.50
Lloydia serotina	.61	20.00	*Senecio spp.*	.03	2.00
Rhodiola integrifolia	.59	10.50	*Antennaria spp.*	.02	2.50
Senecio triangularis	.46	10.00	*Equisetum scirpoides*	.02	6.00
Astragalus umbellatus	.45	22.00	*Stellaria spp.*	.02	5.50
Oxyria digyna	.42	12.50	*Lagotus stelleri*	.01	4.00
Aconitum delphinifolium	.22	10.00	*Solidago multiradiata*	.01	2.50
Anemone parviflora	.22	20.00	*Zygadenus elegans*	.01	2.00
Silene acaulis	.22	5.00	*Senecio atropurpureus*	.008	1.50
Hedysarum alpina	.21	3.50	*Draba spp.*	.007	2.50
Anemone narcissiflora	.16	10.50	*Erigeron spp.*	.007	2.50
Arnica spp.	.15	4.00	*Sibbaldia procumbens*	.005	.50
Saxifraga spp.	.14	22.50	*Astragalus spp.*	.003	1.00
Pedicularis spp.	.12	21.50	*Chrysosplenum tetrandum*	.003	1.00
Oxytropis spp.	.10	2.00	*Rumex arcticus*	.003	1.50
Thalictrum alpina	.10	5.00	*Ranunculus nivalis*	.002	.50
Anemone richardsonii	.08	16.00	*Senecio resedifolia*	.002	.50
Lycopodium annotinum	.08	1.50	*Taraxacum spp.*	.002	1.00
Oxytropis nigrescens	.08	3.00	*Tofielda pusilla*	.002	1.00
LICHENS					
Lichens	4.89	40.50			
MOSSES					
Mosses	9.36	62.50			
BARE GROUND					
Bare ground	17.78	29.50			

NOTE: * denotes unconfirmed species

Appendix XV. Area and habitat analysis of portions of 13 grizzly bear home ranges within the study area.

Bear	Home Range Area[1] (km^2)	% Forest	% Subalpine	% Alpine	% Rock & gravels
Rico Sally	33.0	0.0	31.8	43.6	24.5
Tease (subadult)	179.0	3.5	39.8	22.2	34.4
Express	359.9	11.4	27.8	17.2	43.6
Easy	90.8	3.2	35.7	9.4	52.2
Jaws	269.6	26.7	23.3	15.8	34.1
Sally	117.0	0.0	39.4	32.6	28.0
Tease (adult)	193.2	10.1	23.6	18.8	47.5
Tease (combined)	348.2	9.6	35.5	17.1	37.8
Killer	456.9	0.9	55.5	20.6	22.8
Snaggle Tooth	23.4	0.0	36.8	49.6	13.8
Rugby (subadult)	48.7	59.5	23.2	6.6	10.7
Rugby (adult)	165.8	56.8	14.6	3.1	25.4
Rugby (combined)	193.0	33.2	12.4	30.0	24.4
Average	190.7	13.9	34.4	18.4	33.3

[1] The home range of a bear is that part of the determined home range polygon falling within the study area only.

Appendix XVI. Hunter success and hunting pressure by non-residents for grizzly bears in the Mackenzie Mountains, 1965 to 1977.

Year	GBK	% Kill	H	AA	%HS	Mean kill	HP
1965	18	4.99	49	4	37	4.50	12
1966	19	5.26	89	5	21	3.80	18
1967	23	6.37	115	7	20	3.29	16
1968	37	10.25	105	6	35	6.17	18
1969	50	13.85	136	8	37	6.25	17
1970	38	10.53	151	8	25	4.75	19
1971	27	7.48	128	7	21	3.86	18
1972	32	8.86	191	8	17	4.00	24
1973	29	8.03	160	7	18	4.14	23
1974	25	6.93	136	5	18	5.00	27
1975	22	6.09	147	6	15	3.67	24
1976	13	3.60	187	7	7	1.86	27
1977	28	7.76	206	8	14	3.50	26
Total	361	-	1800	86	22	-	20

GBK = Grizzly bear kill
% Kill = Percentage of the total kill
H = Number of hunters
AA = Number of active outfitting areas that year
% HS = Hunter success = GBK/H
Mean Kill = Kill per active outfitting area (GBK/AA)
HP = Hunting pressure (H/AA)

Appendix XVII. Hunter success and average grizzly bear kill for each of the eight outfitting areas in Zones 12 and 19 for the period 1965 to 1977.

Area	GB kill	%Kill	Hunters	YA	(%) HS	AK	HP
12(1)	42	11.63	282	12	15	3.50	24
12(2)	77	21.33	375	11	21	7.00	34
12(3)	41	11.36	189	13	22	3.15	15
12(4)	64	17.73	290	13	22	4.92	22
12(5)	85	23.55	336	10	25	8.50	34
12(6)	21	5.82	155	12	14	1.75	13
19(N)	4	1.11	11	5	36	0.80	2
19(s)	27	7.48	162	10	17	2.70	16
Total	361	100.00	1800	86	20	4.20	21

Area = Outfitter areas (zone with area in parenthesis)
GB Kill = Grizzly bear kill
% Kill = Percent of total grizzly bear kill
Hunters = Total number of hunters
YA = Total number of years of active outfitting
(%) HS = Percent hunter success (GB kill/hunters x 100)
AK = Average annual grizzly bear kill
HP = Hunting pressure (H/YA)

Appendix XVIII. Grizzly bear harvest per unit area by non-resident hunters in the Mackenzie Mountains from 1969 to 1977.

Outfitting area	Area km^2	Hunted area km^2	% of area hunted	Av. annual GB kill	Total area sq. km/bear	Hunted area sq. km/bear
12 (1)	12,696	2,942	23	3.50	3627	841
12 (2)	19,668	4,457	23	7.00	2810	637
12 (3)	8,231	3,154	38	3.15	2613	1001
12 (4)	13,970	5,800	42	4.92	2839	1179
12 (5)	24,621	4,396	18	8.00	2897	517
12 (6)	22,230	1,554	7	1.75	12,703	888
19 (N)	15,395	179	1	0.80	19,224	224
19 (S)	9,710	1,667	17	2.70	3596	617
Total	126,521	24,149	19	4.20	3915	748

Appendix XIX. Predicted weights from chest girth measurements of grizzly bears, derived from the linear relationship: weight = 2.518 (chest girth) -149.

Chest girth (cm)	Weight (kg)	Chest girth (cm)	Weight (kg)
70	27.4	112	133.1
72	32.4	114	138.1
74	37.4	116	143.2
76	42.5	118	148.2
78	47.5	120	153.2
80	52.5	122	158.3
82	57.6	124	163.3
84	62.6	126	168.3
86	68.6	128	173.4
88	72.7	130	178.4
90	77.7	132	183.5
92	82.8	134	188.5
94	87.9	136	193.5
96	92.8	138	198.6
98	97.9	140	203.6
100	102.9	142	208.6
102	107.9	144	213.7
104	113.0	146	218.7
106	118.0	148	223.7
108	123.0	150	228.8
110	128.1	152	234.7