ASPECTS OF NEWFOUNDLAND BLACK BEAR (*Ursus americanus hamiltoni*) FOOD HABITS AND HABITAT USE IN HUMAN-INFLUENCED ENVIRONMENTS

by

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To my parents

ABSTRACT

I examined the food habits of black bears in two national parks in Newfoundland, Gros Morne National Park and Terra Nova National Park, and described habitat use and home ranges sizes of adult female bears in Gros Morne National Park.

Food habits were determined from scat and stomach content analysis. Green vegetation dominated the spring/summer diet and fruits dominated the late summer/fall diet. Raspberries (*Rubus* spp.), wild sarsaparilla (*Aralia nudicaulis*), bunchberries (*Cornus canadensis*) and blueberries and their relatives (*Vaccinium* spp.) were important berry foods in both study areas. Moose (*Alces alces*) was an important animal food in both areas. In Gros Morne National Park, plant and animal foods available in the tundra region of the park, such as black crowberry (*Empetrum nigrum*) and caribou (*Rangifer tarandus*), were also important.

Home range sizes of five adult females in Gros Morne National Park varied from 27.7 km^2 to 79.9 km^2 (100% minimum convex polygon method, average 47.7 km^2, sd = 21.7 km^2). All five of the home ranges overlapped one of two garbage dumps present in the study area.

Female bears used habitat types according to habitat availability within home ranges. At a larger scale they used balsam fir forest more than expected and tundra, sedge fen and bog, tuckamore, other primarily unforested habitat types less than expected during 1995. In both spring/summer (May - August 14) and late summer/fall (August 15 - November), they used primarily unforested areas less than expected, and used natural forest areas according to availability. They used logged areas according to availability in the spring/summer and more than expected in the late summer/fall period. The increased use of logged areas in the late summer/fall coincided with the increased occurrence of raspberries in the scats.

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CHAPTER ONE: INTRODUCTION

The black bear presumably arrived on the island of Newfoundland after crossing the ice from Labrador at the end of the last ice age (Cameron 1958). It was formally recognized as a separate subspecies by Cameron (1956), who distinguished it from the nominate race on the basis of skull characteristics. Paetkau and Strobeck (1994) used the analysis of nuclear DNA to demonstrate that bears in Newfoundland exhibited significantly less genetic variation than bears in New Brunswick, Québec and Alberta. The low level of genetic diversity in Newfoundland bears is likely associated with a founder effect during postglacial colonization of the island (Paetkau and Strobeck 1996).

The genetic dissimilarity to mainland populations of Newfoundland black bears may account for their larger body size as compared to mainland black bears (Mahoney 1985, Day 1993). A study of black bear morphology in central Newfoundland found bears to be heavier and generally larger in total length and heart girth than mainland bears (Day 1993).

Until recently, little work has been carried out to describe the ecology of this insular subspecies. Black bears on the island have been hunted by settlers since the early 1800's (Reeks 1870), and likely before this by the Beothuks.

The Newfoundland black bear exists in a unique environment, as the island has few native mammal species (14) in comparison to the adjacent mainland of Labrador (34±) (Dodds 1983). The indigenous mammalian fauna is disharmonic, with seven species of the Order Carnivora and only three of the order Rodentia. One of the native carnivores of the island, the Newfoundland wolf (*Canis lupus beothucus*), was driven to extinction in the early 1900's (Dodds 1983). This species was the only potentially significant predator of bears, other than humans, on the island.

The island's fauna has become more "balanced" by introductions (intentional and accidental) of ten or more species that have persisted on the island. Coyotes (*Canis latrans*) invaded the island in the late 1980's, possibly by crossing on ice flows from Cape Breton, but densities are still low. One very "successful" intentional introduction was that of the moose (*Alces alces*) in 1904. This species, a common prey item of black bear in other northern environments, has reached very high densities in areas of Newfoundland where the hunting pressure is low (Oosenburg, pers. comm.). The only other non-domesticated large ungulate present is caribou (*Rangifer tarandus*), which is native to the island. Newfoundland black bears are known to use moose and caribou as a food source and are thought to be highly predatory (Mahoney 1985).

As with any animal, bears require a number of resources including escape and hiding cover (Mollohan et al. 1989), appropriate denning habitat (Lindzey and Meslow 1976), and food (Rogers 1976, Elowe and Dodge 1989). Food is a particularly important resource for bears, which must gain sufficient weight during their active period to sustain them through the winter dormancy period. Common food species consumed by bears vary throughout the range of black bears in North America.

The resources required by bears are frequently abundant in certain habitats, and scarce or absent in others. Bears appear to select habitats that provide the required resources and avoid habitats which do not (Clark et al. 1994, Costello and Sage 1994). Alteration of habitats by humans has often resulted in the avoidance of these areas by bears (Mattson 1990). Activities such as hydroelectric development, intensive agriculture, intensive timber harvesting practices, and human habitation have eliminated bears from many areas in North America (Mattson 1990). A knowledge of habitat types that bears use in an area, and those that they avoid, is necessary for wildlife managers to evaluate potential landscape changes.

Home range size is an aspect of bear spatial ecology that is influenced by resource availability, and an important consideration in the conservation of any territorial animal. The richness of food resources within habitats may be reflected in home range size of black bears (Garshelis and Pelton 1981). Bears occupy larger areas in years of scarce food than in years of abundant food (Pelchat 1983). Payne (1978) speculated that Newfoundland bears may have small, overlapping home ranges in a study of bears caught exclusively at garbage dumps in central Newfoundland. However, his study did not employ radio-telemetry and home range sizes were not estimated.

Garbage dumps often provide bears with a locally abundant food source, and may provide short-term benefits to bear populations in many areas across North America. However, these benefits are often outweighed by human intolerance of human-habituated bears. In Newfoundland, black bears are often considered a nuisance (Payne 1978). Conflicts between bears and humans in Newfoundland occur periodically in areas surrounding garbage dumps. Such encounters (between bears and people, livestock or property) commonly result in the destruction of bears. Up to twenty-eight (28) bears have been reportedly killed as "nuisance bears" over a 10-year period at one landfill site alone in Newfoundland (Porter 1990).

This study aims to describe several aspects of the ecology of black bears on the island of Newfoundland. I determined the food habits of bears within two national parks in Newfoundland, and describe home range size, habitat use, and landfill site use in Gros Morne National Park.

Objectives

1) To determine bear food habits and how they vary seasonally;

2) To document home range sizes;

3) To determine habitat selection of bears within the context of a boreal-forest dominated landscape with anthropogenic influences;

4) To assess the extent to which garbage dumps affect the movements of bears.

STUDY AREA

General

There were two study areas on the island of Newfoundland: Gros Morne National Park (GMNP) and Terra Nova National Park (TNNP) (Figure 1). The climate of Newfoundland is mild, and is largely moderated by the surrounding waters except in the interior of the island. Spring is usually delayed by cold temperatures associated with ice flows carried by the Labrador current during that time of year. Newfoundland is described by Rowe (1972) as part of the boreal forest region of Canada and is dominated by conifers such as balsam fir (*Abies balsamea*) and black spruce (*Picea mariana*). Most of the island is forested, and there also exist extensive areas of heath-and-moss barrens.

Gros Morne National Park

GMNP is 1805 km^2 and lies on the west coast of Newfoundland (49° 20'- 49° 70' N; 57° 30'- 58° 10' W). The park is bordered on the west by the Gulf of St. Lawrence, and on the north, east, and south by commercially tenured timber lands.

The topography of GMNP is varied, and includes low coastal plains ranging from 50m to 150m and the Long Range Mountains, which are the northern extent of the Appalachian Mountains reaching elevations greater than 800m.

There are approximately 8 small towns (<5000 residents each) located within 4 enclaves in the park. The enclaves are areas in which residents may practice agriculture, trap small game, and harvest timber. There is an open pit garbage dump within one of

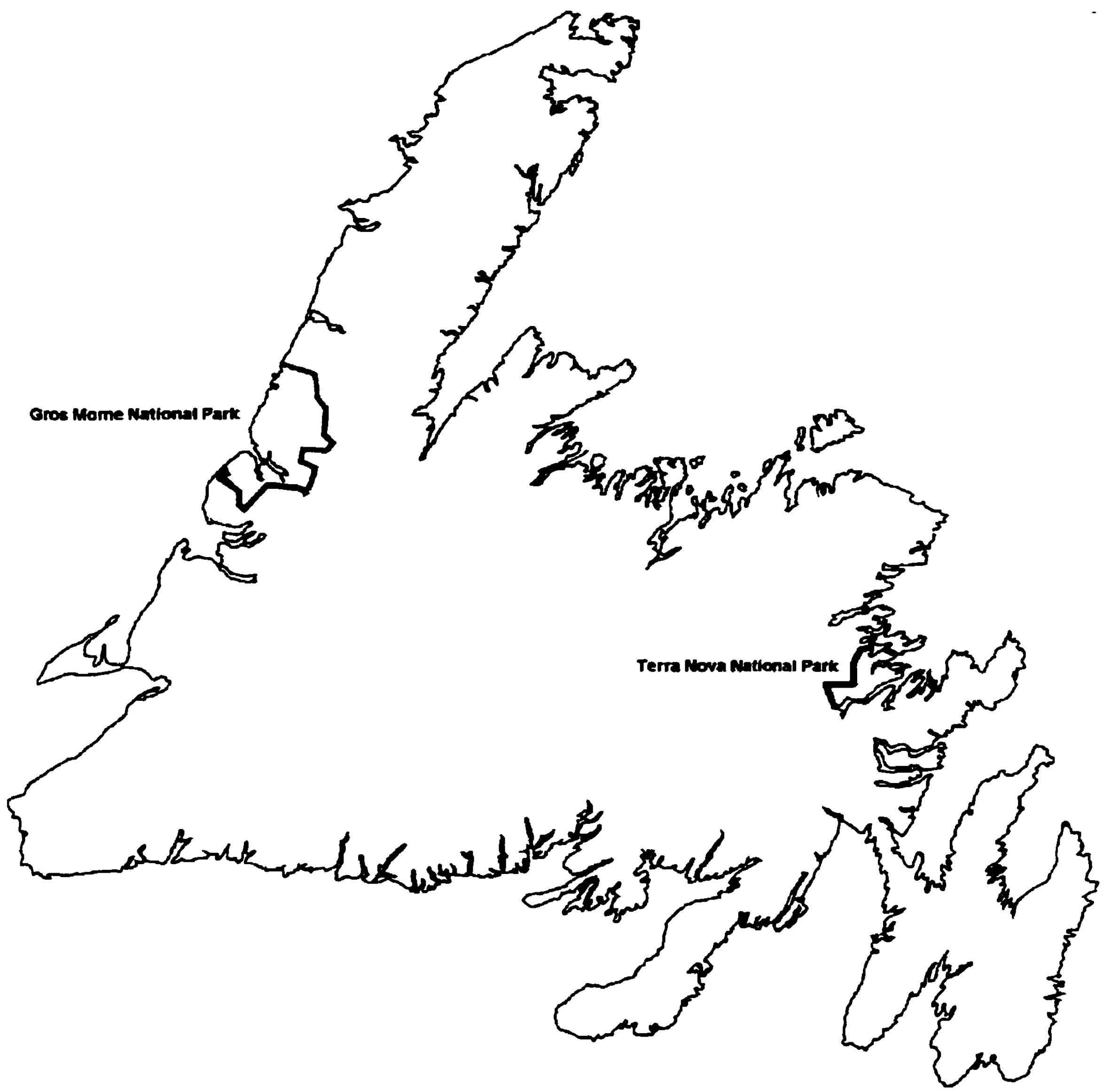


Figure 1. Location of study areas on the island of Newfoundland.

these enclaves in the center of the park (Norris Point Dump). There is a second smaller garbage dump on the southern edge of the park (Lomond Dump).

The vegetation of GMNP is characterized by the forest and scrub of the lowlands and the barrens of the highlands. The park includes three representative areas of nine distinctive ecoregions described for the island (Damman 1983, Figure 2). The lowlands region in the southern extent of the park is part of the Western Newfoundland Ecoregion (WNE). The coastal plains are part of the Northern Peninsula Ecoregion (NPE), from the town of Rocky Harbour northwards. The alpine region is part of the Long Range Barrens Ecoregion (LRBE) to the east.

The low-lying forests in the south of the park exist within the WNE. This ecoregion has the most favourable climate and fertile soils of the island. Balsam fir is the dominant forest cover type. Forest fires are uncommon due to the rarity of prolonged dry periods, and fire origin stands occupy only small areas. As a result, black spruce stands are restricted to poorly drained sites and bedrock outcrops (Damman 1983).

The coastal plains portion of the park exists within the NPE, which is dominated by bogs and scrub forest. It is similar to the WNE in that there is very little fire history in the region and balsam fir is the dominant forest cover. This ecoregion has a short growing season, 110-150 days, compared to 145-170 days for other forested areas.

The LRBE, represented in the barrens of the highlands, is characterized by large areas of dwarf shrub heaths, shallow peatlands, or thickets of stunted conifers (Damman 1983). The dominant heath is *Empetrum eamesii*, and arctic-alpine species such as *Diapesia*

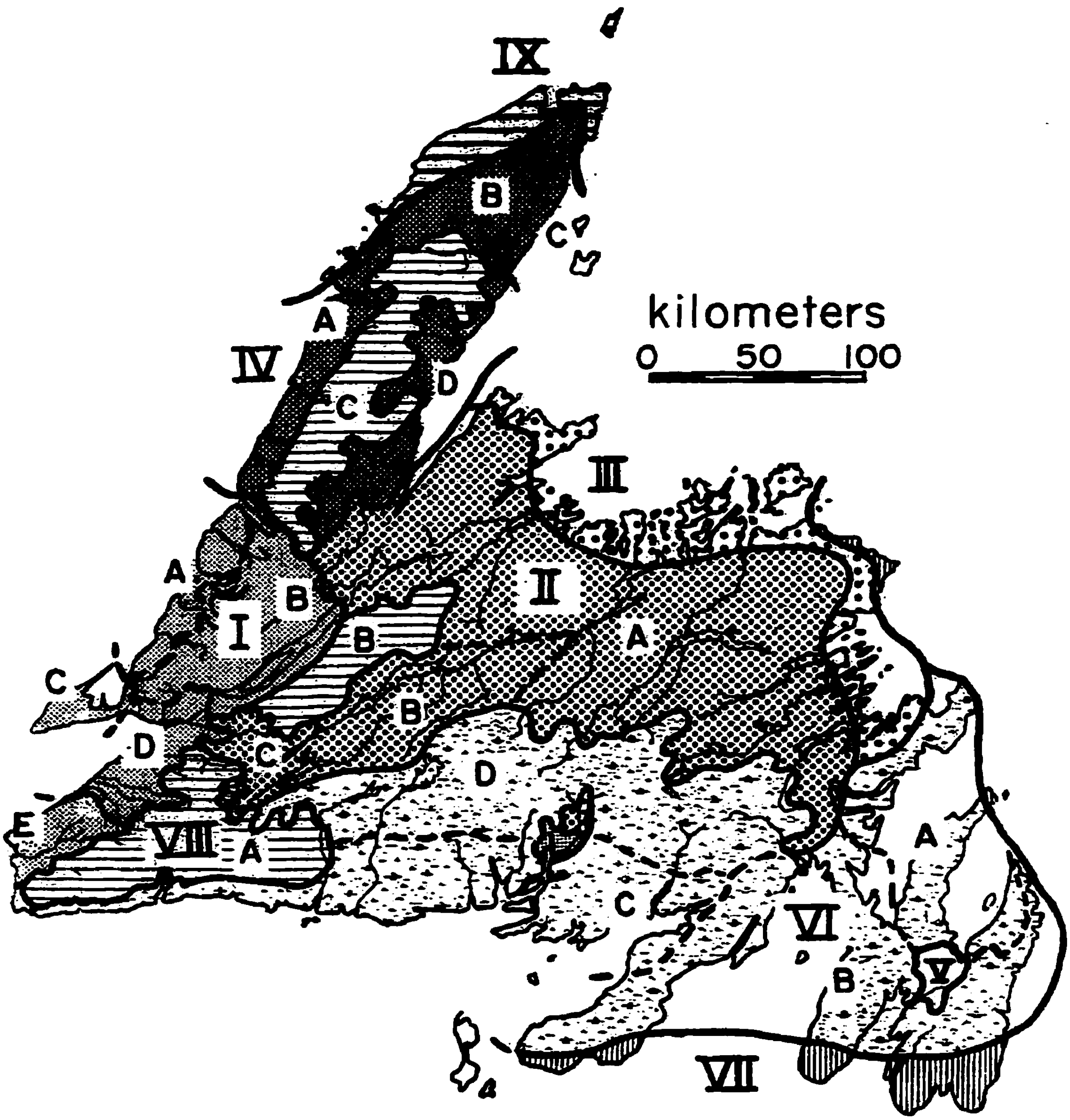


Figure 2. The ecoregions of the island of Newfoundland (Damman 1983).
Roman numerals indicate the ecoregions: I = Western Newfoundland, II = Central Newfoundland, III = North Shore, IV = Northern Peninsula Forest, V = Avalon Forest, VI = Maritime Barrens, VII = Eastern Hyper-oceanic Barrens, VIII = Long Range Barrens, IX = Straight of Belle Isle. Letters indicate subregions within each ecoregion.

lapponica, *Arctostaphylos alpina*, *Loiseleuria procumbens*, and *Juncus trifidus* characterize the vegetation (Meades 1983).

Intensive logging was practiced in the forested areas of GMNP over the past century, but since the park's creation in 1973 the commercial harvest has ceased. Small scale harvesting is still practiced within the park in areas called domestic harvest blocks (DHB) (Figure 3). In these areas, eligible residents are permitted to harvest wood for domestic heating and construction purposes. These regions represent the only significant area of early-successional growth within the park.

Terra Nova National Park

TNNP is 400 km^2 and is located in east-central Newfoundland (48° 23' - 48° 40' N; 53° 41'- 54° 14' W). The park is bound by forest to the north and south, coastline to the east, wetlands to the southwest, and clearcuts along the northwest boundary.

Unlike GMNP, TNNP lacks any mountainous region, and the elevation throughout the park generally ranges from 30-150m. There is one landfill site, the Glovertown dump, next to the park's northern boundary. Most of the park lies within the Central Newfoundland Ecoregion (CNE) as described by Damman (1983). This ecoregion is characterized by the most continental climate of any part of insular Newfoundland. TNNP lies within the Northcentral Subregion of the CNE, which has the highest fire frequency in Newfoundland. Pure black spruce and aspen (*Populus tremuloides*) stands dominate this area because of the frequency of fire (Meades and Moores 1989).

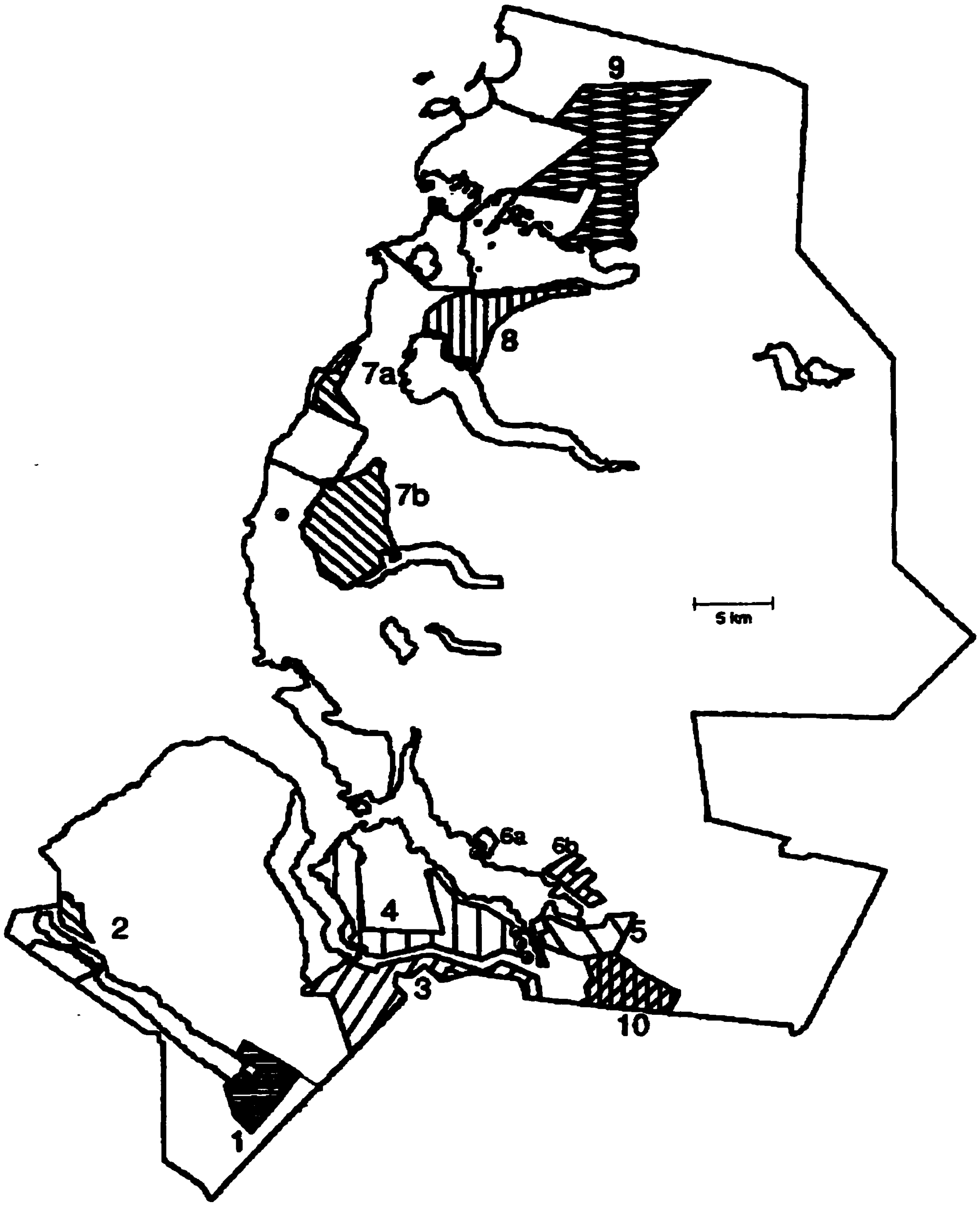


Figure 3: Location of domestic harvest blocks within GMNP. Individual blocks are patterned and indicated with numbers.

CHAPTER TWO: BEAR FOOD HABITS IN NEWFOUNDLAND

INTRODUCTION

Black bears have traditionally been viewed as opportunistic feeders. Studies have indicated that their use of food sources can largely be attributed to food availability (Hatler 1967, Norton 1981, Pelchat 1983, Smith 1984, Holcroft and Herrero 1991). However, other factors such as nutritional requirements and preference could also govern certain food habits (Hatler 1967).

Bears sometimes actively select certain food types although others may be available. Norton (1981) found that when black cherries (*Prunus serotina*) were abundant, black bears in northern Wisconsin preferred them to other fruits. Hatler (1967) found that blueberries (*Vaccinium* spp.) were preferred in Alaska over other available berries.

The type and amount of food available to bears in the autumn are particularly important to bear populations. This time of year has been termed the "hyperphagia" stage, when bears must accumulate enough fat to sustain them through the denning period (Nelson et al. 1983). Availability of adequate fall foods may determine whether bears have cubs the following year (Elowe and Dodge 1989). The physiological condition of female bears after the fall season may prevent implantation of the blastocysts or influence litter size and cub survival. Rogers (1976) suggested that female bears may have to attain a critical weight in the fall or they will not have cubs. Elowe and Dodge (1989) found that failure of certain food sources may result in decreased reproductive success and cub survival.

Scarcity of natural food sources may affect bears in other ways. Schooley et al. (1994) found that the abundance of beechnuts (*Fagus grandifolia*) affected the denning chronology of female black bears in Maine, which denned early when beechnuts were scarce. In Alberta, Pelchat (1983) reported that bear home range sizes were larger in years of scarce food than in years of abundant food.

Bear/human interactions may increase in years of natural food shortages. In Alaska, bears used human food sources (and thus became "problem" bears) to a greater extent in years when preferred foods were scarce (Hatler 1967). Payne (1978) suggested that garbage may be a primary food source for bears in areas of Newfoundland where there are several adjacent garbage dumps, although bear food habits were not analyzed in his study.

Fall foods differ greatly throughout the range of the black bear in North America. In southern regions they depend heavily on hard mast species such as oak (*Quercus* spp.) (Eagle and Pelton 1983, Elowe and Dodge 1989). In the boreal and mixed wood forests they depend on soft mast species such as cherries (*Prunus* spp.) (Norton 1981) and hard mast species such as beech (Costello 1992, Samson and Huot 1994). In far northern populations where the coniferous forest meets the tundra, bears depend on low growing soft mast species such as blueberries (*Vaccinium* spp.) (Hatler 1972).

Bears digest animal protein more efficiently than plant protein, and bears with access to regular sources of animal protein may gain more weight than those without such access (Bunnell and Hamilton 1984). Schwartz and Franzmann (1991) suggested that black bears in Alaska attained larger body sizes in an area with a high moose (*Alces alces*) density due to the availability of moose calves.

Food sources may potentially affect the reproductive success, denning, home range size, behavior, and size of black bears. The study of bear food habits allows wildlife managers to better understand the dynamics of bear populations.

The main objective of this portion of the study was to determine seasonal food habits of bears in Newfoundland.

METHODS

Fecal droppings (scats) were collected opportunistically along trails and roads in TNNP (1992-1995) and GMNP (1993-1995). Scats were also collected when encountered during trapping activities, at landfill sites, and at moose and caribou mortality locations. Different scats collected in the same area at the same time were regarded as a single collection if the contents were very similar. The scats were preserved in glass jars or plastic bags in a solution of FAA (formalin, alcohol, and acetic acid) or frozen.

Scat analysis largely followed the methods of Smith (1984), with some minor alterations (Appendix I). Berry seeds were identified with a reference collection and an identification manual (Montgomery 1978). The technique for identification of hair samples was modified from Kennedy and Carbyn (1981) (Appendix II). Hair samples were identified with a reference collection and an identification manual (Adorjan and Kolenosky 1969). In some cases it was not possible to distinguish between juveniles of the family Cervidae. Bear hair was presumed to have originated from grooming and was excluded from the analysis. Contents of scats were classified into 49 categories of food items (Appendix III).

In 1994, stomachs from hunted black bears were collected for content analysis. Prospective hunters in hunting areas 2, 3, 4, and 5 around GMNP (Figure 4) were asked to save the stomachs of any black bears taken. The stomachs were frozen and procedures for content analysis were the same as those for scat samples.

The data are presented on a seasonal basis, as the diet of bears changes during the year. Preponderance of scats collected from a single month may otherwise cause that season to be over-represented when results are combined. Two seasons were recognized based on the shift in the diet from mainly green vegetation in the early part of the season to berries in the late part of the season: spring/summer (May - August 14) and late summer/fall (August 15 - November). The GMNP samples and TNNP samples were considered separately, unless otherwise indicated. Food items were considered important if they occurred in 10% or more of the scats in the respective study areas and at average volumes of 6-26% of the scats or greater.

RESULTS

A total of 186 bear scats were collected during the study period (Table 1). Ten bear stomachs were collected in the GMNP area (Table 2). Forty-eight of the 196 samples (25%) were collected within 1 kilometer of a landfill site. Of the 115 samples collected in the GMNP region from 1993 to 1995, 56 (49%) were collected in the spring/summer period and the remaining 59 (51%) were collected in the late summer/fall period. Of the 81 samples collected from TNNP, 57 (70%) were collected in the spring/summer period, and 24 (30%) were collected in the late summer/fall period.

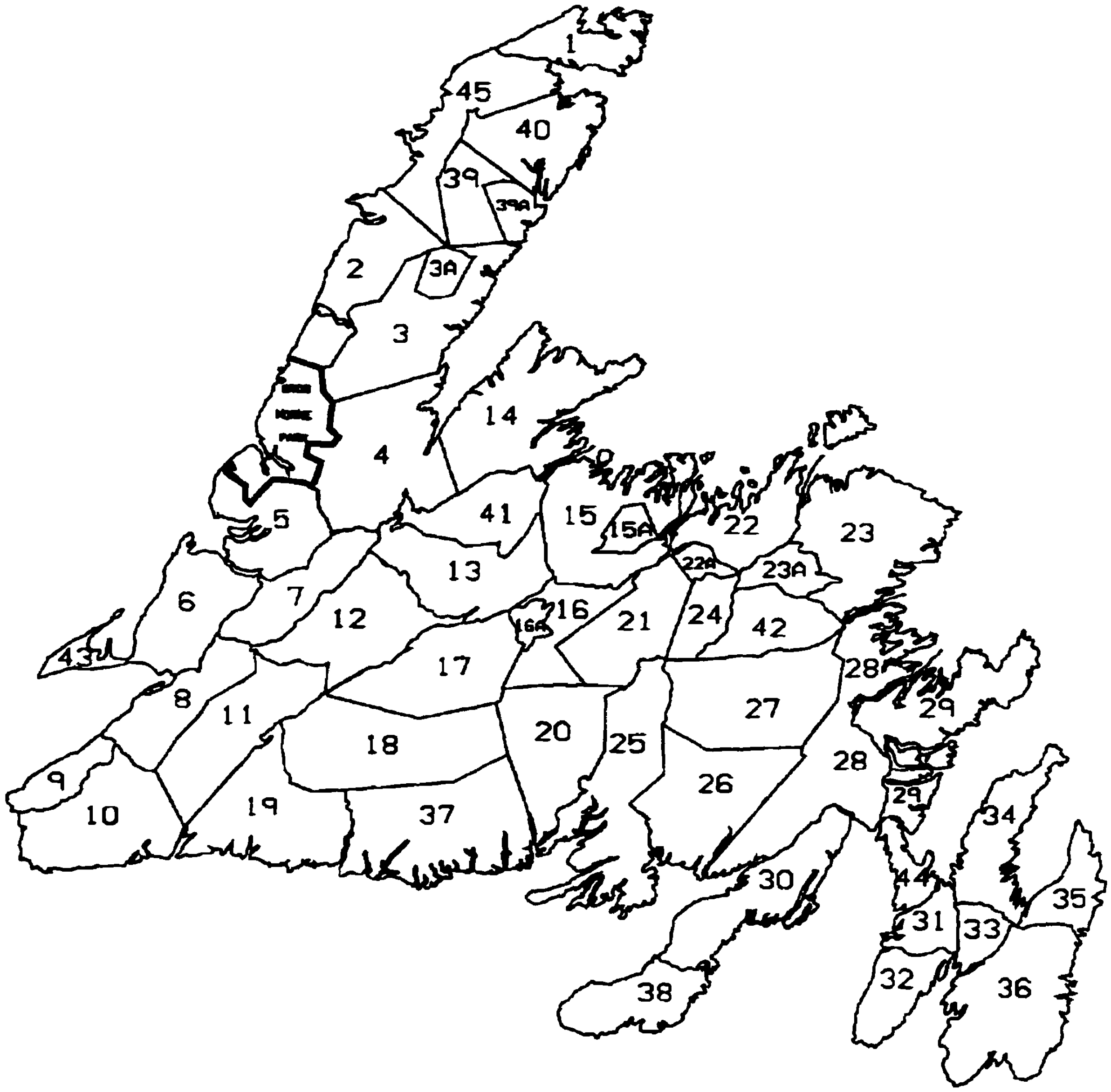


Figure 4. Locations of black bear hunting areas in Newfoundland (Newfoundland and Labrador Wildlife Division, unpublished map).

Table 1: Number of bear scats collected from GMNP and TNNP by month (1992 - 1995).

	GROS MORNE				TERRA NOVA					TOTAL
MONTH	1993	1994	1995	TOTAL	1992	1993	1994	1995	TOTAL	all areas
May	0	0	1	1	3	2	0	3	8	9
June	0	2	9	11	30	0	0	1	31	42
July	7	8	3	18	11	2	0	1	14	32
August	5	24	16	45	4	3	0	2	9	54
September	0	11	8	19	0	6	4	1	11	30
October	0	2	7	9	2	0	1	5	8	17
November	0	2	0	2	0	0	0	0	0	2
TOTAL	12	49	44	105	50	13	5	13	81	186

Table 2: Black bear stomachs collected from the GMNP area.

Date of kill	Sex	Approx. age	Area killed	Fate
May 21, 1994	F	juv.	Area 4	hunted
May 27, 1994	F	adult	Area 4	hunted
May 28, 1994	M	juv.	Area 4	hunted
June 7, 1994	F	juv.	Area 2	hunted
June 11, 1994	F	adult	Area 4	hunted
July 1, 1994	M	adult	Area 5	hunted
Sept 9, 1994	M	juv.	Area 4	hunted
Sept 24, 1994	M	adult	Area 4	hunted
Oct 3, 1994	M	adult	Area 4	hunted
Jun 22, 1995	F	juv.	GMNP	accidental death

Plant matter

Green vegetation occurred in 77% of the 196 samples collected during the study. It was found in 81 of 115 GMNP area samples (70%) and 69 of the 81 TNNP samples (85%) (Tables 3 and 4). Fruits and berries were found in 52% of all the samples: 72 of the GMNP area samples (63%) and 28 of the TNNP samples (35%). In both study areas, green vegetation dominated the spring/summer diet and berries dominated the late summer/fall diet (Figure 5).

Important green vegetation for both areas were grasses, forbs (herbaceous dicots), and spruce and fir needles. Grasses were the most common food item encountered in both study areas, found in 34 of 115 (30%) and 40 of 81 (49%) of the samples from the GMNP area and TNNP, respectively. Grasses were mainly consumed in the spring/summer season. In late summer/fall grass was eaten only occasionally.

Forbs and leafy vegetation were also common in the diet, and were found in 31 of the 115 GMNP area samples (27%) and 34 of the 81 TNNP samples (42%). They appeared to be consumed more frequently in the spring/summer season than in the late summer fall season. They usually made up 6-25% of the volume of the scats in which they occurred. Leaves of berry-producing species such as blueberry (*Vaccinium* spp.) were often found with berries in fall scats.

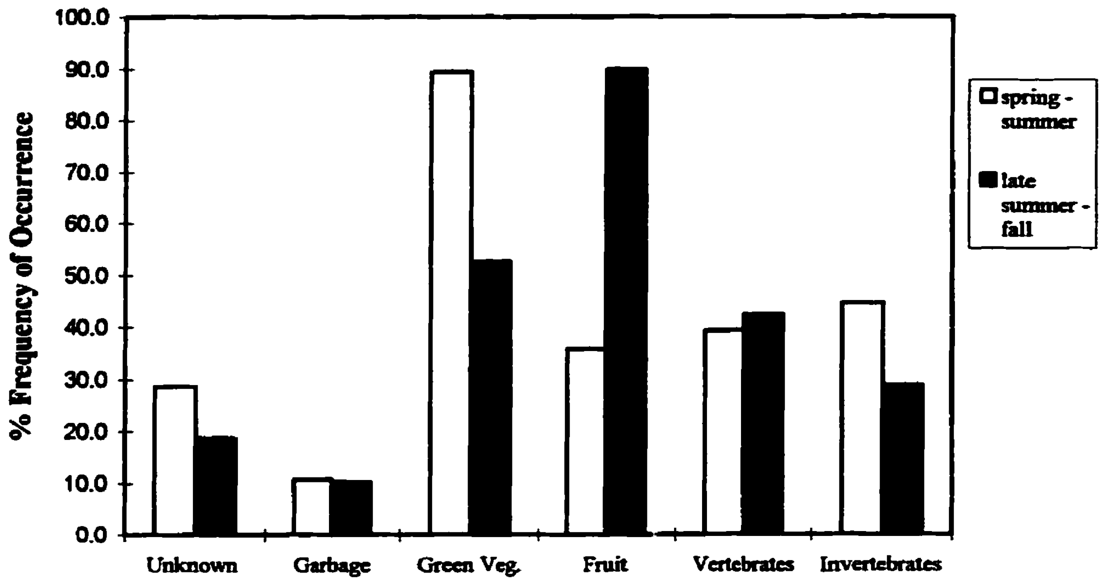
Table 3: Food items occurring in black bear scats (*n*=105) and stomachs (*n*=10) from the GMNP area from 1993 to 1995 (spring/summer = May to Aug 14; late summer/fall = Aug 15 to Nov 22). Percent frequency of occurrence is shown along with the average volume class (A=trace-5%, B=5-25%, C=25-50%, D=50-75%, E=75-100). Percent frequency of major groups is in bold.

	SPRING -SUMMER			LATE SUMMER- FALL			GMNP
FOOD ITEMS	1993 n=8	1994 n=26	1995 n=22	1993 n=4	1994 n=32	1995 n=23	TOTAL n=115
GREEN VEGETATION	**100**	**92.3**	**81.8**	**50**	**46.9**	**56.5**	**70.4**
Grasses	87.5 D	26.9 C	54.5 D	0	6.3 C	26.1 C	29.6 C
Leaves	37.5 B	38.5 B	18.2 C	0	25.0 C	26.1 B	27.0 B
Moss	50.0 B	11.5 B	9.1 B	0	3.1 A	0	8.7 B
Equisetum sp.	0	15.4 D	4.5 A	0	0	0	4.3 C
Dandelion	0	3.8 B	18.2 B	0	0	0	4.3 B
Needles	50.0 B	23.1 B	9.1 B	0	12.5 B	4.3 B	14.8 B
Cow parsnip	0	3.8 C	0	0	0	0	0.9 C
Unknown green veg.	12.5 D	38.5 D	27.3 C	50.0 D	18.8 D	4.3 C	22.6 D
Woodchips	12.5 A	3.8 B	0	0	3.1 A	0	2.6 B
Roots	12.5 A	0	0	0	0	0	0.9 A
FRUITS	**25**	**53.8**	**18.2**	**75**	**96.9**	**82.6**	**63.5**
Amelanchier spp.	0	0	0	0	6.3 A	0	1.7 A
Aralia nudicaulis	12.5 B	11.5 C	13.6 D	75.0 D	40.6 C	4.3 A	20.9 C
Arctostaphylos alpina	0	0	4.5 E	0	0	4.3 A	1.7 C
Aronia melanocarpa	0	0	0	0	3.1 B	4.3 A	1.7 B
Cornus canadensis	0	7.7 A	13.6 A	0	21.9 B	26.1 C	15.7 B
Cornus stolonifera	0	0	0	0	15.6 C	13.0 B	7.0 B
Empetrum nigrum	0	3.8 A	0	0	15.6 C	39.1 C	13.0 C
Frageria sp.	0	19.2 B	0	0	6.3 A	0	6.1 B
Gaultheria hispidula	0	3.8 A	4.5 A	25.0 A	21.9 B	13.0 B	11.3 B
Rhamnus alnifolius	12.5 A	3.8 A	4.5 B	25.0 A	9.4 A	0	6.1 A
Rubus chamaemorus	12.5 B	3.8 A	0	0	12.5 B	0	5.2 B
Rubus spp.	12.5 B	30.8 B	9.1 B	25.0 A	34.4 B	30.4 C	26.1 B
Sambucus pubens	0	7.7 C	0	0	0	17.4 B	5.2 B
Smilacina sp.	0	0	0	0	6.3 A	0	1.7 A
Sorbus americana	12.5 A	3.8 A	0	0	37.5 D	8.7 D	13.9 D
Streptopus roseus	0	0	4.5 B	0	9.4 B	0	3.5 B
Vaccinium spp.	0	11.5 B	0	0	28.1 B	30.4 B	16.5 B
Vaccinium vitis-idea	0	0	0	0	9.4 B	34.8 C	9.6 C
Viburnum edule	0	3.8 A	0	0	12.5 A	4.3 A	5.2 A
Viburnum trilobum	0	3.8 A	0	0	0	0	0.9 A
Unknown fruit	12.5 A	19.2 A	0	0	15.6 A	8.7 B	11.3 A
ANIMAL REMAINS	**87.5**	**76.9**	**63.6**	**75**	**56.3**	**60.9**	**66.1**
Flesh	0	11.5 C	9.1 D	0	0	0	4.3 C
Moose	0	19.2 A	13.6 B	0	28.1 B	26.1 B	20.0 B
Caribou	25.0 C	3.8 E	18.2 B	0	3.1 A	17.4 B	10.4 C
Cervidae young	0	0	4.5 E	0	0	0	0.9 E
Beaver	0	0	0	0	6.3 B	0	1.7 B
Snowshoe hare	0	0	0	25.0 D	0	0	0.9 D
Unknown fur	12.5 A	0	4.5 B	0	6.3 A	4.3 A	4.3 A
Bone	0	0	27.3 B	25.0 A	0	0	6.1 B
Feathers	0	0	0	25.0 A	0	4.3 B	1.7 B
Bear	25.0 A	19.2 A	22.7 B	0	15.6 A	0	14.8 A
Ants	62.5 A	53.8 A	9.1 B	25.0 A	12.5 B	21.7 A	27.0 A
Maggots	0	7.7 A	13.6 B	0	9.4 B	17.4 C	10.4 B
GARBAGE	**25.0 B**	**11.5 C**	**0**	**0**	**15.6 C**	**4.3 D**	**10.4 C**
UNKNOWN MATTER	**50.0 C**	**19.2 D**	**31.8 C**	**0**	**12.5 C**	**30.4 B**	**23.5 C**

Table 4: Food items observed in bear scats from TNNP (*n*=81) from 1992 to 1995 (spring/summer = May to Aug 14; late summer/fall = Aug 15 to Nov 22).
Percent frequency of occurrence is shown along with the average volume class (A=trace-5%, B=5-25%, C=25-50%, D=50-75%, E=75-100%). Percent frequency of occurrence of major groups in bold.

	SPRING - SUMMER			LATE SUMMER - FALL				TNNP
	1992	1993	1995	1992	1993	1994	1995	TOTAL
FOOD ITEMS	*n*=47	*n*=5	*n*=5	*n*=3	*n*=8	*n*=5	*n*=8	*n*=81
GREEN VEGETATION	**93.6**	**80.0**	**100**	**66.6**	**75.0**	**100**	**37.5**	**85.2**
Grasses	74.5 D	80.0 D	0	0	12.5 C	0	0	49.4 D
Leaves	42.6 B	40.0 B	60 C	66.7 B	50.0 B	60.0 B	0	42.0 B
Moss	17.0 B	40.0 A	80 C	0	12.5 A	0	0	18.5 B
Equisetum sp.	4.3 E	0	0	0	0	0	12.5 C	3.7 D
Needles	17.0 B	40.0 B	80 B	0	0	0	0	17.3 B
Ferns	2.1 B	0	0	0	0	0	12.5 A	2.5 B
Seaweed	0	20.0 A	0	0	0	0	0	1.2 A
Unknown green veg.	10.6 B	0	20 B	0	37.5 C	0	12.5 C	12.3 C
Woodchips	10.6 B	0	40 B	0	0	40.0 D	0	11.1 B
Roots	0	0	0	0	0	20.0 B	0	1.2 B
Lichens	2.1 B	0	0	0	0	0	0	1.2 B
FRUITS	**12.8**	**20.0**	**0**	**100**	**87.5**	**0**	**100**	**34.6**
Aralia nudicaulis	0	0	0	33.3 E	75.0 B	0	37.5 C	12.3 C
Aronia melanocarpa	0	0	0	0	0	0	37.5 A	3.7 A
CornusCanadensis	0	0	0	0	50.0 B	20.0 A	37.5 C	9.9 B
Empetrum nigrum	0	0	0	0	0	0	12.5 A	1.2 A
Gaultheria hispidula	0	0	0	0	37.5 B	40.0 B	25.0 B	8.6 B
Rubus spp.	6.4 B	0	0	33.3 A	37.5 B	40.0 C	50.0 B	16.0 B
Sambucus pubens	0	0	0	0	0	0	12.5 A	1.2 A
Smilacina sp.	4.3 A	0	0	0	0	0	50.0 C	7.4 C
SorbusAmericana	0	0	0	0	0	0	12.5 E	1.2 E
Streptopus roseus	0	0	0	0	12.5 A	0	0	1.2 A
Vaccinium spp.	0	0	0	66.7 E	50.0 B	0	62.5 B	13.6 B
Vaccinium vitis-idea	0	0	0	33.3 C	12.5 B	40.0 C	50.0 C	9.9 C
Unknown fruit	2.1 A	20.0 A	0	0	25.0 C	40.0 A	37.5 B	11.1 B
ANIMAL REMAINS	**74.5**	**80.0**	**80.0**	**33.3**	**87.5**	**60.0**	**12.5**	**67.9**
Moose	14.9 B	0	0	0	12.5 B	20.0 A	0	11.1 B
Cervidae young	12.8 B	0	0	0	0	0	0	7.4 B
Beaver	2.1 A	0	0	0	0	0	0	1.2 A
Unknown fur	4.3 A	0	20.0 B	0	0	0	0	3.7 B
Bone	2.1 B	0	0	0	0	0	0	1.2 B
Feathers	4.3 A	0	0	0	0	0	0	2.5 A
Bear	14.9 B	20.0 A	60.0 B	0	0	0	0	13.6 B
Ants	42.6 B	80.0 B	0	33.3 A	87.5 B	20.0 A	12.5 A	42.0 B
Maggots	10.6 B	20.0 A	0	0	0	20.0 A	0	8.6 B
Unknown insects	4.3 A	0	0	0	0	0	0	2.5 A
GARBAGE	**29.8 C**	**0**	**0**	**0**	**0**	**0**	**0**	**17.3 C**
UNKNOWN MATTER	**36.2 C**	**60.0 C**	**20.0 B**	**0**	**37.5 B**	**40.0 C**	**0**	**32.1 C**

GMNP Bear Area Food Habits (N=115)



TNNP Bear Food Habits (N=81)

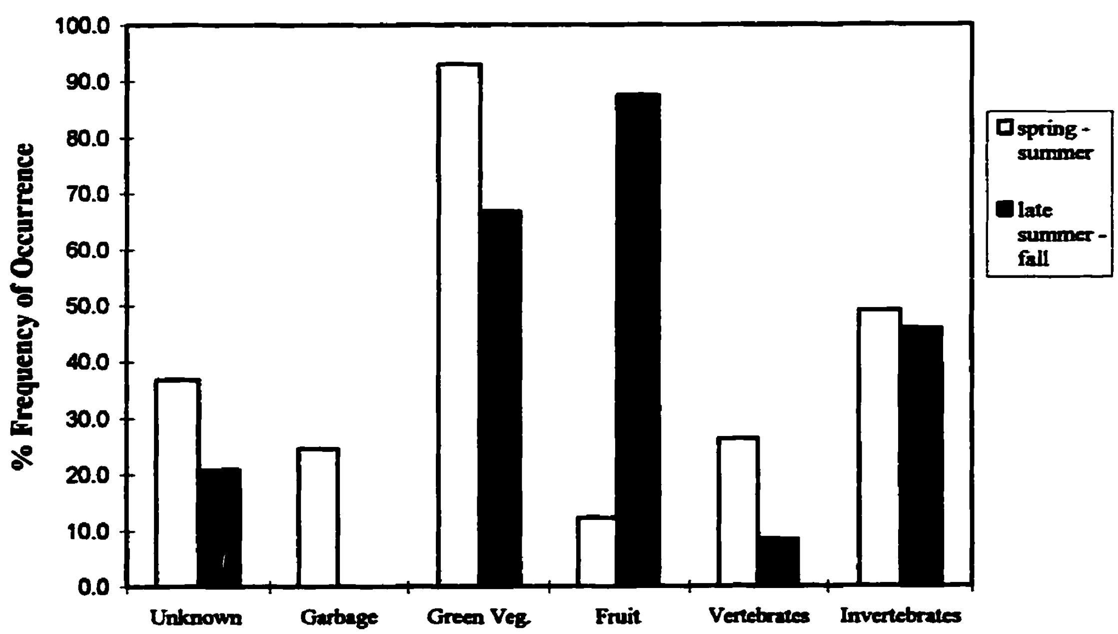


Figure 5: Seasonal food habits of black bears in GMNP and TNNP based on percent of total occurrences of each food type in scats and stomachs. Years are combined (1992 - 1995).

In August, September, and October, berries were frequently found in bear scats (Tables 3 and 4). Berry species occurred in GMNP bear scats earlier in the season than in TNNP bear scats (Table 5). Wild sarsaparilla (*Aralia nudicaulis*), raspberries and related species (*Rubus* spp.), bunchberries (*Cornus canadensis*), blueberries, and mountain cranberries (known locally as "partridgeberries") (*Vaccinium vitis-idaea*) were important berry species in both study areas. The GMNP area had several additional important species including black crowberries (*Empetrum nigrum*), creeping snowberries (*Gaultheria hispidula*), and mountain ash (*Sorbus americana*).

Table 5: Dates of first seasonal occurrence of berry species in bear scats collected in GMNP (1993-1995) and TNNP (1992-1995).

	Date of first seasonal occurrence	
FOOD ITEM	GMNP	TNNP
FRUITS		
Amelanchier spp.	Aug 24, 1994	na
Aralia nudicaulis	Jul 24, 1993	Aug 19, 1992
Arctostaphylos alpina	Aug 3, 1995	na
Aronia melanocarpa	Oct 8, 1994	na
Cornus canadensis	Aug 7, 1994	Sep 3, 1993
Empetrum nigrum	Aug 14,1994	Aug 28,1995
Fragaria virginiana	Jul 31, 1994	na
Gaultheria hispidula	Aug 14, 1994	Sep 3, 1993
Rhamnus alnifolius	Jul 13, 1994	na
Rubus chamaemorus	Aug 6, 1993	na
Rubus spp.	Jul 31, 1994	Aug 7, 1992
Sambucus pubens	Aug 14, 1994	Aug 28, 1995
Smilacina sp.	na	
Sorbus americana	Aug 2, 1994	Sep 16, 1995
Streptopus roseus	Aug 14, 1995	Sep 11, 1993
Vaccinium spp.	Jul 31, 1994	Aug 25, 1993
Vaccinium vitis-idaea	Aug 24, 1995	Sep 8, 1993
Viburnum edule	Jul 31, 1994	na
Viburnum trilobum	Aug 1, 1994	na

Of the berry species found, raspberries and their relatives were found most frequently in both study areas, and were present in scats every year from 1992 to 1995. *Rubus* spp. constituted on average 6-25% of those scats in which they were found and were often eaten during August and September.

Wild sarsaparilla was present in bear scats of both study areas every year except in TNNP in 1994, when no fall scats were collected. It was used quite heavily and constituted an average volume class of 25-50% in both study areas. It was commonly consumed by bears in August and September.

Use of blueberries was commonly noted in GMNP and TNNP samples. On average they made up 6-25% of the volume of the scats in which they were encountered.

Mountain cranberries were found every year in which October scats were collected. On average they made up 26-50% of those scats in which they were observed, in both study areas.

Use of bunchberries was recorded every year except for 1992. In both study areas they constituted on average 6-25% of the volume of those scats in which they were found.

Crowberries were considered to be important in GMNP but not in TNNP. Crowberries were found in 15 of 115 samples (13%) from GMNP but only 1 of 81 samples (1.2%) from TNNP.

Mountain ash berries were important only in GMNP where they constituted an average volume of 50-75% of those scats in which they were found. Mountain ash fruits were more frequent in 1994 GMNP scats than in 1995 scats, occurring in 37.5% and 8.7% of the scats, respectively.

Creeping snowberry was important only in GMNP samples. In both study areas it made up an average volume of 6-25% of those scats in which it was found.

Use of the alpine bearberry (*Arctostaphylos alpina*) was observed in GMNP but not in TNNP. In Gros Morne it was only found in two scats, both of which were collected in the tundra region.

Animal matter

Animal matter was present in the samples in the form of flesh, hair, bone, feathers, and insects (Tables 3 and 4). Bird and mammal remains (excluding bear) were found in 65 of the 196 samples (33%): 41% of GMNP samples and 21% of TNNP samples contained vertebrate remains. Invertebrate remains were found in 80 of the 196 samples (41%): 37% of GMNP samples and 48% of TNNP samples.

Moose was considered an important animal food in both GMNP and TNNP. Other important animal foods in the GMNP area were caribou (*Rangifer tarandrus*), which were not found in TNNP scats, and maggots (Diptera species) which were present but less frequent in TNNP scats. The only other important animal food in TNNP (besides moose) was ants (Formicidae species). Ants were found in GMNP samples but less frequently than in TNNP scats.

Beaver (*Castor canadensis*) fur occurred in at least 3 of 196 samples. Two of these samples were stomachs from bears hunted at the same bait site within 2 weeks of each other. The bait contained chicken fryer fat and moose but not beaver. This could be the result of 2 bears feeding on the same carcass, possibly as a result of predation.

Snowshoe hare (*Lepus americanus*) remains were only confirmed in one bear scat which was collected in GMNP. However, 8 of 196 scat and stomach samples contained fur that could not be identified.

Garbage

Garbage was consumed by bears in both GMNP and TNNP, and occurred frequently in those bear scats collected at landfill sites. Garbage appeared in 13% of 196 samples, comprising on average 26-50% of the volume of samples in which it occurred. Of the 48 scats collected within 1 km of landfill sites, 35% (17) contained garbage. Of the 148 non-dump samples (>1 km from landfill sites), 6% (9) contained garbage. comprised. Two of 9 "non-dump" samples containing garbage were stomach contents of two adult males legally shot over bait during the fall hunting season of 1994. One of these stomachs was filled with what appeared to be an entire shredded black garbage bag, with some moose hair and several berries. Other scats with garbage contained material such as styrofoam, plastic, and cloth; two of the scats contained a cigarette butt.

DISCUSSION

Bears were omnivorous during the study, although plant matter occurred more frequently in bear scats and stomachs and in greater volumes than animal matter. Black bear diets, while usually including some animal matter, are primarily comprised of vegetation (Jonkel and Cowan 1971, Beeman and Pelton 1980, Eagle and Pelton 1983, Costello 1992). Consumed plant matter was classified into two categories: green vegetation which was mainly eaten in the spring/summer period, and fruits which were mainly eaten in the late summer/fall period.

Predominance of green vegetation in the spring/summer scats has been observed in most bear studies (Paquet 1991, Costello 1992, Boileau et al. 1994). Adult female bear F2 and her yearlings (see Chapter 3) were frequently sighted along a roadside in GMNP in May and June feeding on dandelions (*Taraxacum officinale*). These observations declined as the summer progressed, coinciding with the availability of more palatable foods. Bears commonly use grasses and sedges in the early summer when berries and hard mast are not yet available. Early summer use of graminoid species has been noted across North America (MacHutchon and Smith 1990, Boileau et al. 1994).

The presence of leaves of berry-producing species in the fall scats may have been incidental to berry feeding. Similarly, the consumption of spruce and fir needles was probably incidental to feeding on other food items, especially ants. In GMNP I have observed many ant hills consisting mainly of conifer needles.

Berries occurred in bear scats earlier in the season in GMNP than in TNNP, which may reflect the delayed season in the eastern part of the island due to its proximity to coastal ice flows.

Raspberries and related species were the most common berry species found in the present study. Costello (1992) found that during the summer *Rubus* spp. were the most common fruits identified in bear scats in the Adirondack region of New York. Samson and Huot (1994) observed *Rubus idaeus* to be one of the most frequently eaten berry species in summer in La Mauricie National Park in southern Québec. Holcroft and Herrero (1991) reported that *Rubus* spp. occurred at the highest volumes among berry species in bear scats in southwestern Alberta. Boileau et al. (1994) noted that *Rubus* spp. were among the major fruit bearing plants consumed in Gaspésie Park in Québec. They suggested that the presence of *Rubus* spp. in areas disturbed by cutting activities or insect damage probably attracted bears. The domestic harvest blocks in GMNP were preferred by bears in late summer (Chapter 4), which was likely due to the berry species present in the early seral stages.

Wild sarsaparilla was another common species found in this study, and was present in high volumes when it occurred. Boileau et al. (1994) and Pelchat (1983) noted that wild sarsaparilla was a major berry producing species used in Québec and northeastern Alberta, respectively.

Vaccinium spp. were frequent in both study areas; mountain cranberries generally produce fruit later than other blueberry species (Ryan 1978) and were found in samples collected later in the fall. Hatler (1972) suggested that *Vaccinium* may be one of the most important genera of fruit species used by bears on the continent. Researchers have documented its use from Alaska (Smith 1984, Hatler 1972) to New Brunswick (Zytaruk and Cartwright 1978) to Tennessee (Beeman and Pelton 1980). Samson and Huot (1994) reported that blueberries were commonly found in scats in southern Québec. Pelchat (1983) noted that the berries of *Vaccinium* spp. were prominent in the black bear diet in northeastern Alberta when berry production was high.

The importance of black crowberries in the diet of GMNP bears and lack thereof in the diet of TNNP bears was likely due to the habitat differences in the two parks; GMNP has alpine tundra regions and TNNP does not. The vast tundra in GMNP is favorable to mats of black crowberry (Berger et al. 1993). Within GMNP, there were more crowberries found in the scats collected in the tundra region than in the lowlands. Crowberries were also found to be used in the Yukon (MacHutchon and Smith 1990) and interior Alaska (Hatler 1967).

Alpine bearberry was another berry associated with tundra regions found only in GMNP. Use of alpine bearberry has been previously recorded in interior Alaska (Hatler 1967). Researchers have noted the use of a closely related species of bearberry (*Arctostaphylos uva-ursi*) in Alberta (Holcroft and Herrero 1991, Pelchat 1983) and Alaska (Hatler 1967).

Use of mountain ash berries in the GMNP region was noted by Reeks in 1870, who wrote "Later in the summer the various berries, such as mountain ash (*Pyrus americana*), for which it readily climbs, ... are its principal food...". In 1994 it was perhaps the most important berry species eaten by bears in the park, and constituted the highest volumes of all the fruiting species in the scats in which it was found. The decline in use of mountain ash in GMNP from 1994 to 1995 may be due to the scarcity of this species during its usual fruiting period in 1995, as noted by several park employees that year. This species was one of the most common foods eaten in La Mauricie National Park in southern Québec in a year when beechnuts failed (Samson and Huot 1994).

It appears that Newfoundland black bears include mammals and birds in their diet more often than do bears elsewhere in North America; mammal and bird remains occurred in 33% of scat and stomach samples. Paquet (1991) reported a 3.1% occurrence of mammal and bird remains in black bear scats collected in Riding Mountain National Park in Manitoba. In Gaspésie Provincial Park in Québec, remains of vertebrates occurred in 9% of samples (Boileau et al. 1994). The collection of scat at caribou and moose calf mortalities in the present study biased the sample slightly toward a high occurrence of mammals; exclusion of scats (15) collected at mortality sites resulted in a 29% occurrence of mammal and bird remains.

Mahoney (1985) reported that bears take on average 15% of the caribou calf cohort in the Grey River Herd in southern Newfoundland. He also reported that bear predation on moose calves in Newfoundland is prevalent.

It is not known how much of the vertebrate remains found in scat and stomach samples in the present study originate from park-maintained bear snaring sites, hunter bait stations, natural carrion feeding, or predation. The density of moose in the two study areas is quite high, due to the absence of wolves on the island and the protection from hunting offered by the parks. It is likely that the high moose density in GMNP, estimated at 3.0 animals per square kilometer (Keith 1996), is exploited by bears who certainly could partake of the abundance of moose roadkills available to them, in addition to the winter-killed animals in the springtime. Bears may prey upon moose neonates in spring. There is some evidence that bears may consume unretrieved or injured moose just outside the park after the moose hunting season begins in fall (see Chapter 3).

Remains of Cervidae young found in scats collected at caribou and moose calf carcasses in remote areas of GMNP were assumed to be ingested as a result of predation. Fifteen of the 105 GMNP scats were collected at 6 caribou and 3 moose calf kill sites in the tundra region of the park. Twelve of these scats contained bone fragments or Cervidae hair.

Results from ongoing caribou research in GMNP indicate that over a period of 3 years, 13 of 24 mortalities of collared calves (54%) were caused by bear (Mawhinney et al. 1996). In Gaspésie Provincial Park, Québec, Boileau et al. (1994) reported that black bears were responsible for 3 of 11 caribou calf mortalities (27%) for which the cause of death could be determined.

Black bear predation on moose has been well documented in Alaska (Franzmann et al. 1980, Ballard et al. 1990, Schwartz and Franzmann 1991), but has been reported infrequently in other areas of North America. Remains of moose were found in Riding Mountain National Park in southern Manitoba (Paquet 1991), and in Gaspésie Park in southern Québec (Boileau et al. 1994), but in both cases unnatural feeding on bait or at dumps was suspected. No moose remains were found in 30 black bear stomachs in an earlier study in southern Québec (Juniper 1978).

Two observations of bears chasing young moose were made in GMNP during the study: one by a park warden in the alpine region and the other by several highway workers in the lowland region. In Terra Nova, a similar chase was observed by park wardens. In none of these chases was the bear successful; however, these instances indicate that bears may occasionally attempt to prey upon young moose.

Neither snowshoe hare nor beaver appear to constitute important bear foods on the island. In Alaska, snowshoe hare was a primary food source for black bears (Schwartz and Franzmann 1991).

Garbage was found in less than one seventh of the scat and stomach samples, and most of the samples containing garbage were collected within 1 km of a landfill site. Garbage occurred in less than half of those samples collected within 1 km of a landfill site. From these observations, it appears that natural foods are more important in the diet of black bears than are unnatural foods. It is possible that the importance of garbage was underestimated in the diet of black bears in this study, because human foods may be digested more thoroughly than natural foods, and therefore may be less detectable in scats (Grenfell and Brody 1983). However, Hatler (1972) found that the proportion of garbage material does not usually change along the digestive tract, due to the commonly high incidence of undigestible material in ingested garbage.

In the present study bear scats were collected along trails and roads in the study areas, and when encountered during any field activities. Opportunistic collection of scat samples is typical of most bear food habit studies (Kellyhouse 1980, Norton 1981, Holcroft and Herrero 1991, Costello 1992, Boileau et al. 1994, Samson and Huot 1994), and while it is an efficient means of data collection, it precludes sound statistical analysis of food habits. The collection of scats along random transects or systematically along sampling routes would allow more rigorous comparisons of results within and among studies.

One of the goals of this study was to describe the food habits of bears within the two national parks of Newfoundland, which had never been undertaken previously. I did not measure the availability of the various food items within the habitat types of the parks. In 1994 I endeavored to measure the abundance of blueberries in plots in GMNP to monitor the availability of this species over a two year period. I chose to measure blueberries because *Vaccinium* species were noted to be important to bears across North America (Hatler 1972, Pelchat 1983, Smith 1984). I assumed that the availability of this species would be more important to bears than the other berry species present in the study area. After examination of the scats collected during 1993 and 1994, however, it was evident that other species such as raspberries, wild sarsaparilla, and mountain ash were more commonly found than blueberry. In view of these findings, I did not measure blueberry plots in 1995, as operational costs outweighed the benefits. In 1996 a monitoring program was initiated in GMNP to measure the availability of several species including raspberries, wild sarsaparilla, mountain ash, blueberries, and other species.

In conclusion, several species of plants and animals are important to bears in Newfoundland. Early successional plant species including raspberries, mountain ash, and blueberries are used heavily. Black bears are able to forage in the alpine tundra regions, where they may consume black crowberries and prey upon caribou calves. The unnaturally high density of moose present in some areas of Newfoundland, namely in national parks and areas inaccessible to hunters, may provide a more consistent source of protein for Newfoundland bears compared to mainland populations. Garbage is consumed by bears using landfill sites in Newfoundland and supplement natural foods; whether it is an essential component of their diet remains unknown.

CHAPTER THREE: HOME RANGES

INTRODUCTION

Burt (1943) defined home range as the area traversed by an animal in its normal activities of food gathering, mating, and caring for young. Home ranges of adult male black bears are usually much larger than those of adult females (Jonkel and Cowan 1971, Reynolds and Beecham 1980, Young and Ruff 1982). Adult male bears have home ranges that commonly overlap several adult female home ranges, thus allowing them the opportunity to breed with more than one female. Females usually have much smaller home ranges, and Amstrup and Beecham (1976) suggested that female bears should occupy the minimum area required to secure adequate nutrition for self-maintenance and to support the development of young.

Bears are intrasexually territorial in some environments (Jonkel and Cowan 1971, Young and Ruff 1982). Horner and Powell (1990) suggested that adult female black bears exhibit territorial behavior, expressed in part by the amount of overlap in their home ranges, in response to differing levels of resource productivity.

Black bear movements within their home range are influenced by the abundance of food resources within habitats (Garshelis and Pelton 1981). Bears occupy larger areas in years of scarce food than in years of abundant food (Pelchat 1983). Young and Ruff (1982) suggested that home range sizes of female bears estimated using the same methods for different areas could provide a means of comparing the quality of black bear habitat among regions.

Payne (1978) studied bears captured at garbage dumps and suggested that Newfoundland bears may have small home ranges. He proposed that concentrated food sources at landfill sites may result in small home ranges which overlap with those of other bears.

The purpose of this portion of the study was to determine home ranges size and overlap of adult female bears and to assess how local landfill sites may influence these factors.

METHODS

Bear Trapping, Handling, and Telemetry

Most bears were captured using Aldrich foot snares at baited stations located within GMNP south of the town of Rocky Harbour. The snare sites were located within 100 meters of the main park road and were of the "cubby" type (Johnson and Pelton 1980). In this set-up the bait is placed at the rear of a small corral, usually made from fallen trees, to which there is only one entrance, with one or two snares being placed at the entrance. The baits varied from moose and caribou meat to donuts and molasses. Occasionally "stink baits" were used consisting of rotting broiler chickens tied in burlap bags over the snare sites. The snares were checked daily. In areas known to be frequented by bears, such as at the Lomond garbage dump and sites of nuisance bear activity, bears were captured in culvert traps. Bears were also "free darted" at the local landfill site, or from a helicopter in the high country. All bears were tranquilized with the immobilizing agents Telazol (tiletamine HCl and zolazepam HCl; Fort Dodge Laboratories, Fort Dodge, Iowa) or Rompun (Xylazine HCl; Miles Laboratories, Rexdale, Ontario) and Ketamine HCl (Rogar/STB Inc., London, Ontario).

Immobilizing agents were administered by a dart shot from a dart gun using a low impact charge. When possible, captured bears were weighed (to the nearest kg) using spring scales and the following body measurements were recorded to the nearest cm: i) total length, from tip of nose to tip of tail along contour of body; ii) neck girth, taken halfway between head and shoulders; iii) chest girth, taken immediately behind front legs; iv) head girth, taken around broadest part of the head in front of ears; v) shoulder height, from top of scapula to tip of middle claw with leg fully extended; vi) front and hind foot width, bottom of the foot, across widest part of the pad; and vii) front and hind pad length. Each bear was tagged with a numbered ear tag. Females over 100 lbs and adult males were fitted with VHF collars transmitting in the 148.0 - 148.999 mHz range or Platform Transmitter Terminal (PTT) collars (Telonics Inc., Mesa, Arizona), which were monitored at regular intervals via satellites (Argos).. The PTT collars were also equipped with a conventional VHF unit transmitting in the 150.0 - 150.999 mHz range for standard ground or aerial telemetry.

Ground telemetry was conducted with a hand-held antenna or with a vehicle-mounted null antenna system (two "H"- antennae arranged on a cross boom and a null combiner) (Telonics Inc., Mesa, Arizona). Telemetry was conducted during daylight hours. Triangulation was employed when tracking from the ground, with three or more bearings taken within 50 minutes of each other. Ground locations were attempted, on average, every second day. Aerial telemetry of bears was performed periodically throughout the study by a helicopter or fixed-wing aircraft. The PTT collars were programmed to record a location every two days. I attempted to minimize serial correlation of data by using only locations obtained more than 20 hours apart. Bearings obtained by ground-based telemetry were plotted using the program LOCATE II (Nams 1990), which provided error ellipses for each location (calculated from the average angle error).

With the satellite locations, Service Argos provided a location quality index with each re-location (classes A, B, 0, 1, 2, 3). I only used the 2 highest quality location types, classes 2 and 3, which are supposedly accurate within a radius of 500 m and 150 m, respectively. Accuracy of the aerial telemetry was assumed to be within 2 km^2 (radius of 798 m).

Home Ranges

Home range sizes of bears were estimated using the computer program HOME RANGE (Ackerman et al. 1990). This program also tested for serial correlation among bear locations using the methods of Swihart and Slade (1985, 1986). Home range sizes were based on the 100% minimum convex polygon method (MCP, Mohr 1947). This method is commonly used by researchers and allows for comparison with other studies. The 95% minimum convex polygon and 95% adaptive kernal technique (Worton 1989) were determined using the program CALHOME (Kie et al. 1994). Only locations with error ellipses of less than 2 km^2 were used for the home range analysis. Sightings of these bears at the dump were excluded from the home range analysis. The number of locations sufficient to delineate 100% MCP home range size was determined using a modification of a technique described by Schooley (1990) (Appendix IV).

RESULTS

Bear Trapping and Handling

Twenty-one bears were captured in GMNP from 1993 to 1995 (Appendix V) . The measurements of adult bears are summarized in Table 6. Fourteen of these bears were fitted with radio-collars; however, during the study four of the collars slipped off and one collared bear died during recapturing. Two other bears lost their collars but were subsequently re-collared.

Table 6: Summary of body morphology (mean ± SD, sample size in brackets) of adult black bears in GMNP, 1993-1995.

Measurement	FEMALES	MALES
Chest girth (cm)	97.2 ± 8.8 (7)	118.1 ± 15.4 (5)
Total length (cm)	157.6 ± 7.5 (8)	185.8 ± 15.1 (4)
Neck girth (cm)	58.7 ± 6.9 (6)	74.3 ± 17.2 (4)
Front paw width (cm)	11.2 ± .8 (8)	13.7 ± 1.2 (4)
Shoulder height (cm)	78.5 ± 12.8 (7)	94.1 ± 6.2 (4)

Telemetry and Home Ranges

Ten collared bears (7 adult females, 2 adult males, 1 juvenile female) were located 243 times from June to October in 1995 (Table 7, Figure 6). However, only five adult females (F1, F2, F3, F4, and F5) were successfully located on a regular basis. These five were located on average once every 3.5 days (n=207). None of these females had cubs in 1995, but four of them (F1, F2, F3, and F5) had cubs in 1994. Seventeen (8.4%) of their locations were from helicopter or fixed-wing aircraft, 10 (4.9%) were sightings from the ground, 27 (13.3%) were by satellite, and 149 (73.4%) were ground telemetry locations.

The five adult females (F1, F2, F3, F4, and F5) were located frequently enough to estimate home range sizes (Appendix IV). The number of locations required to sufficiently delineate home range sizes varied from 21 to 36, and the average was 25.6 locations. Serial correlation among locations was observed in four (F1, F2, F3, and F4) out of five radio-tagged females ($P < 0.05$). The average home range size of these five bears was 47.7 km^2 (range = 27.7 km^2- 79.9 km^2, sd = 21.7 km^2) (Table 8). Home ranges taken from other North American studies are given in Table 9.

Table 7: Number of locations with a 2 km^2 accuracy or better of radio-collared bears from June to October 1995 in GMNP.

No.	Sex	Number of locations	Date of init. capture	Date of last 1995 location
F1	F	35	18-Jul-93	30-Oct-95
F2	F	48	16-Jul-94	30-Oct-95
F3	F	45	13-Aug-94	30-Oct-95
F4	F	39	20-Aug-94	20-Oct-95
F5	F	40	2-Sep-94	23-Oct-95
F6	F	4	4-Sep-94	22-Jun-95
F8	F	9	30-Aug-95	07-Oct-95
F9	F	4	22-Sep-95	22-Oct-95
M1	M	6	22-Jun-95	04-Oct-95
M2	M	13	12-Jul-95	04-Oct-95
total		243		

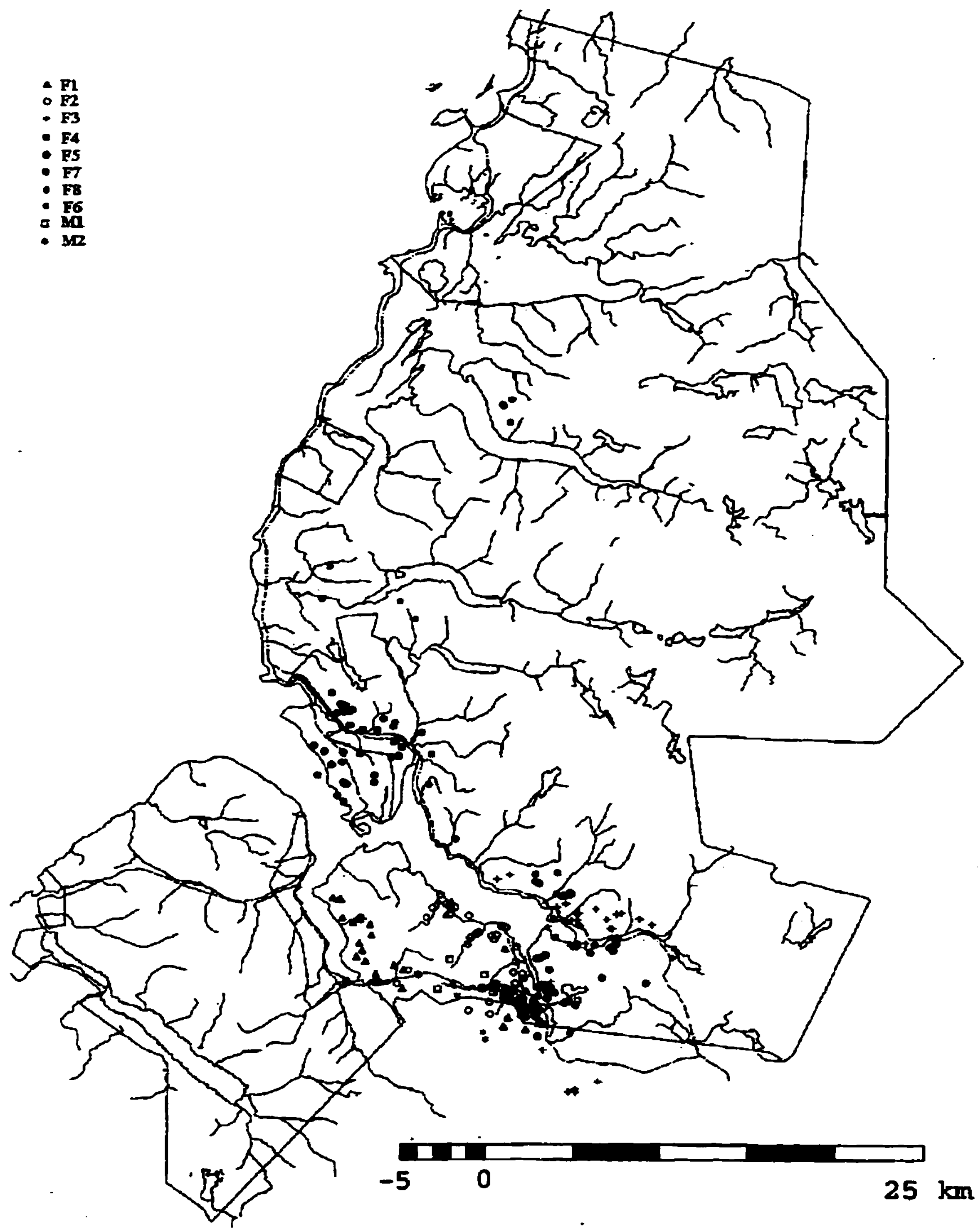


Figure 6: Locations of radio-collared bears in 1995.

The home ranges of the five adult female bears all included one of the two garbage dumps in the park (Figure 7). Female bears F1, F2, F3, and F5 all had home ranges that included the Lomond dump, wheras F4's home range included the Norris Point dump (Figure 7, Appendix VI). The largest home range (79.9 km^2) was for female F3 who moved outside the park for a 9-day period from Sept. 17 to Sept. 26, 1995 (Appendix VII).

The relatively small home range of adult female F5 was located entirely within the home range of adult female F3, encompassing approximately 35% of female F3's home range. However, excluding those locations in the immediate vicinity (within 1 km) of the dump, only 4 (11%) of female F3's 35 locations were within the boundaries of F5's home range. Female F3 appeared to move through the region of female F5's home range to access the Lomond garbage dump (Appendix VII).

Approximately 64% of the home range of adult female F1 and 90% of that of female F2 overlapped each other. Unlike bears F3 and F5, they often used the same areas within the overlapping portion of their ranges. However, they used these areas at different times, and were never located within 500m of each other, excluding the observations of simultaneous feeding at the Lomond garbage dump.

Table 8: Home range areas for radio-collared black bears in GMNP from June to October 1995.

BEAR NUMBER (# locations)	AREA (km^2) 100% Minimum Convex Polygon	95% Minimum Convex Polygon	95% Adaptive Kernel
F1 (35)	58.7	55.5	99.3
F2 (48)	41.3	38.8	44.4
F3 (45)	79.9	65.1	122.1
F4 (39)	30.9	26.1	40.9
F5 (40)	27.7	17.9	30.4
mean	47.7 (sd=21.7)	34.7 (sd=14.2)	67.4 (sd=40.7)

Table 9: Adult female black bear 100% MCP annual home ranges in northern regions of North America.

Location	N	No. of locations	Home range (km^2) Mean	Range	Reference
GMNP, Newfoundland	5	207	47.7	27.7-79.9	this study
Adirondacks, New York	5	493	31.2	7.0 - 55.1	Costello (1992)
Gaspésie, Québec	5	-	47	8 - 65	Boileau (1993)
PNM[b], Québec	24	-	68.2	-	Samson and Huot (1994)
Western Manitoba	5	399	23.9	16.1 - 32.1	Klenner (1987)
Riding Mt. Nat. Park, Man.	14	-	169	-	Paquet (1991)
Northern Alberta	3	63	7.5	6.2 - 9.3	Fuller and Keith (1980)
Cold Lake, Alberta	12[a]	542	19	-	Pelchat (1983)
Southern Yukon	9	128	28.1	6.8 - 75.4	MacHutchon and Smith (1990)

[a] female bears over the age of 1 year

[b] Parc National de la Mauricie

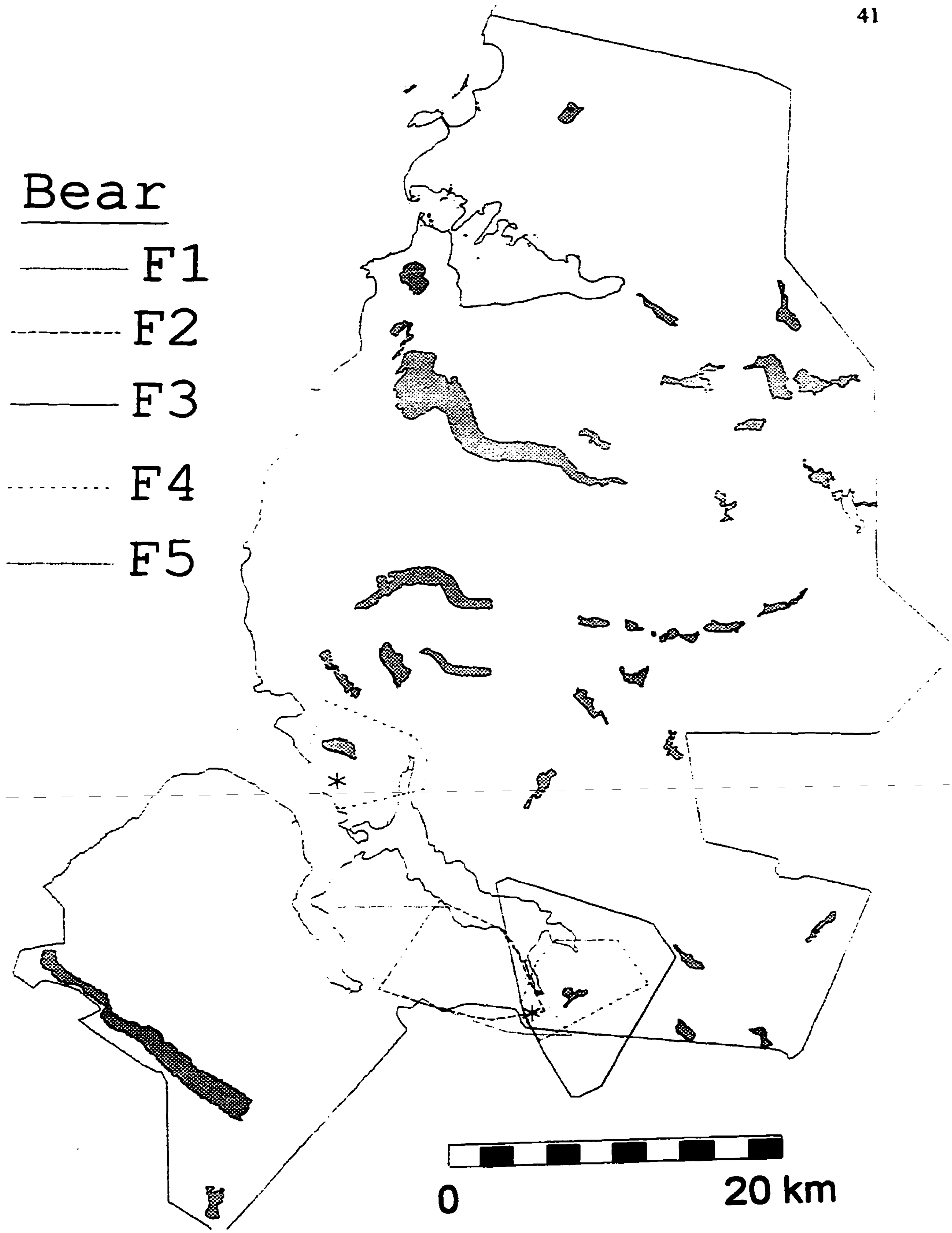


Figure 7: Home ranges of five adult female bears (F1, F2, F3, F4, F5) in GMNP from June to October in 1995). The asterisks indicate the locations of the two garbage dumps within the study area.

DISCUSSION

Only five of ten radio-collared bears could be located sufficiently frequently to calculate home ranges. These were five females that were primarily located in the lowland area in the south of the park. Two other females (F , F8) were not collared until later in the season and two adult males (M1, M2) were rarely located within the park. Males generally occupy much larger home ranges than females and it is often not possible to locate them from the ground consistently throughout a study (Young and Ruff 1982, Costello 1992).

The locations taken from four of the adult females were serially correlated. Powell (198) proposed that all movements by a bear depend on past experiences and that no two telemetry locations are ever truly independent. Swihart et al. (1988) suggested that for some animals it may be impossible to obtain a large sample size of independent data within a biological season.

The largest adult female home range estimate (F7) was 2.6 times larger than the smallest home range estimate (F5). A contributing factor to the large home range size of F7 was a long range excursion she made outside the park during a 9-day period in September 1995. During this period she was located 5 times in an area just outside the park boundary. Her movement to this area was possibly related to the opening of the moose hunting season in that area on Sept. 9, and consequently to the availability of unretrieved or injured moose as a food source. During this period I collected several bear scats in this area that were composed primarily of moose hair and insect larvae (maggots), suggesting consumption of carrion. Grenfell and Brody (1987) also suspected bear feeding on unretrieved deer during the deer hunting season in northern California. If the locations taken between Sept. 17 and Sept. 26, 1995 are excluded from the home range estimate of female F3, the home range for this bear would be 46.9 km^2, and the average home range size for the five female bears would change from 47.7 km^2 to 41.1 km^2 (sd = 12.5 km^2).

The home range sizes of adult females in this study are similar to those observed in Idaho (Amstrup and Beecham 1976), Québec (Boileau 1993, Samson and Huot 1994), and New York (Costello 1992). Dennis et al. (1996) reported large annual home range sizes of two adult female bears in another study in western Newfoundland (61.3 km^2 and 103.2 km^2); however, these ranges are not directly comparable to the present study because they were based on two years of data. Earle (1995) also reported large summer home ranges for female bears in TNNP (average = 110 km^2, sd = 138 km^2, range = 24.4 to 269.5 km^2, n=3). However, the data that Earle (1995) presented were averaged over three years of data, and are not directly comparable to the present study.

The large variation in home range sizes (27.7-79.9 km^2) observed in the female bears of GMNP cannot be attributed to differences in reproductive state, as all five bears were without cubs in 1995. Costello (1992) also found that the home range sizes of adult females in the Adirondack Mountains of New York varied considerably among individuals in the same year (7.0-53.1 km^2). The annual home range of adult females in La Mauricie National Park in southern Québec varied from 15.1 to 369.2 km^2 in one year (Samson and Huot 1994).

The extensive overlap among the home ranges of 4 adult females in this study is comparable to the high degree of overlap reported by Garshelis and Pelton (1981) in Great Smoky National Park, Tennessee. Klenner (1987) suggested that considerable overlap of adult female home ranges in western Manitoba may have been in part due to social instability which prevented the establishment of relatively constant home ranges, as the bears were subjected to high mortality by hunters and trappers. In Idaho, Amstrup and Beecham (1976) observed extensive home range overlap, which they attributed to a dietary reliance on plant foods that occurred in patches. Horner and Powell (1990) similarly ascribed home range overlap in bears in the southern Appalachian Mountains to a habitat that was described as highly productive with a clumped distribution of bear foods.

The presence of the Lomond garbage dump was perhaps the primary reason for the extensive overlap of home ranges in this study. The home ranges of four collared females overlapped in the vicinity of the dump, which occurred at the edge of all four home ranges. Rogers (1987) noted overlap among territories at garbage dumps, which occurred at the edges of territories in Minnesota. In Manitoba, 18 bears had home ranges which overlapped a landfill site located just outside the boundary of Riding Mountain National Park (Pacas and Paquet 1994).

There is some indication that at least two of the bears' home ranges overlapped solely because of the landfill site. Although the home range of adult female F5 was entirely within that of adult female F3, it appeared that F3 spent relatively little time in the home range of F5, possibly passing through solely to access the landfill site. The geography of the area precluded her use of any other land route to the landfill without traveling extensively.

There was a high degree of spatial overlap in the ranges of adult female bears F1 and F2. However, they were never observed using the same area (within 500 m) in the overlapping portion of their home ranges at the same time. Nevertheless, on several occasions these two bears were seen using the garbage dump at the same time and appeared to be quite tolerant of each other, coming within 5 meters of each other with no sign of aggression. Similarly, Young and Ruff (1982) found that two adult female home ranges in Alberta overlapped spatially but usually not temporally, although simultaneous use of a garbage dump was recorded. They concluded that adult female bears were territorial at Cold Lake, as indicated by their temporal avoidance in shared areas away from the dump.

There may have been other adult females in the area who were not captured. The home ranges of these bears could obviously not be measured, and may have overlapped the home ranges of the collared bears both spatially and temporally. However, in 37 days when bears were observed at the Lomond landfill site, there was only one other adult female bear observed (F7), besides the females already collared. This uncollared bear had been captured once, but slipped her radio-collar within several days. I feel reasonably certain that we collared nearly all of the adult females that used the landfill site, except for this one bear.

In a recent study in western Newfoundland, Dennis et al. (1996) reported the home female bears in TNNP appeared to be territorial, as no significant spatial overlap of their home ranges occurred.

In summary, adult female bears in GMNP had moderate home range sizes and exhibited territorial behavior. The overlap in the bear home ranges did not indicate a high degree of tolerance among these bears, as they appeared to avoid each other within the overlapping portions of their home ranges. The presence of the Lomond garbage dump, and use of the dump by bears, likely caused much of the overlap that was observed in the home ranges.

CHAPTER FOUR: HABITAT SELECTION

INTRODUCTION

Habitat use of animals likely reflects the availability of necessary resources. For black bears, food is a particularly important resource. Bears go without food and water for several months of the year during their winter dormancy period. Before they den, they must accumulate enough fat reserves to sustain them during the winter. Fat storage during this time of year is especially important to reproductive females, who may have to attain a certain critical weight in order to become pregnant (Rogers 1976).

Black bears depend heavily on vegetation for much of their diet, and habitat use may not only reflect the spatial distribution of important plant foods, but the phenology of plant species as well. Food choices of bears in Newfoundland changed over the season (Chapter 2). Seasonal changes in black bear habitat use are well documented and have commonly been attributed to variation in food availability (Unsworth et al. 1989, Hellgren et al. 1991).

Black bear use of logged areas has been documented by many researchers (Lindzey and Meslow 1977, Young and Beecham 1986, Unsworth et al. 1989, Boileau et al. 1994, Costello and Sage 1994, Sampson and Huot 1994), and has largely been attributed to increased food availability in these disturbed areas (Boileau et al. 1994, Costello and Sage 1994). On the other hand, some authors have reported black bear avoidance of cut-over areas (Jonkel and Cowan 1971, Clark et al. 1994).

The presence of domestic harvest blocks in GMNP, where residents cut wood for domestic heating and construction purposes, provided a unique opportunity to study bear use of cut-over areas in an area where they are protected from hunting.

Garbage dumps also influence bear movements (Rogers 1987, Paquet 1991), often to their detriment (Rogers et al. 1976, Mattson 1990). In Newfoundland, as in other areas, bears using local landfill sites are often assumed to be dependent on human food sources, and are seen essentially as "beggars" of the wildlife kingdom. For this, they have been destroyed unnecessarily and often in great numbers at landfill sites.

The objective of this portion of the study was to determine whether bears select certain habitat types over others, and the extent to which bears use landfill sites.

METHODS

Telemetry

Triangulation was employed with ground telemetry, with three or more bearings taken within 50 minutes of each other. Ground locations were attempted on average every second day. Aerial telemetry of bears was performed periodically throughout the study from a helicopter or fixed-wing aircraft. The PTT collars were programmed to record a location every two days. I attempted to minimize serial correlation of data by only using those locations which were obtained more than 20 hours apart.

Habitat Availability and Selection

Dominant vegetation types in GMNP were delineated from aerial photos and as described by Berger et al. (1992). Habitat boundaries were digitized into SPANS GIS (Tydac technologies Inc. Nepean, Ontario 1995). Vegetation types in the park were classified as grass, intertidal salt marsh, sedge fen and bog, sphagnum bog, riverine thicket and meadow, larch scrub, black spruce forest and scrub, tuckamore (krummholz), heath dwarf scrub, balsam fir forest, heath-lichen tundra, serpentine barrens, cleared settled areas, and water (Figure 8, Berger et al. 1992, 1:150 000).

I generated a second GIS map layer depicting logging activity in the park. For this map layer I recognized three categories of forest management: logged areas - forested areas (black spruce forest and balsam fir forest) occurring within the domestic harvest blocks; natural forest - forested areas (black spruce forest and balsam fir forest) occurring outside the domestic harvest block (non-harvested areas); and primarily unforested areas (composed of heath lichen tundra, sedge fen and bog, and tuckamore). Domestic harvest blocks #3, #4, #6a, and #6b fell within the study area. The enclave town of Rocky Harbour was treated as a domestic harvest block as well, due to the similar cutting practices. Two areas that are classified by GMNP as domestic harvest blocks (block #5 and block #10) were treated as natural forest, as they are inaccessible to people and receive little to no use by residents (C. Wentzell, Parks Canada, pers. comm.). The natural forest included areas that may have been logged >22 years prior to sampling.

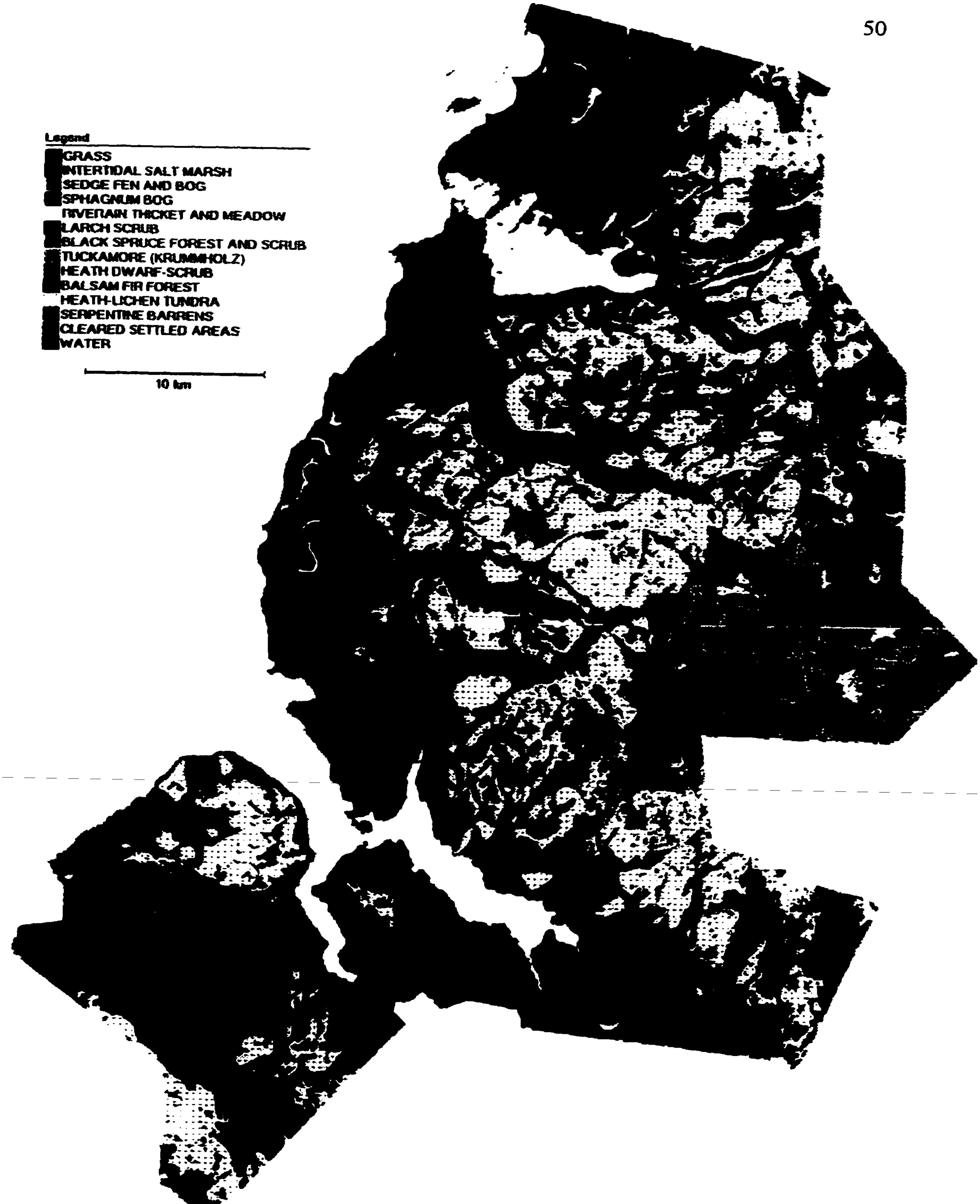


Figure 8: Dominant vegetation types within GMNP (Berger et al 1992, 1:150 000)

Radio-telemetry data from five adult female bears (F1, F2, F3, F4, and F5, see Chapter 3) were used for the habitat selection analysis. Data from the other collared bears were excluded from the analysis due to an inadequate number of locations.

The ground locations were plotted using the program LOCATE II (Nams 1990), which provided error ellipses for each location (calculated from the average angle error). Only those ellipses less than 2 km^2 were used for the habitat use analysis. The error ellipses of each location returned by LOCATE II were superimposed onto the digitized habitat maps using Spans GIS. I assigned a habitat type to each location according to the habitat encompassing the largest area within the error ellipse. In the case where 2 habitats enclosed 50% of the ellipse, both were assigned and weighted by 0.5. Locations with the largest habitat encompassing <40 % of the ellipse were discarded.

With the satellite locations, Service Argos provided a location quality index with each re-location (classes A, B, 0, 1, 2, 3). I only used the 2 highest quality location types, classes 2 and 3, which are supposedly accurate within a radius of 500 m and 150 m, respectively. Accuracy of the aerial telemetry was assumed to be within 2 km^2 (radius of 798 m). With these locations I created circular error areas based on the appropriate radius, and superimposed these areas onto the habitat maps. Habitat types were assigned to these locations by the same method as the error ellipses.

I used Chi - square goodness of fit tests to determine if bear habitat use differed from expected use based on habitat availability (Neu et al. 1974). Some habitat categories were merged so that the criterion for Chi - square tests could be met (Dixon and Massey 1969). Small, infrequent habitat types were excluded from the analysis if they received no use by bears (Aebischer et al. 1993). When habitat use was significantly different from expected use ($P < 0.05$), Bonferroni z statistics were used to determine which habitat types were used more or less frequently than expected (Neu et al. 1974, Byers et al. 1984). The data for the five females were pooled (Alldredge and Ratti 1986) because the standard deviation of the number of locations taken for each bear was relatively small (average number of locations = 41.4, sd = 5.1). Where possible, I tested habitat selection by season, based on a dietary shift from primarily green vegetation in spring/ summer (May - August 14) to berries in late summer/fall (August 15 - November).

Johnson (1980) recognized the hierarchical nature of an animal's selection of habitat at distinct scales. The largest scale, termed first order selection, is the selection of a geographical range of a species. Second order selection (or *landscape level selection*) occurs within the geographical range, and determines the home range of an individual. Third-order selection (or *stand level selection*) involves the use of habitats within a chosen home range. Aebischer et al. (1993) recommended that analyses of habitat selection should be carried out in stages to identify differences in habitat selection at each level.

To assess habitat use at the landscape level I included habitats that were not used by bears, and that were not included in home ranges. Therefore, I defined the perimeter of the study area based on locations of snare sites rather than composite home ranges. Arcs with a radius of the average 100% MCP home range size of adult females were circumscribed around each snare site to create a boundary for the study area.

To assess habitat use at the stand level I examined each individual's use of habitats within their respective 100% MCP home ranges. All locations of the five adult females that fell within the park were included in this analysis.

Use of the Garbage Dump

In the summers of 1994 and 1995 I periodically visited the dump during July and August to record the presence of bears. In 1995 I also visited the dump during September and October. These recordings were made opportunistically during radio-tracking activities, and were taken during daylight hours between 9:00 and 20:00. The caretaker of the Lomond dump and park employees also provided me with information on bears at the dump.

I attempted to quantify use of the Lomond garbage dump (by bears F1, F2, F3, and F5) and the Norris Point dump (by bear F4) by generating 300 random locations within each home range and comparing the distances of the random and actual locations (Mann Whitney U test) to the dump.

RESULTS

Landscape Level Habitat Selection

Of the 207 locations taken of the five adult females, 191 (92%) fell within the delineated study area. Ten of these 191 locations (5%) fell outside the park where habitats were not described; these locations were excluded from the habitat use analysis. Sightings of bears at the garbage dumps were excluded from the habitat use analysis, as these data violate the assumption of equal detectability of animals throughout the study area.

All vegetation types of the park were not present in the defined study area. I excluded from the analysis uncommon habitat types that were present in the study area but unused by bears: intertidal salt marsh, sphagnum bog, riverine thicket and meadow, cleared settled areas, and water. These categories made up less than 4% of the study area combined. The five remaining vegetation categories were included in the habitat use analysis: balsam fir forest, black spruce forest and scrub, sedge fen and bog, heath lichen tundra, and tuckamore. Use of these five vegetation types were not tested seasonally, due to inadequate sample sizes. The data from locations taken from June to October were pooled to determine overall habitat use for the whole study period. Habitat use differed from habitat availability by dominant vegetation type ($\chi^2 = 28.56$, df = 4, $P < 0.001$, n = 181) (Table 10). Balsam fir forests were used more than expected and heath lichen tundra, sedge fen and bog, and tuckamore were used less than expected ($P = 0.05$, n = 181). Black spruce forest types were used according to availability ($P = 0.05$, $n = 181$).

To determine seasonal use of dominant vegetation types, I merged the heath lichen tundra, sedge fen and bog, and tuckamore habitat types into one category which I termed "primarily nonforested". These three habitat types were all used less than expected in the analysis of the pooled data, and are generally found adjacent to one another in the higher elevations of the park.

Table 10: Availability and use of dominant vegetation types by 5 female black bears in GMNP from June to October, 1995.

Bear number	Sedge fen and bog	Heath-lichen tundra	Black spruce forest	Tuckamore	Balsam fir forest
	Ratio of observed locations to expected locations based on available habitat type				
Total[a] (n=181)	0/5.9[b]	1/15.2[b]	13.5/16.1	1/5.5[b]	165.5/138.3[b]

[a] Number of locations within habitat types significantly different from the number expected based on habitat availability ($\chi^2 = 28.56$, $P < 0.001$).

[b] Particular habitat type use significantly different from expected based on habitat availability (Bonferroni Z-test, $P = 0.05$).

Habitat use differed from habitat availability estimated by dominant vegetation type in spring/summer (χ^2 = 14.23, P < 0.001, n = 88) (Table 11), and late summer/fall (χ^2 = 14.33, P < 0.001, n = 93) (Table 12). In spring/summer bears used nonforested habitats less than expected, balsam fir forest more than expected, and black spruce forest and scrub according to availability (all tests P = 0.05, n = 88). The same patterns of use were observed in the late summer/fall (all tests P = 0.05, n = 93).

Habitat use was tested seasonally for forest management type. Habitat use differed from habitat availability by forest management type in spring/summer (χ^2 = 16.81, df = 2, P < 0.001, n = 87) (Table 13), and late summer/fall (χ^2 = 27.56, P < 0.001, n = 93) (Table 14). In spring/summer bears used nonforested areas less than expected (P = 0.05, n = 87), and logged areas and natural forest according to availability. In late summer/fall bears used nonforested areas less than expected (P = 0.05, n = 93), logged areas more than expected (P = 0.05, n = 93), and natural forest according to availability.

Table 11: Availability and use of dominant vegetation types by 5 female black bears in GMNP during spring/summer 1995.

Number of locations	Ratio of observed locations to expected locations based on available habitat type: Primarily non-forested	Black spruce forest and scrub	Balsam fir forest
Total[a] (*n*=88)	1/12.9[b]	6/7.8	81/67.2[b]

[a] Number of locations within habitat types significantly different from the number expected based on habitat availability ($\chi^2 = 14.23$, $P < 0.001$).

[b] Particular habitat type use significantly different from expected based on habitat availability (Bonferroni Z-test, $P = 0.05$).

Table 12: Availability and use of dominant vegetation types by 5 female black bears in GMNP during late summer/fall 1995.

Number of locations	Ratio of observed locations to expected locations based on available habitat type: Primarily non-forested	Black spruce forest and scrub	Balsam fir forest
Total[a] (*n*=93)	1/13.6[b]	7.5/8.3	84.5/71.1[b]

[a] Number of locations within habitat types significantly different from the number expected based on habitat availability ($\chi^2 = 14.33$, $P < 0.001$).

[b] Particular habitat type use significantly different from expected based on habitat availability (Bonferroni Z-test, $P = 0.05$).

Table 13: Availability and use of forest management types by 5 female black bears in GMNP during spring/summer 1995.

Number of locations	Ratio of observed locations to expected locations based on available habitat type: Non-forested	Forested areas within cutting blocks	Natural forest
Total[a] (*n*=87)	1/15.2[b]	30/22.3	56/49.5

[a] Number of locations within habitat types significantly different from the number expected based on habitat availability ($\chi^2 = 16.81$, $P < 0.001$).

[b] Particular habitat type use significantly different from expected based on habitat availability (Bonferroni Z-test, $P = 0.05$).

Table 14: Availability and use of forest management types by 5 female black bears in GMNP during late summer/fall 1995.

	Ratio of observed locations to expected locations based on available habitat type		
Number of locations	Nonforested	Forested areas within cutting blocks	Natural forest
Total[a] (n=93)	1/16.3[b]	41.5/23.8[b]	50.5/52.9

[a] Number of locations within habitat types significantly different from the number expected based on habitat availability ($\chi^2 = 27.56$, $P < 0.001$).

[b] Particular habitat type use significantly different from expected based on habitat availability (Bonferroni Z-test, $P = 0.05$).

Stand Level Habitat Selection

Of the 207 locations taken of the five adult females, 14 (7%) fell outside the park boundary and could not be assigned a habitat type; these locations were excluded from the habitat use analysis.

Habitat use of individual females within their home ranges could not be tested due to inadequate sample sizes; instead I pooled the results from all the females within their respective home ranges. The effective study area for the pooled results was strictly those areas contained within the home ranges of the females.

Bear use of dominant vegetation types within home ranges did not differ seasonally. In spring/summer females appeared to use unforested habitat types less than expected, however, habitat use did not differ from availability at the $P < 0.05$ level ($\chi^2 = 4.86$, df = 2, $P < 0.10$, n = 91) (Table 15). In the late summer/fall females used habitat types according to availability ($\chi^2 = 2.20$, df = 2, $P < 0.40$, n = 102) (Table 16).

Table 15: Availability and use of dominant vegetation types within the MCP home ranges of 5 female black bears in GMNP during spring/summer 1995.

Bear Number	Ratio of observed locations to expected locations based on available habitat within home range: Primarily nonforested	Black spruce forest and scrub	Balsam fir forest
F1 (10)	0/1.5	1/0.3	9/8.2
F2 (20)	0/1.3	1/0.1	19/18.6
F3 (25)	0/0.6	0/2.6	25/21.7
F4 (21)	1/1	3/5.2	17/14.9
F5 (15)	0/0.2	1/1.5	14/13.3
Total (*n*=91)	1/4.6	6/9.6	84/76.8

Table 16: Availability and use of dominant vegetation types within the MCP home ranges of 5 female black bears in GMNP during late summer/fall 1995.

Bear Number	Ratio of observed locations to expected locations based on available habitat within home range: Primarily nonforested	Black spruce forest and scrub	Balsam fir forest
F1 (21)	2/3.1	1.5/0.6	17.5/17.2
F2 (25)	0/1.7	1/0.1	24/23.3
F3 (15)	1/0.4	0/1.6	14/13
F4 (18)	0/0.8	5/4.4	13/12.8
F5 (23)	0/0.3	0/2.3	23/20.4
Total (*n*=102)	3/6.3	7.5/9	91.5/86.7

Habitat use within home ranges did not differ seasonally by forest management type. In the spring females again appeared to use nonforested habitat types less than expected, but difference in overall habitat use was not detected ($\chi^2 = 2.91$, df = 2, $P < 0.30$, $n = 90$) (Table 17). In the fall three out of five females appeared to use logged areas more than expected, but difference in overall habitat use was not detected ($\chi^2 = 4.43$, df = 2, $P < 0.20$, $n = 102$) (Table 18).

Table 17: Availability and use of forest management types within the MCP home ranges of 5 female black bears in GMNP during spring/summer 1995.

Bear Number	Ratio of observed locations to expected locations based on available habitat within home range		
	Non-forested	Forested areas within cutting blocks	Natural forest
F1 (10)	0/1.5	6/5.1	4/3.5
F2 (20)	0/1.3	7/11.5	13/7.2
F3 (25)	0/0.6	4/1.8	21/22.5
F4 (20)	1/0.9	14/12.8	5/6.2
F5 (15)	0/0.2	2/0.5	13/14.3
Total (n=90)	1/4.5	33/31.7	56/53.7

Table 18: Availability and use of forest management types within the MCP home ranges of 5 female black bears in GMNP during late summer/fall 1995.

Bear Number	Ratio of observed locations to expected locations based on available habitat within home range		
	Non-forested	Forested areas within cutting blocks	Natural forest
F1 (21)	2/3.1	14/10.6	5/7.3
F2 (25)	0/1.7	9/14.4	16/9
F3 (15)	1/0.4	9.5/1.1	4.5/13.5
F4 (18)	0/0.8	14/11.6	4/5.6
F5 (23)	0/0.3	1/0.8	22/22
Total (n=102)	3/6.3	47.5/38.4	51.5/57.3

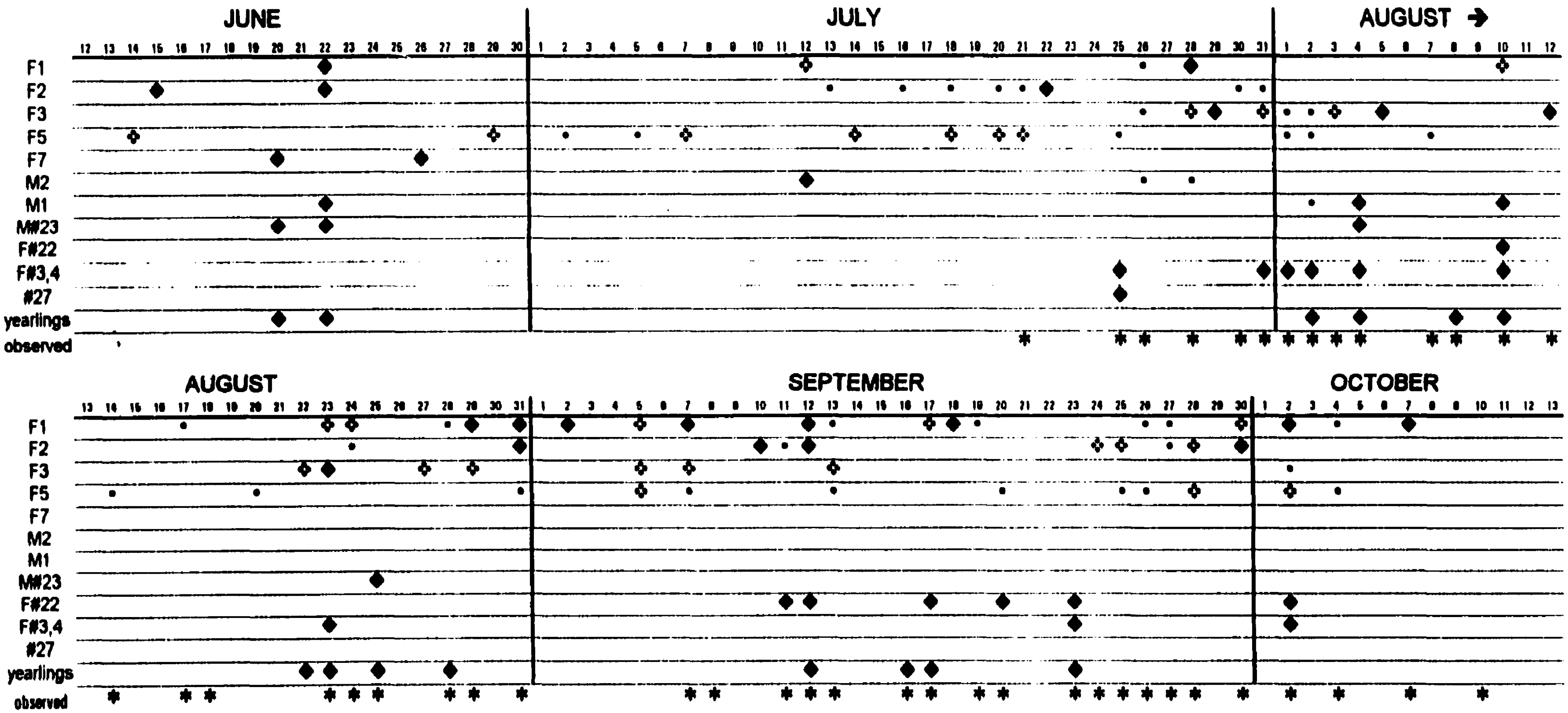
Use of Garbage Dumps

The two garbage dumps in the park were within the home ranges of five female bears radio-tracked regularly. None of these females had cubs in 1995. The Norris Point dump was within the home range of female F4, and the Lomond dump was within the home ranges of bears F1, F2, F3, and F5, all of whose home ranges overlapped in the immediate vicinity of the dump (Chapter 2).

I observed at the Lomond dump on 44 occasions from July 21 to Oct. 15 in 1995. I spent approximately 16.4 hours observing at the landfill site (average 22 min./observation). Twelve additional sightings of bears at the dump were reported by park employees and the dump caretaker. Each of the four females whose home ranges overlapped at the Lomond dump were sighted there at some point during 1995 (Figure 9). Three of these bears (F1, F2, and F5) were also seen at the dump during 1994.

In view of the periodic sightings of bears at the garbage dumps, I hypothesized that the dumps affected the bears' behaviour and that bear locations within their respective home ranges may be clustered around the garbage dumps. However, distances of observed locations from the respective dumps did not differ from 300 randomly generated distances within each bear's home range (all tests $P > 0.05$); bear locations within their home range were not clustered around the dump.

In 1994 female F1 was seen at the Lomond dump on only 3 occasions, fewer than the other marked bears. In contrast, in 1995, she was seen there on 10 occasions, more often than any of the other marked bears. Twelve of 35 radio locations (34%) taken in 1995 were within 2 km of the dump. She did not use the dump frequently in the early



◆ bear sighted at the dump by myself or park staff

✧ bear estimated/located within 1 km of dump

• bear located within 2 km of dump

* days I observed at the dump

Figure 9. Bears located at or near Lomond dump in 1995.

part of the summer, but was commonly seen there from late August until October 7.

In 1994 female F2 was commonly seen at the Lomond dump, eight times in July and August, and once in October. In 1995, however, she was sighted only four times from June to October. Thirteen of 48 radio locations (27%) of this bear in 1995 placed her within 2 km of the dump. She was sighted at the dump once in mid-July and was in the vicinity for one week, and did not appear to use the dump frequently again until the last week of September.

Female F3 was not observed at the Lomond dump at all in 1994. In 1995, she was not observed in the vicinity of the dump until the last week of July, when she was near the dump and sighted there twice over a ten day period. Then she apparently moved away from the dump, and was sighted there only once until the last week of August. She was located within 1 km of the dump occasionally from the last week of August until mid-September. Eleven of 45 radio locations (24%) of this bear placed her within 2 km of the dump.

In 1994 female F5 was seen at the Lomond dump three times in July and August. She was only seen there twice in 1995, in early June. Although she was not seen at the dump in July 1995, her radio locations frequently placed her within 1 and 2 km of the site. For the rest of the season she was occasionally within 2 km of the site. Twenty-one of 40 locations (53%) of bear F5 were within a 2 km radius of the dump.

Other bears seen at the Lomond dump in 1995 were 2 collared adult males (M1 and M2), another adult female (F7), one juvenile tagged male (#23), and two tagged yearling females (#22 and #3-4, who was an offspring of F2).

DISCUSSION

Adult female bears within GMNP showed habitat selection at the landscape level but not at the stand level. At a large scale (i.e., over the defined study area) they avoided nonforested areas and preferred balsam fir forested areas during both spring and summer. At a smaller scale (i.e., within the respective home ranges), however, they used the habitats according to availability. Similarly, bears preferred logged areas in the fall at the landscape level, but not at a stand level.

The difference in habitat use at two different spatial scales may suggest an adaptive strategy that defines bear habitat use. The detection of habitat selection at a landscape level may indicate that placement of a home range is more crucial to the overall fitness of a bear than the subsequent movements that it makes within its home range in a single year. The black bear is a long-lived animal, and although it has a low reproductive rate, its longevity allows for an impressive number of offspring throughout its lifetime. A black bear's lifetime reproductive output would be maximized if its spatial use patterns favoured its long-term survival (e.g., acquiring a relatively stable, defendable home range that meets nutritional and denning requirements) rather than its short-term needs (e.g., short-term foraging activities and movements). Therefore, habitat preferences may be more detectable at a landscape level than at a stand level.

In GMNP, female bear home ranges were found to overlap, although individuals avoided each other temporally within the overlapping portion of their respective ranges (see Chapter 3). This temporal avoidance attests to the long-term survival strategy of female bears in the study. Confrontation between two adult females may jeopardize their long-term survival; they may avoid each other at the cost of probable short-term foraging sacrifices. If I examined only habitat use of these bears at a small scale (i.e., within home ranges), social interactions such as mutual avoidance of bears may conceal the importance of certain habitats. Thomas and Taylor (1990) suggested that the study of habitat use strictly within an animal's home range may not be appropriate for management purposes, because resulting inferences may not hold at larger scales. The placement of a home range is itself an important selection process for an animal (Johnson 1980). Investigating bear use of habitats at multiple levels, including a landscape level, may therefore be more pertinent to management of the population as a whole.

The examination of habitat use on a landscape level suggested that the presence of logging activity affects bear use of an area. In the forested region of GMNP bears used the domestic harvest blocks more than expected and the natural forest less than expected in the fall. Costello and Sage (1994) reported that female adult bears used even-aged managed habitats more than expected and non-managed habitats less than expected in both spring and summer in the Adirondack region of New York. In contrast, Clark et al. (1994), conducting research in Arkansas, found low bear summer use of shortleaf pine regeneration areas, although bear foods were abundant in these sites.

Logging practices may affect how bears use the area. Clearcutting, which involves the removal of all trees in an area, may have different effects on bears than selective cutting, which involves the removal of individually selected trees from an area while leaving the bulk of the forest stand to grow. Unsworth et al. (1989) found that bears preferred selection cut shrubfields for feeding and avoided recent (<8 years old) clearcuts in summer. Young and Beecham (1986) found that bears preferred 20-40-year-old selection cuts in all seasons and avoided clearcuts during the same time intervals. They believed that selection cuts provided abundant food and available trees for escape cover. Clark et al. (1994) speculated that intensive pine management resulting in clearcuts may deter bears, possibly due to the lack of cover in these areas. Mollohan et al. (1989) found that female black bears did not use areas that did not provide adequate security, even if food was available. They suggested that habitat selection appeared to be based first on cover and secondarily on food.

Bears have been found to avoid clearcuts, especially those described as "recent" (Unsworth et al. 1989) or associated with intensive management (Jonkel and Cowan 1971, Clark et al. 1994). However, in some studies bears have been found to prefer clearcuts (Boileau et al. 1994, Sampson and Huot 1994). Bears in La Maurice National Park in Québec left the protected, fire suppressed forests of the park to forage in peripheral clearcuts in summer (Sampson and Huot 1994).

The scale of the clearcut operation likely influences bear use. Lindzey and Meslow (1977) suggested that the size and configuration of clearcuts, along with other factors, will influence density, dispersion, sex and age composition of groups of bears living in the proximity of the clearcuts. Young and Beecham (1986) proposed that the negative impact of individual clearcuts can be minimized by harvesting small and irregularly shaped areas in a rotation that precludes adjacent placement of cuts within a 20-year period. Unsworth et al. (1989) suggested that specific sites within clearcuts should be maintained for bedding and hiding cover.

The small scale cutting associated with the domestic harvest blocks and enclaves of GMNP provide both early successional plants and the escape cover that bears appear to require. Bears did not avoid these areas at any time of the year, and they preferred them to the non-harvested forest in the late summer/fall. The preferential use of these areas corresponds to the ripening of early successional berry species such as *Rubus*. The increased consumption of such berry species in the late summer/fall (Chapter 2) affirms the importance of these disturbed areas.

Two separate populations of bears within GMNP have been proposed: those that primarily use the high country and those that primarily use the low country (S. Mahoney, pers. comm.). This study was not designed to examine the existence of two such populations, and trapping efforts primarily focused on bears occupying the lower elevations. If two distinct bear populations exist, the present study only examined the habitat use of the low country population of bears, which avoided higher-elevation habitats including heath lichen tundra and sedge fen and bog.

Bear use of the higher elevations was evidenced by tracking two bears that were captured later in the season of 1995. An adult female (F8) with 3 cubs was captured late in summer 1995 in a low country snare that was less than 1 km from heath lichen tundra. She was collared but could thereafter not be located by regular ground telemetry and was located 9 times by satellite and aerial telemetry. Three of nine of her locations placed her in heath lichen tundra, and the rest of her locations were in balsam fir forest. A second female with three cubs, F9, was darted from a helicopter in September 1995 in the high country region of the park. She also could not be located by ground telemetry and was located 3 times in 1995 by satellite. All three satellite locations indicated that she was in heath lichen tundra, which suggests that tundra may be her primary habitat. The collection and contents of bear scat in the high country (Chapter 2) indicated that bears are foraging in the tundra region, using food sources abundant on the barrens at certain times of the year.

All radio-tracking activities were restricted to daylight hours during this study, and nocturnal activity was not measured. I believe that some bears in the GMNP were nocturnal to a certain degree, or at least crepuscular, as bear use of the garbage dump increased at sunset. Nocturnal habits of bears may result from human-induced modifications to the environment (Ayres et al. 1986), whereas bears exhibit a diurnal pattern of activity in natural environments (Ayres et al. 1986, Lariviere et al. 1994). However, sightings at the dump of four of five collared females (F1, F2, F3, F5) during the day, further sightings of female F2 feeding near roadsides with her yearlings during the day, and 5-hour tracking of female F4 during the day in August 1995 indicate that these female bears exhibit some degree of diurnal activity. In another preliminary study in western Newfoundland, 24-hour monitoring periods indicated that two females bears were most active around dawn and early afternoon (Dennis et al. 1996). These two females were inactive from near midnight to an hour before dawn.

The Lomond landfill site appeared to attract bears to a certain degree, but did not significantly affect movements within their respective home ranges. Locations within the home ranges of the animals were not significantly clumped around the garbage dump. However, all five females home ranges overlapped one of two dumps within the park

(Chapter 3). This indicates that the garbage dumps may have affected bear movements at a larger scale, and likely the shape of the home ranges were influenced by the dumps. Of the 239 locations taken of all the bears captured in the lower elevations of the park, 65 (27.2%) of these were within 2 km of the Lomond dump. Earle (1995) found that 26% of all his telemetry locations were within a 2 km radius of the dump in his study area. Of the 168 locations of four female bears known to use the Lomond landfill site in the present study, 57 (33.9%) were within a 2 km radius of the dump.

In conclusion, female bears in the lowland region of GMNP appeared to prefer forested regions over non-forested regions throughout the year and disturbed forest over natural forest in the late summer/fall. Although the lowland bears avoided habitats associated with higher elevations, use of these areas was recorded for 2 animals captured late in the season. The female bears in the low country were frequently located in the vicinity of a garbage dump, but the presence of the dump did not appear to affect the animals' use of the rest of their home ranges.

CHAPTER FIVE: GENERAL DISCUSSION

The diet of black bears in Newfoundland resembles black bear diets in other boreal forest regions such as those located in Alberta, Manitoba, and Québec. The most commonly used berry species in this study were *Rubus* spp., which are typical of disturbed habitats. Raspberries and related species were also the most common species that were reported as heavily used by bears in other studies in boreal forest and mixed-wood regions (Costello 1992, Boileau et al 1994, Samson and Huot 1994). Mountain ash berries and the berries of *Vaccinium* spp. were other seral species commonly eaten by bears in Newfoundland.

The food habits and radio telemetry data of the present study indicate that bears benefit from moderate habitat disturbance. An area that has been logged or cut is transformed to an early successional stage, which favours the growth of seral plant communities. Increases in soft mast production following cutting have been observed in many regions (Rogers 1976, Lindzey and Meslow 1977, Noyce and Coy 1990, Clark et al. 1994, Costello and Sage 1994). Irwin and Hammond (1985) recommended maintaining a mosaic of successional stages, including clearcutting (<10 ha), to benefit bears in Wyoming.

Fire and insect damage also serve to open forest canopy and may be beneficial to bears. Bears were found to use burned habitats more than non-managed habitats in the Adirondack Mountain region of New York (Costello and Sage 1994). Bears were found to use insect damaged areas more than expected in Gaspésie Park in Québec (Boileau et al. 1994).

Although the GMNP region has little fire history due to the general wetness of the area, it has had some insect damage throughout its recent past (Hudak et al. 1989). In 1988, the GMNP region was subjected to moderate to severe defoliation by the hemlock looper, *Lambdina fiscellaria* (Hudak et al. 1989). The native hemlock looper and spruce budworm (*Choristoneura fumiferana*), and the introduced balsam woolly adelgid (*Adelges piceae*) are insect pests which have caused extensive tree mortality in Newfoundland in recent decades (Hudak and Raske 1995). Naturally disturbed areas in GMNP, along with the human-disturbed domestic harvest blocks, undoubtedly have increased diversity of plant species as a result of the disturbance. Bear use of insect-damaged areas was not measured in the present study. Bears were found to use the domestic harvest blocks more than expected and the uncut forest less than expected during the late summer/fall.

This study primarily focused on bears in a forested region. Bears are generally thought to be reliant on some type of forested habitat. Herrero (1972) proposed that open habitats cannot be fully exploited by black bears due to the female's requirement of forest cover when raising cubs. Bears in GMNP, however, exploit the open habitats that occur at higher elevations in the Long Range Mountains. Two collared females, both with a litter of 3 cubs, were sighted and radio-located on the barrens several times throughout the study. Recent research in northern Labrador has also documented the existence of black bears in open barrens hundreds of kilometers from forested areas (Veitch 1995).

Analysis of bear scat collected in tundra regions of GMNP indicated elements of their diet that were similar to black bear diets in the more northern parts of their range such as Alaska and the Yukon. Black bears exploited both animal and plant food sources in the higher elevations of GMNP. Caribou calves, usually born in early June, are frequently consumed by black bears in the tundra over the summer. Black crowberry, a fruit abundant in the tundra in the late summer, was also commonly eaten by bears in the tundra when it was available.

Management Implications

The bears in the present study may have benefited from some human activities, using garbage dumps and cut over areas. However, prior to the study, bears were commonly shot at the Lomond landfill site because they were seen as "nuisance" animals (Porter 1990). Bears using landfill sites are exposed to humans more than bears in the wild, and the resulting habituation may lead to more human/bear encounters and more instances of "problem" bears. Bears using landfill sites are commonly viewed as "pests" that are dependent on unnatural food sources and therefore expendable. To eliminate the risk of bear encounter at landfill sites, they need to be made inaccessible to bears.

Agriculture, forestry, and industry have fragmented important black bear habitats across North America (Kellyhouse 1980, Mattson 1990, Hellgren and Maehr 1992). This reduction of habitat has resulted in local extirpations and isolation of black bear populations (Maehr 1984, Hellgren and Maehr 1992). In Newfoundland, commercial timber harvesting and the establishment of timber roads are making vast tracts of land more accessible to humans than ever before. New roads constructed by forest harvesters result in influxes of hunters, trappers, fishermen, and ATVs, in addition to the commercial loggers for whom they were built. The present study showed that bears profit from small scale forestry, due to the presence of early successional species in disturbed areas. Forestry practices such as soil scarification and the use of herbicides inhibit the growth of seral species, and would likely negate any benefits that the logging operations inadvertently provide.

Other northern mammal species have been found to benefit from habitat disturbance. Peck and Peek (1991) recommended the continuation of prescribed burning in British Columbia to create and maintain elk (*Cervus elaphus*) range. Poole et al. (1996) suggested that wildfires in the Northwest Territories provide a variety of successional stages which may enhance habitat conditions for snowshoe hare and lynx (*Lynx canadensis*). On the other hand, Ouelett et al. (1996) found that caribou in southeastern Québec appear to rely on mature forests where they feed heavily on arboreal lichens, and suggested that logging activities would be deleterious to caribou.

Investigations into the ecology of wildlife populations enables resource managers to make well-informed decisions about maintaining optimal habitat conditions. Future research should focus on the effects of human resource use on wildlife. Managers should assess the effects of intensive forestry practices, which increase the efficiency of harvesting operations often to the detriment of wildlife. It must be widely recognized that a monoculture of planted trees is not a "forest", and that such human encroachment ultimately results in ecological deserts.

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APPENDICES

Appendix I: Analysis of Black Bear Scats

1. Scats were completely thawed and weighed.

2. Scats were placed in a large beaker (1000-2000 ml), and 3 ml of water was added for each gram of scat. The resulting mixture was stirred and allowed to stand 30 minutes to several hours depending on consistency and condition of the scat. This procedure rehydrates desiccated scats, separates individual food items and helps restore food items to their original shape and color.

3. When the scat became rehydrated, it was uniformly mixed with the water until the mixture appeared homogenous. Then 240 ml of the mixture was removed by using a 60 ml plastic scoop, while re-mixing the solution frequently. Two hundred and forty ml of mixture is approximately 180 g of water and 60 g of scat.

4. The 240 ml of mixture was poured on to nested sieves. The scats were washed thoroughly through the sieves using a spray nozzle with moderate water pressure. The following Canadian Standard Sieve sizes were used: No. 4 (4.74 mm mesh) for separating large items such as grass bits and whole leaves; No. 10 (2.00 mm mesh) for separating items such as ants and berries; and No. 40 (0.42 mm mesh) for separating out small seeds such as those of *Vaccinium* spp., sand or dirt, if present, and any fragments of larger items.

5. Using a spray nozzle, the largest mesh sieve was be backwashed into a clean 250 x 400 x 60 mm white enamel pan.

6. The pan contents were carefully examined by removing them from the pan with forceps and placing all like items together in a petri dish. If the majority of a scat was composed of one food item then other material was removed with forceps.

7. The enamel pan was emptied and cleaned, and steps 5-6 were repeated for the next largest mesh size, then for the next smallest mesh size.

8. The remainder of the scat/water mixture was poured from the beaker through the sieves as described above and grossly examined for items not seen before. The contents of each sieve were examined but not physically separated. The purpose of this step was to locate any items that were not found before and to determine if the remaining items that were already found are present in about the same proportions as previously encountered.

9. The volume of the scat that the various food items comprised was visually estimated. Percent volume categories of 0, 0-trace, trace-5%, 6-25%, 26-50%, 51-75%, and 76-100% were used.

10. Any unknown specimens were isolated from the sample and later identified.

Appendix II: Identification of Hair Samples

Hair samples collected from scats and stomachs were washed with ethanol and a fine brush and allowed to dry. They were then placed on a strip of acetate transparency paper and placed on a standard microscope slide. Another slide was then placed on top of the sample, and the two slides were clamped together using large "butterfly" paper clips. The samples were then placed in an oven at 250° F for 20 minutes. This step caused the acetate to melt slightly and caused the hair samples to leave an impression in the acetate. The samples were then removed from the oven and allowed to cool to room temperature. The uppermost slide was carefully removed. Each individual hair strand was then displaced a few millimeters from where it was attached to the acetate strip, revealing the impression left by the hair on the acetate. The impression and the hair itself could then be viewed using a compound microscope at 100x and 400x.

Appendix III: Food Items in Bear Scat and Stomach Samples

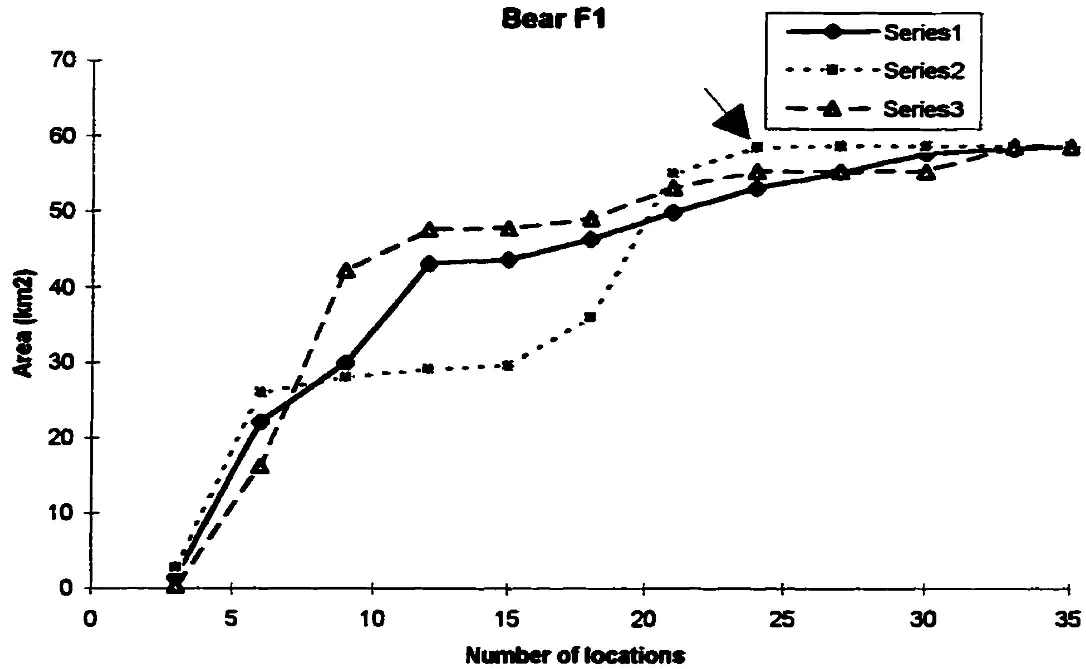
COMMON NAME	SCIENTIFIC NAME or TAXONOMIC GROUP
GREEN VEGETATION	
Grasses	Poaceae
Leaves	Leaves
Moss	Moss
Horsetails.	*Equisetum* sp.
Dandelion	*Taraxacum officinale*
Needles	*Abies balsamea* and *Picea marina*
Cow parsnip	*Heracleum maximum*
Ferns	Ferns
Seaweed	Seaweed
Unknown green veg.	Unknown green veg.
Wood debris	Unknown
Roots	Unknown
Lichens	Unknown
FRUITS	
Chuckley-pears	*Amelanchier spp.*
Wild Sarsaparilla	*Aralia nudicaulis*
Alpine Bearberry	*Arctostaphylos alpina*
Black Chokeberry	*Aronia melanocarpa*
Bunchberry	*Cornus canadensis*
Red Osier Dogwood	*Cornus stolonifera*
Crowberries	*Empetrum spp.*
Fragaria sp.	*Fragaria sp.*
Creeping Snowberry	*Gaultheria hispidula*
Alder-leaved Buckthorn	*Rhamnus alnifolia*
Baked Apple	*Rubus chamaemorus*
Raspberries.	*Rubus spp.*
Red Elderberry	*Sambucus pubens*
Smilacina sp.	*Smilacina sp.*
American Mountain Ash	*Sorbus americana*
Twisted-stalk	*Streptopus roseus*
Blueberries	*Vaccinium spp.*
Mountain Cranberries	*Vaccinium vitis-idea*
Squashberry	*Viburnum edule*
Highbush Cranberry	*Viburnum trilobum*
Unknown fruit	Unknown
ANIMAL REMAINS	
Flesh	Unknown
Moose hair	*Alces alces*
Caribou hair	*Rangifer tarandrus*
Cervidae young hair	Cervidae
Beaver hair	*Castor canadensis*
Snowshoe hare hair	*Lepus americanus*
Black bear hair	*Ursus americanus*
Unknown hair	Unknown
Bone	Bone
Feathers	Aves
Ants	Formicidae
Maggots	Diptera
Unknown insects	Unknown
GARBAGE	Garbage
UNKNOWN MATERIAL	Unknown

Appendix IV: Determining the Number of Locations Required to Calculate Home-Range Sizes.

The minimum convex polygon (MCP) method is more robust than other home range estimators when the number of locations is low (Harris et al. 1990). However, as with other home range estimators, home range sizes estimated using the MCP method increase with additional animal locations until an point is reached where more locations result in little or no observed increase (Odum and Kuenzler 1955). In the present study I attempted to determine the number of locations required to estimate the MCP home range size.

I created location-area graphs for each bear in the study that was located at least 10 times or more during 1995. For each bear, I randomly chose 3 locations and calculated a home range size using the 100% MCP estimator with the computer program HOME RANGE (Ackerman et al. 1990). Then I randomly chose three more locations, for a total of 6 locations, and calculated a new home range size. I repeated this procedure until all locations taken between June and October of 1995 were added. This process allowed me to construct a location-area graph series for this individual. I constructed three such series for each bear (Figure 1).

I assumed that the number of individual locations was large enough for a particular bear if 2 of 3 series reached a point at which adding additional locations did not increase the home range size by more than 3% for at least 2 consecutive additions (each addition consisting of 3 locations). At this point the location-home range size series leveled off to a certain extent and was considered relatively stable even after the addition of subsequent locations. For each bear that met this criterion, I determined the number of locations where home range stability was reached. Five bears, females F1, F2, F3, F4 and F5, met this criterion and the number of locations required was 24, 24, 36, 21, and 24, respectively (average 25.8 locations). Adult male M2 did not meet the criterion, and 13 locations were insufficient to determine a home range.



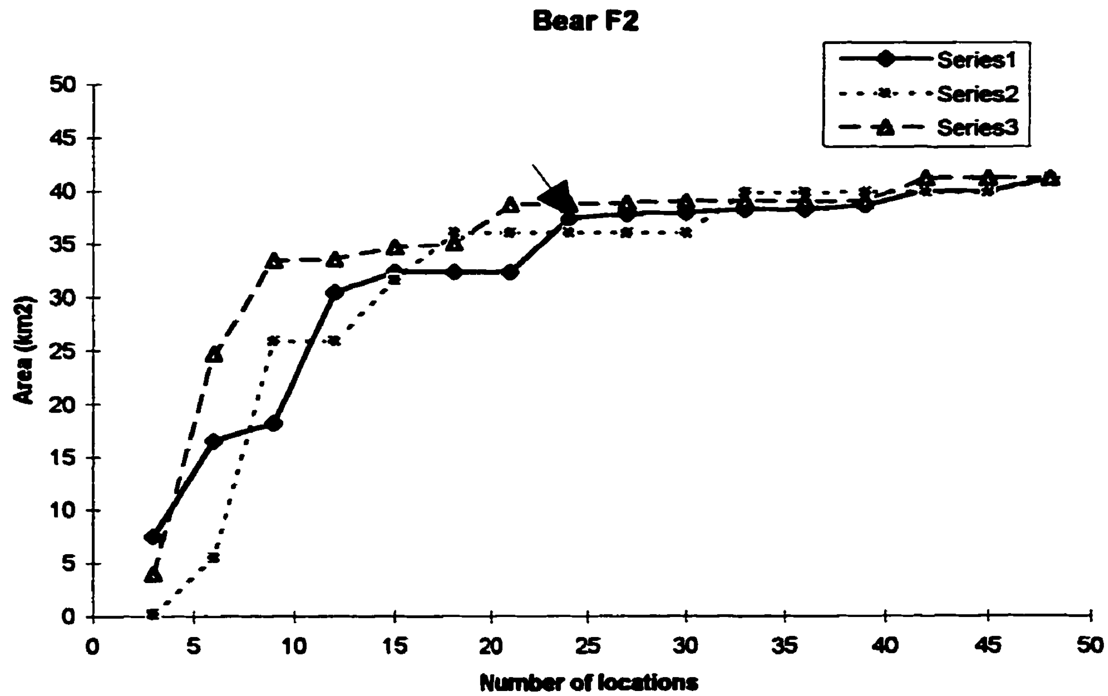
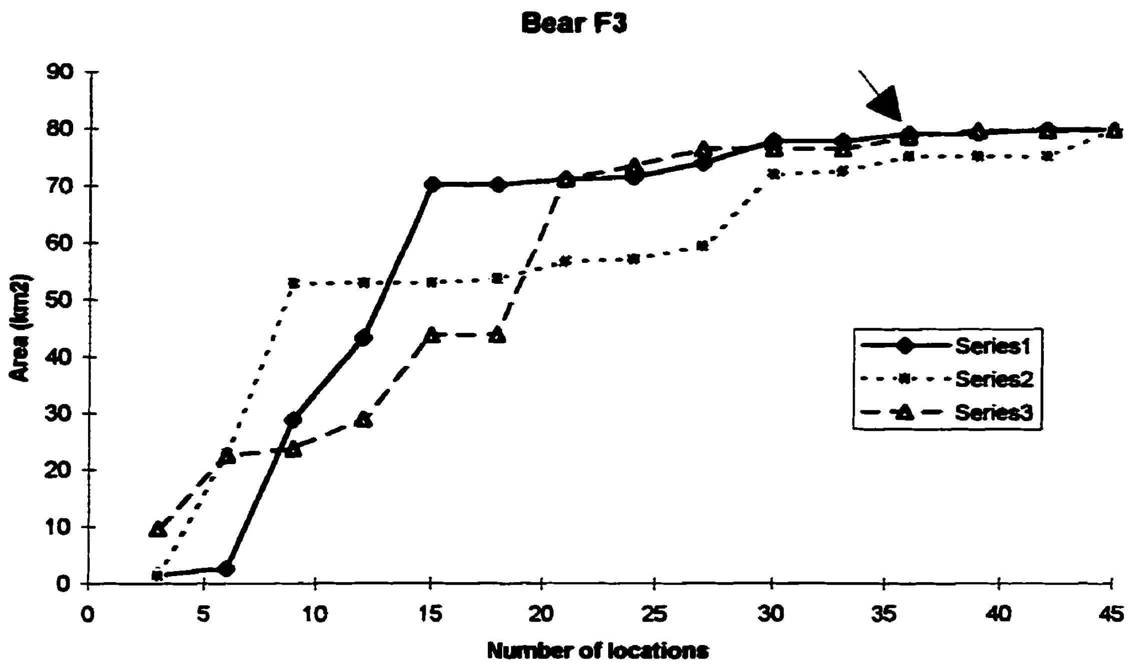


Figure 1: Location-home range size charts for bears monitored in 1995. Arrows indicate the point at which I estimated sufficient locations were collected to determine home range size.



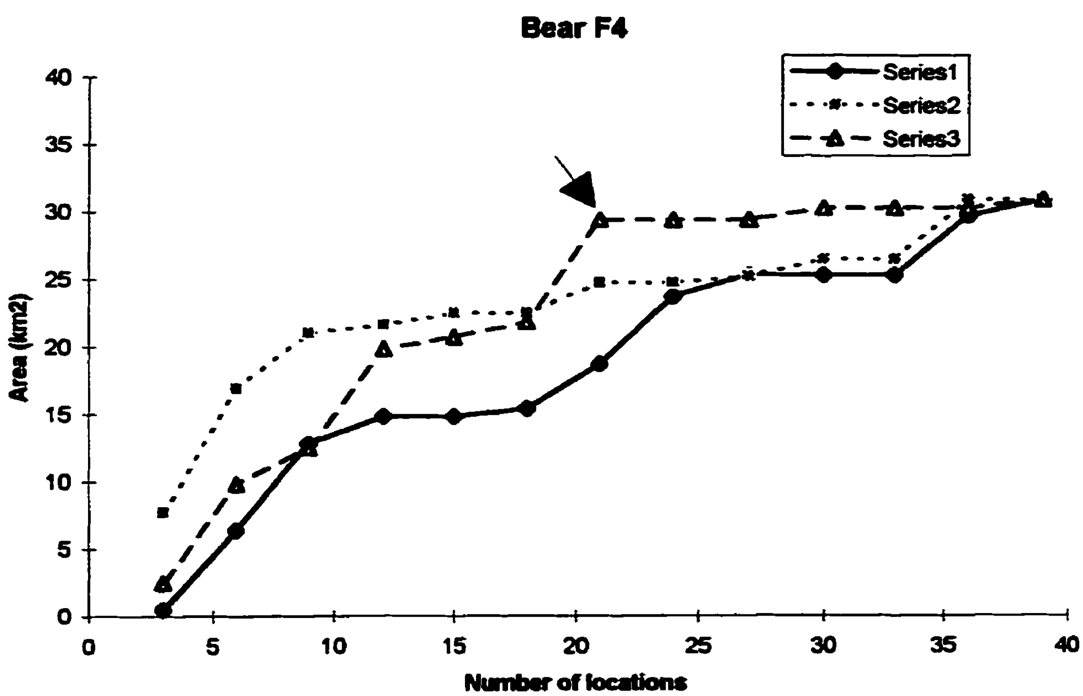
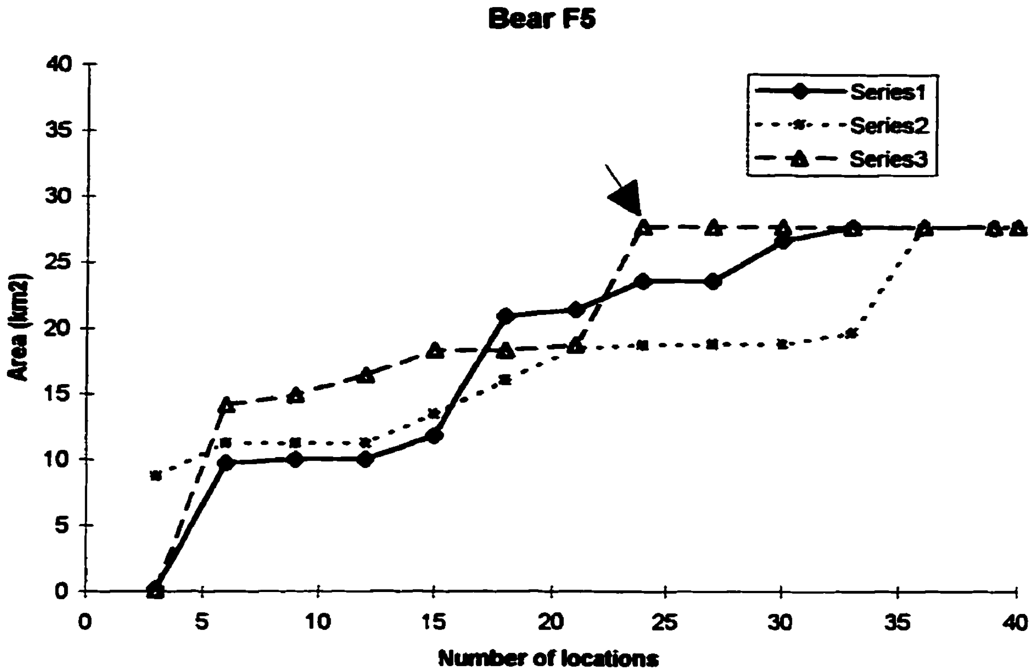


Figure 1 (continued): Location-home range size charts for bears monitored in 1995. Arrows indicate the point at which I estimated sufficient locations were collected to determine home range size.



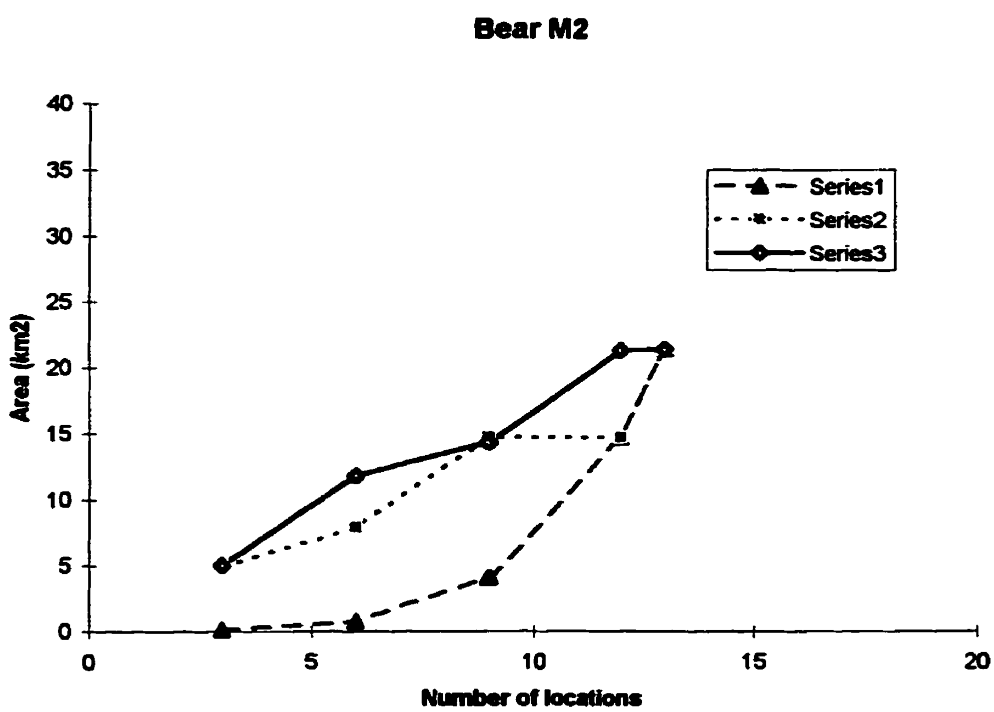


Figure 1 (continued): Location-home range size charts for bears monitored in 1995. Arrows indicate the point at which I estimated sufficient locations were collected to determine home range size.

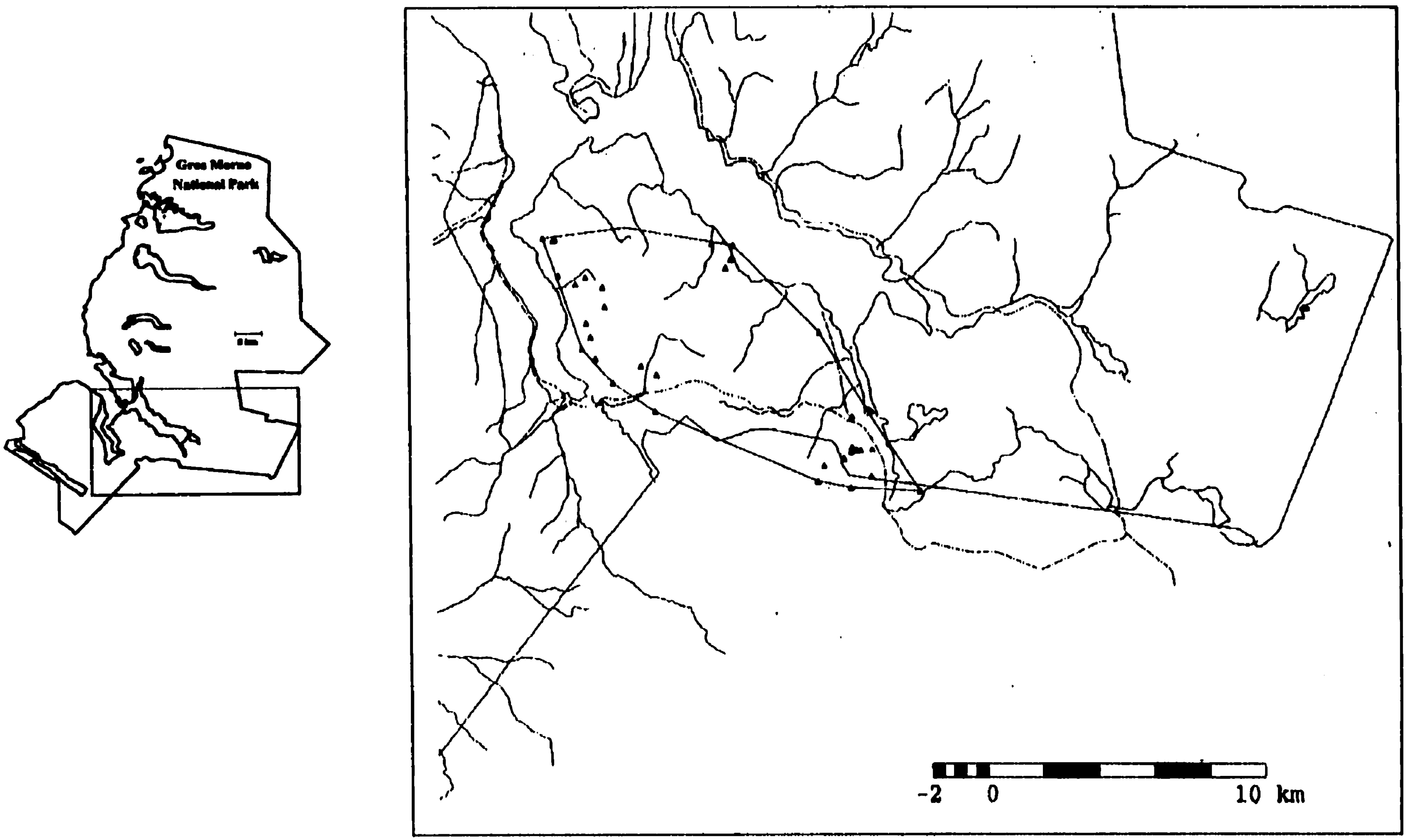
Appendix V. Black Bear Captures in GMNP from 1993-1995.

APPENDIX V: Black bear captures in Gros Morne National Park, 1993-1995.

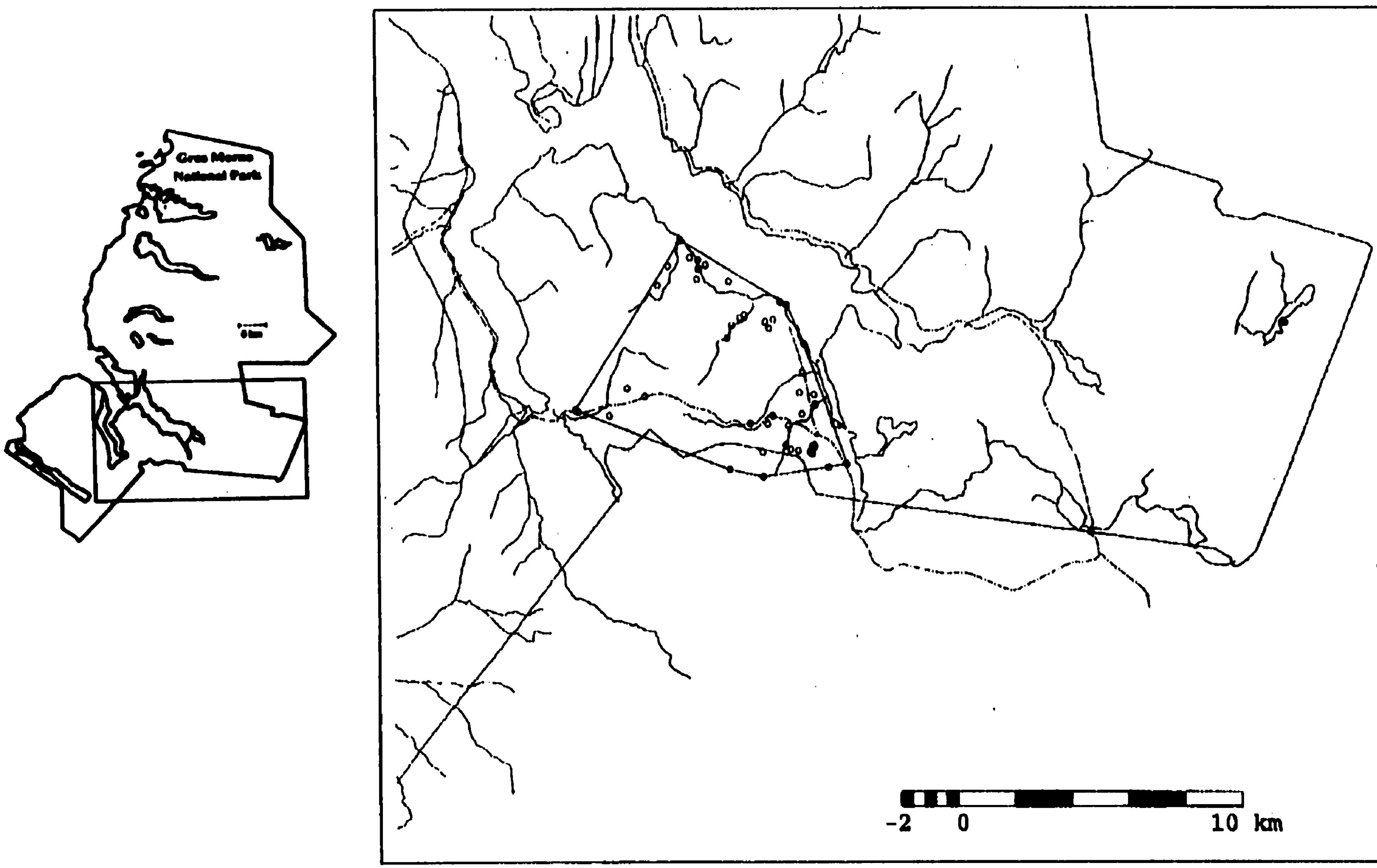
Date of init. capture	No.	Sex	EAR TAGS Left	Right	Collar	Initial capture location	Weight	Recapture date	Recollared	Reproductive history[a]
9-Jul-93	F931	F	13 red	-	slipped	Lomond dump road	120kg (est)			unknown
11-Jul-93	M931	M	-	8 blue	-	0.5 km E Lomond	39kg			
18-Jul-93	F1	F		12 red	slipped	Lomond dump, free dart	60 kg (est)	22-Jun-95	150.110	3 cubs 1994
20-Jul-93	M932	M	9 blue	-	-	2 km S Lomond bound.	53 kg			
29-Jul-93	M933	M	10 blue	-	-	Lomond dump culvert	39 kg			
6-Aug-93	F933	F	-	11 red	-	0.5 km E Lomond road	45 kg			juvenile
16-Jul-94	F2	F	2 yellow	1 yellow	slipped	100m W Lomond road	71 kg	15-Jun-95	150.210	2 cubs 1994
2-Aug-94	F942	F	3 yellow	4 yellow	-	Lomond dump road	12 kg			juvenile
13-Aug-94	F3	F	5 yellow	6 yellow	148.764	Dicks Brook snare	63 kg			3 cubs 1994
14-Aug-94	F944	F	8 yellow	9 yellow	-	0.5 km E Lomond road	54 kg			juvenile
20-Aug-94	F4	F	22 yellow	21 yellow	148.785	Norris Point Boundary	79 kg	11-Aug-95		no cubs seen in 1994 or 1995
26-Aug-94	M941	M	-	23 yellow	-	Lomond dump culvert	59 kg (est)	8-Jun-95	slipped	
2-Sep-94	F5	F	10 yellow	15 yellow	148.795	Lomond dump culvert	94 kg			3 cubs 1994
4-Sep-94	F6	F	11 yellow	12 yellow	148.774	Tuckers Brook snare	39 kg			juvenile
9-Sep-94	M942	M	7 yellow	20 yellow	slipped	Lomond dump culvert	111 kg			
8-Jun-95	F951	F	-	23 orange	-	Lomond dump culvert	26 kg			juvenile
22-Jun-95	M1	M	17 blue	18 blue	149.630	Lomond dump free dart	190 kg (est)			
26-Jun-95	F7	F	183 yellow	184 yellow	slipped	Lomond dump culvert				3 cubs 1994
12-Jul-95	M2	M	25 blue	24 blue	148.774	Rocky Barachois culvert	125 kg (est)			
30-Aug-95	F8	F	180 yellow	179 yellow	150.890	Rocky Barachois culvert	59 kg			3 cubs 1995
22-Sep-95	F9	F	188 yellow	-	150.170	North Rim, helicopter	59 kg (est)			3 cubs 1995

[a] determined from sightings of bears.

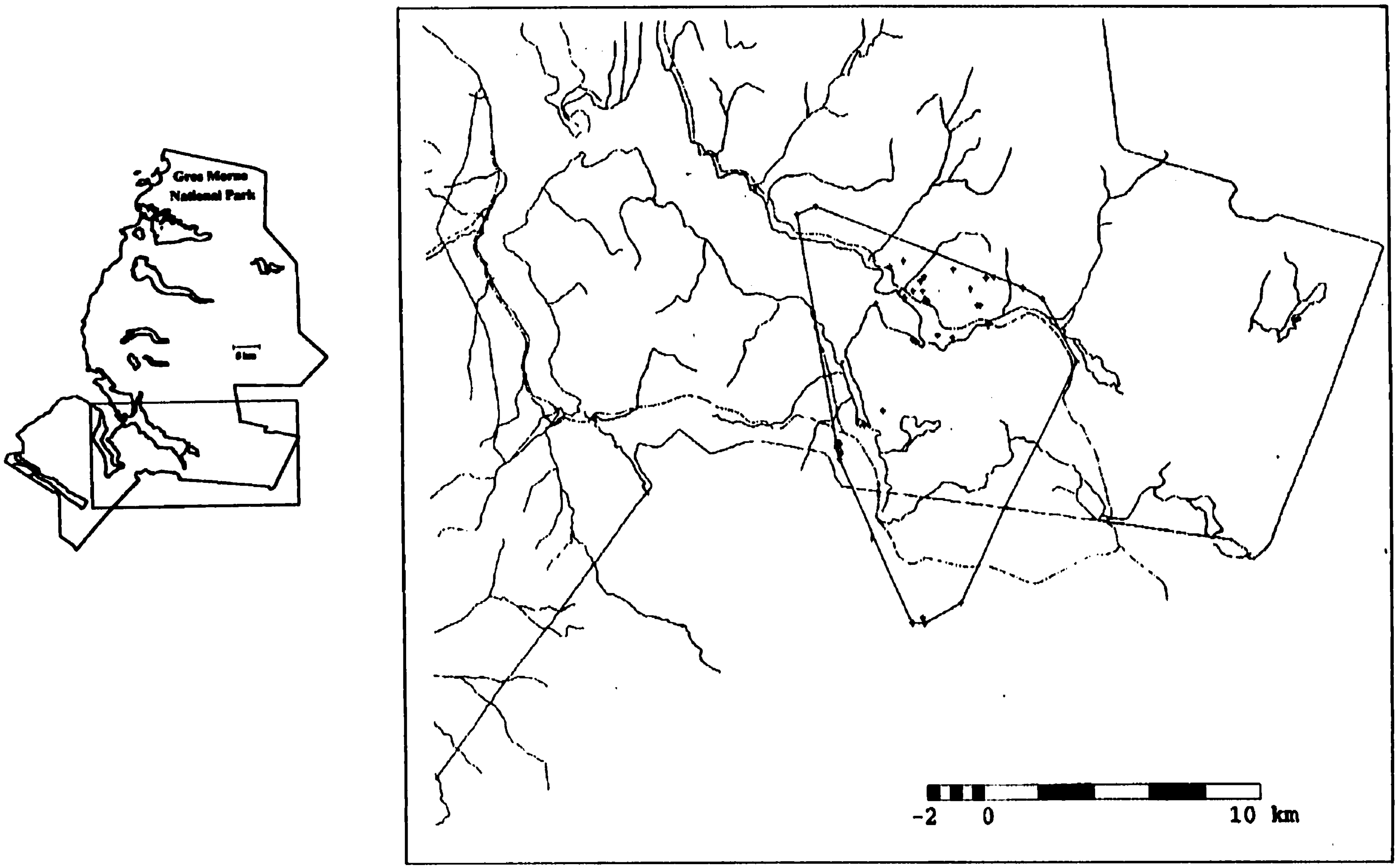
Appendix VI: Home Ranges of Adult Females in GMNP during 1995.



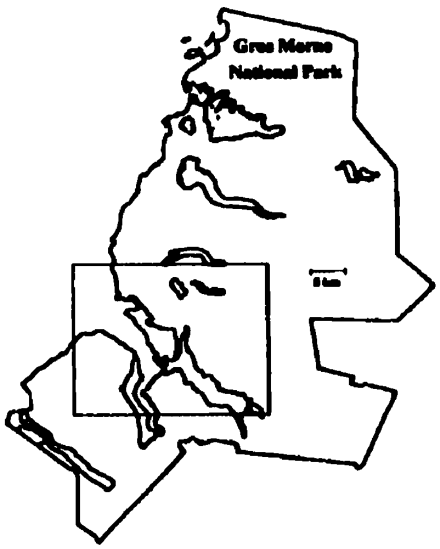
Appendix VI (continued). Home range of adult female bear F1 during 1995.

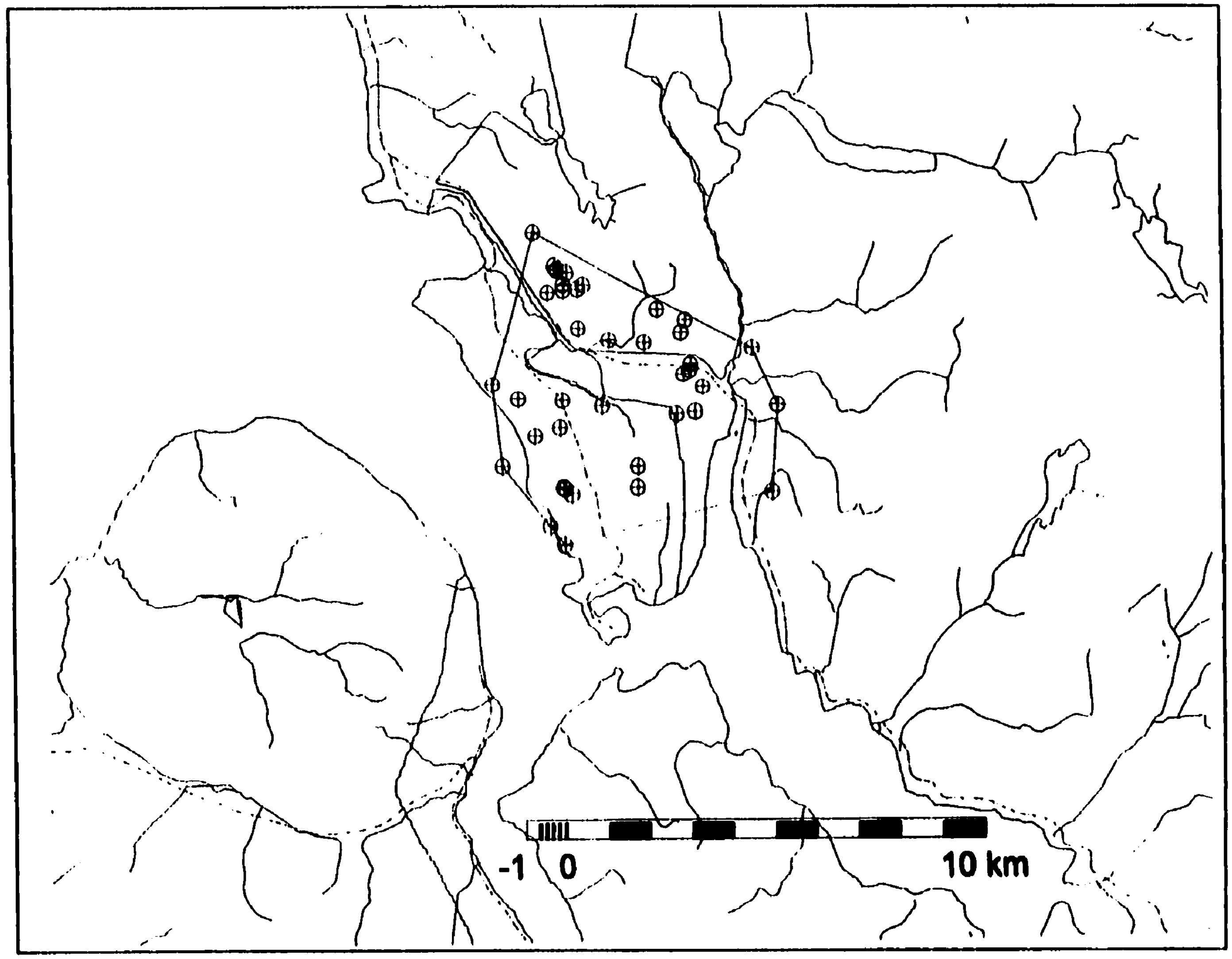


Appendix VI (continued). Home range of adult female bear F2 during 1995.

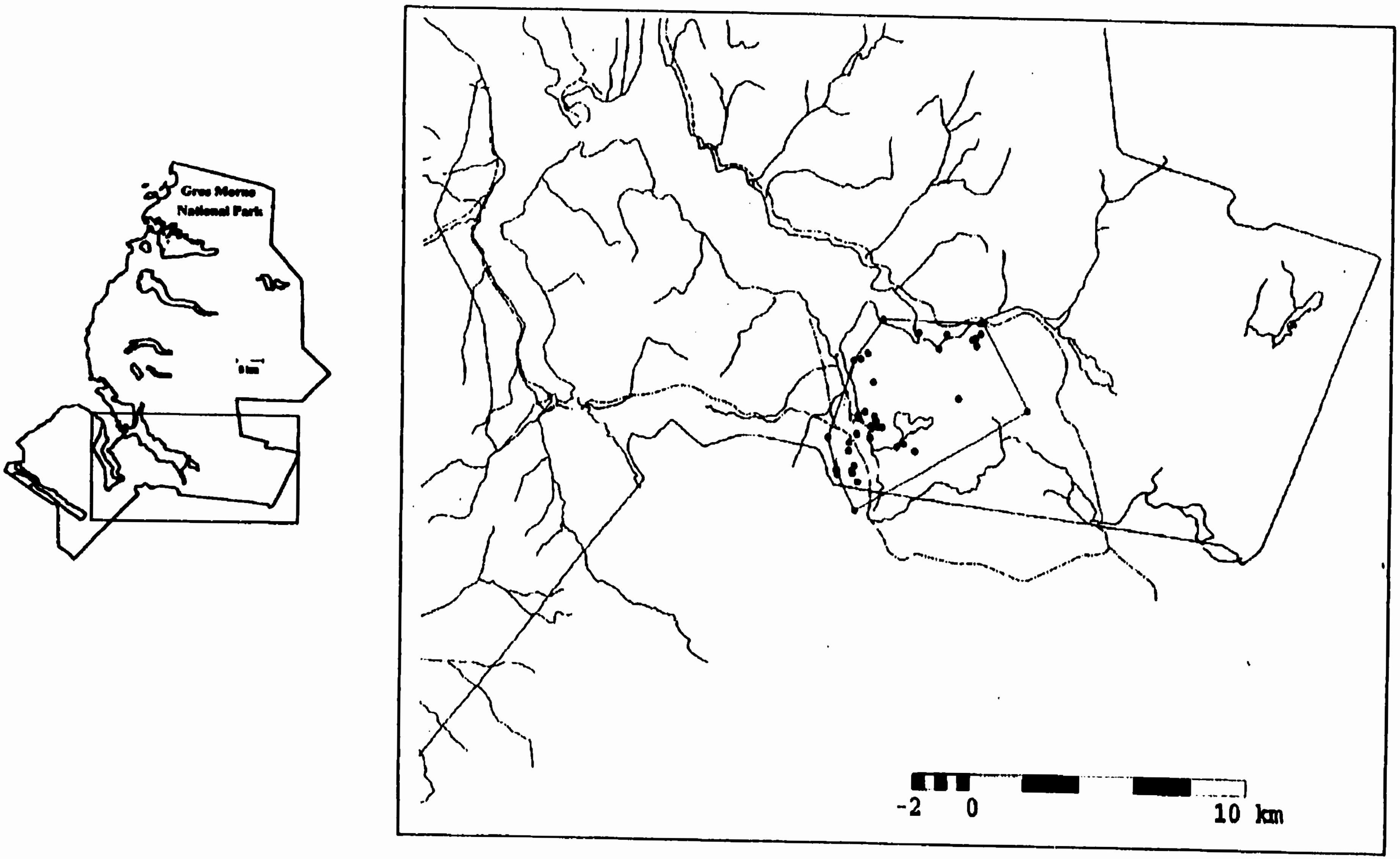


Appendix VI (continued). Home range of female bear F3 during 1995.



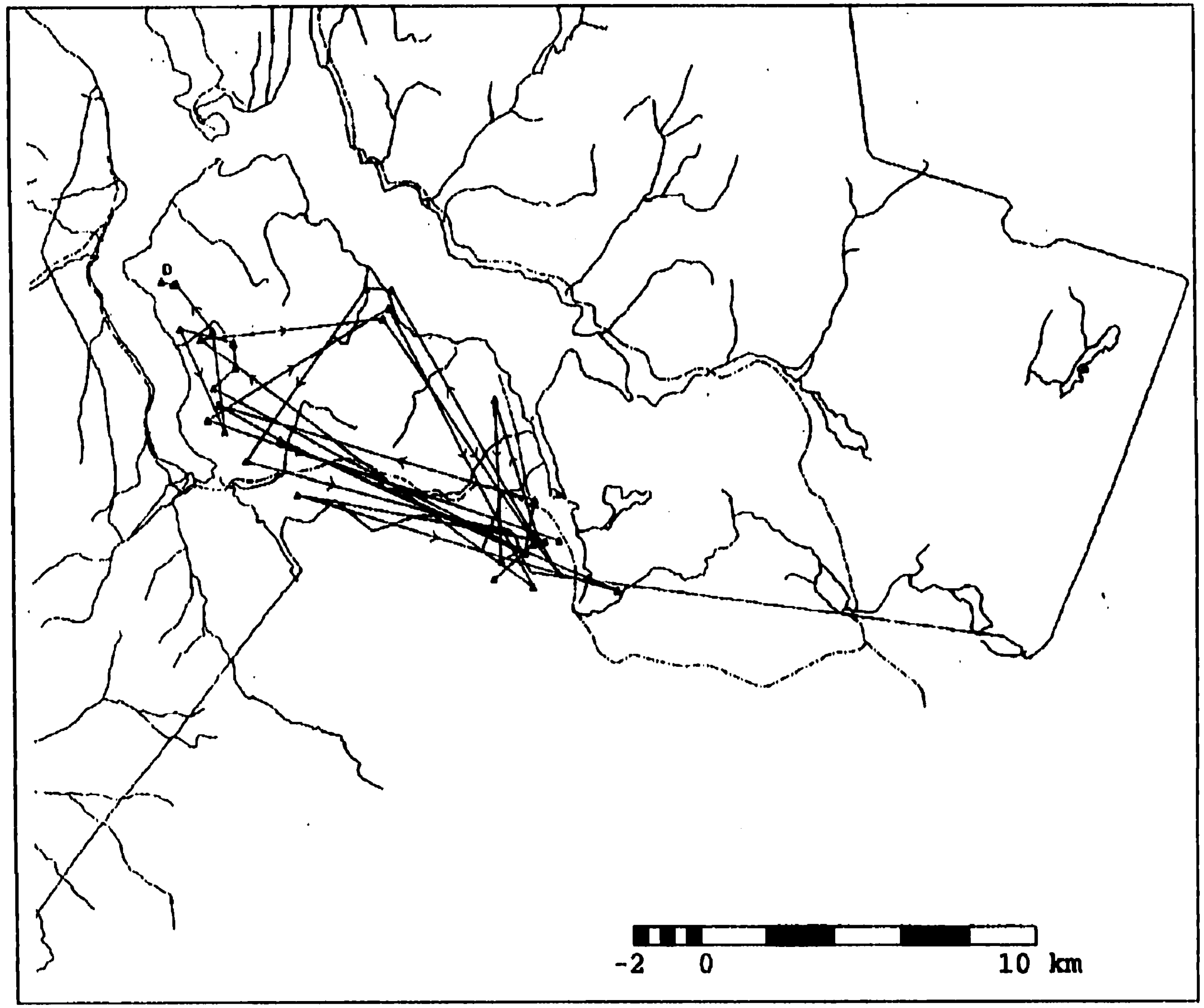


Appendix VI (continued). Home range of female bear F4 during 1995.

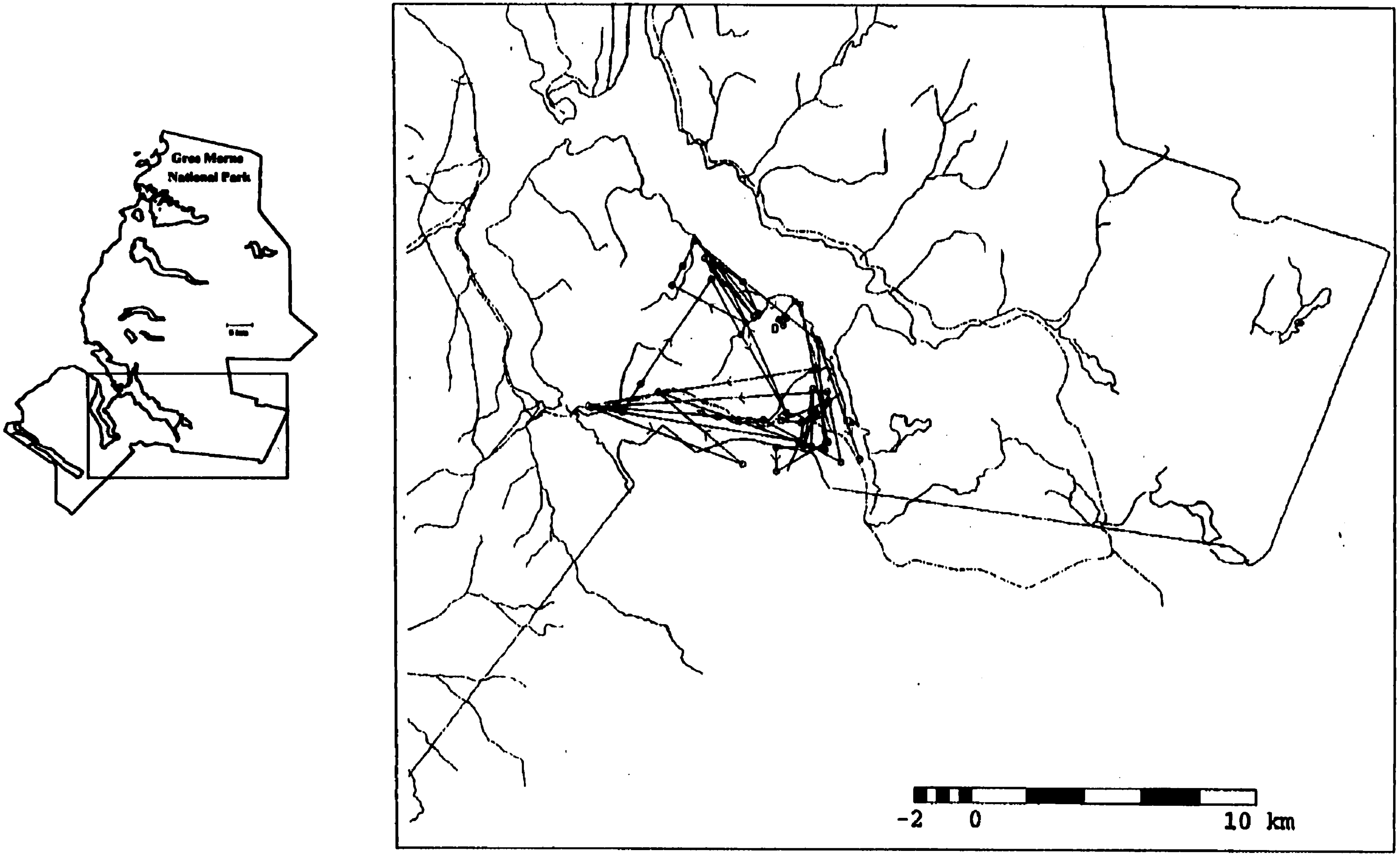


Appendix VI (continued). Home range of adult female bear F5 during 1995.

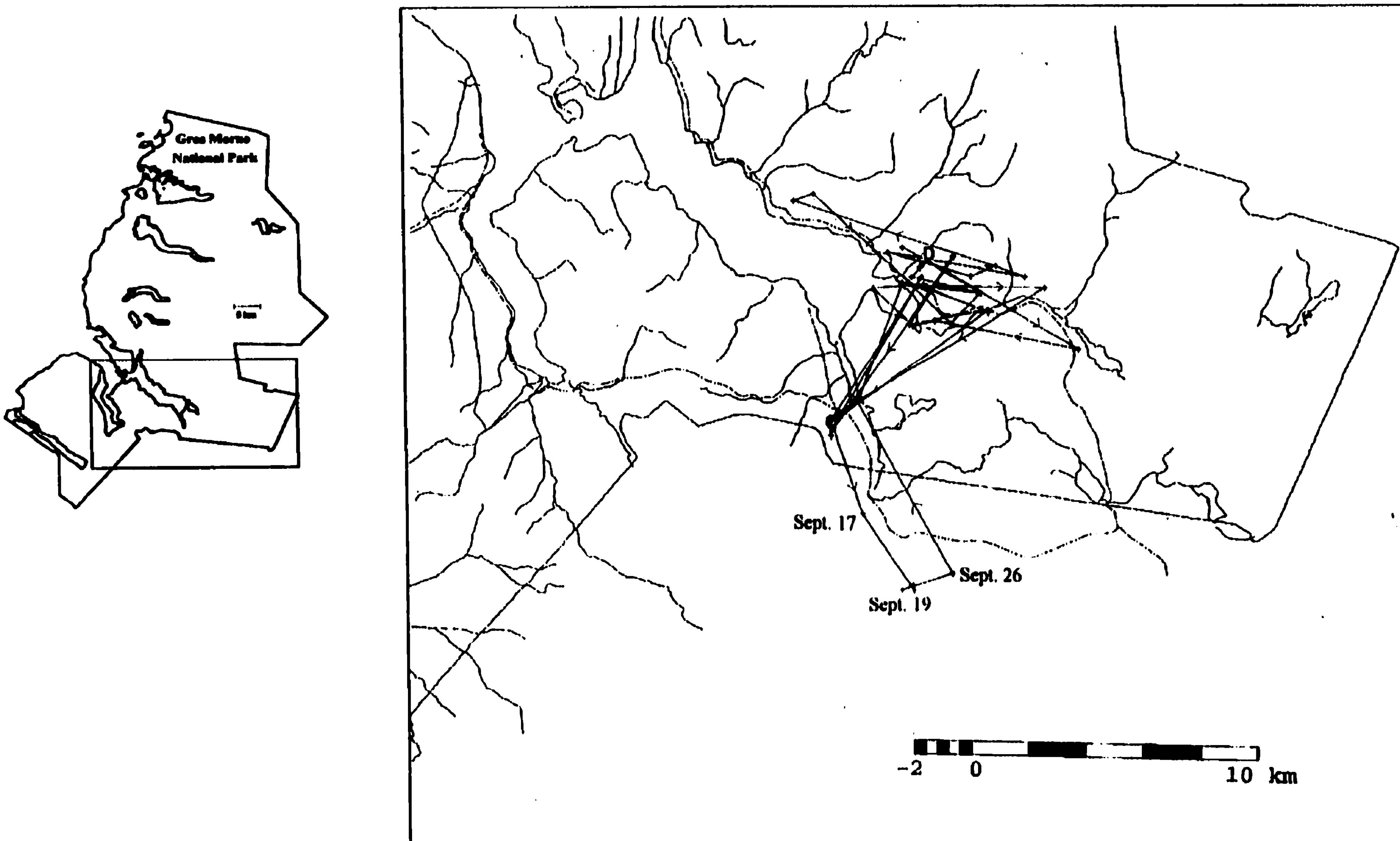
Appendix VII: Consecutive Locations of Adult Females in 1995.



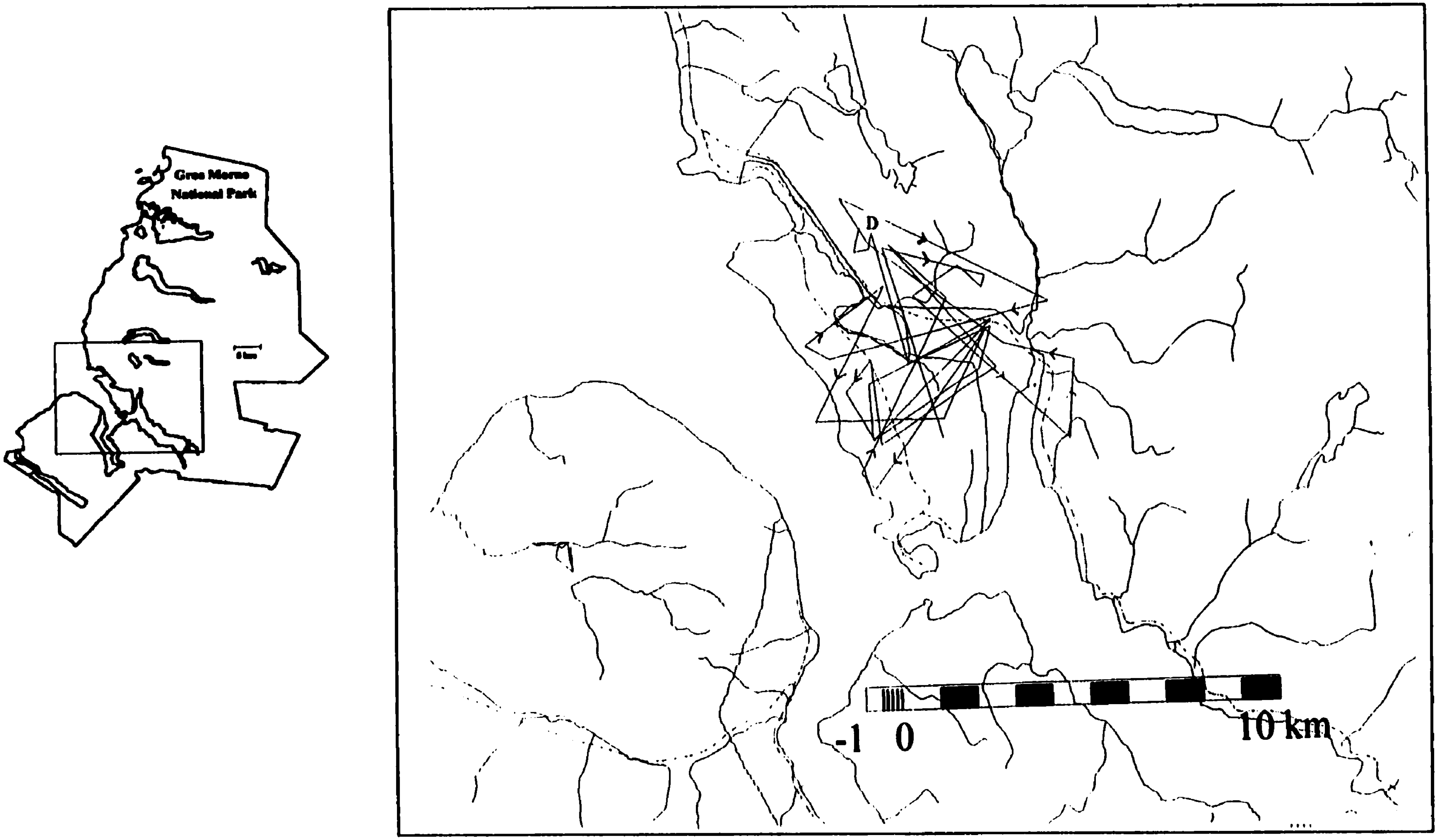
Appendix VII: Consecutive movements of bear F1 during 1995. "D" indicates the den site selected in fall 1995.



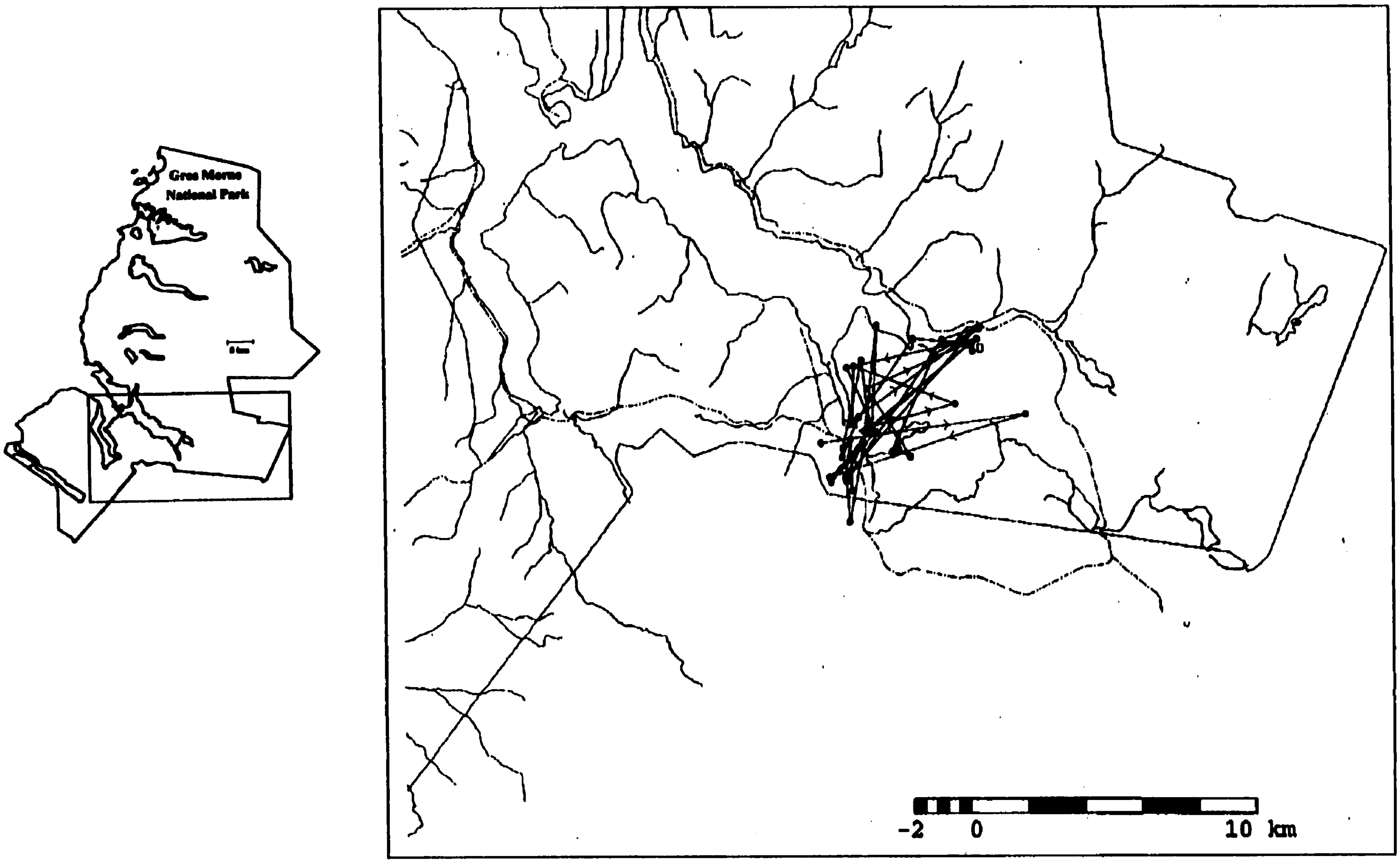
Appendix VII (continued): Consecutive movements of bear F2 during 1995. "D" indicates the den site selected in fall 1995.



Appendix VII (continued): Consecutive movements of bear F3 during 1995. "D" indicates the den site selected in fall 1995.



Appendix VII (continued). Consecutive movements of bear F4 during 1995. "D" indicates the den site selected in fall 1995.



Appendix VII (continued): Consecutive movements of bear F5 during 1995. "D" indicates the den site selected in fall 1995.