LYNX RESEARCH
IN THE NWT, 1990-91

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ABSTRACT

This report summarizes lynx harvest trends, and ongoing research programs conducted during 1990-91 in the NWT. Results of carcass collections, pelt measurements, snowshoe hare indices, and a live-trapping and radio-collaring study are given.

The 1990-91 harvest was 2094 pelts, a decrease of 26% over the previous year. Average pelt price dropped by half to $62.

A total of 45 lynx carcasses was collected from trappers in Fts. Simpson and Providence, to: a) determine the most appropriate length for dividing pelts between kittens and older animals, b) determine the age structure and sex ratios of the harvest, and c) compare lynx body condition and reproductive rates among areas and years. The collection contained only 4 kittens (9%); yearlings dominated the sample overall (56%). Because of the low number of kittens, further refinement to the pelt length to distinguish kittens from older lynx was not possible. Most of the lynx taken were males (60.0%). Body condition increased over the previous 2 years for all age and sex classes. Both the proportion of female lynx pregnant and the mean *in utero* litter size decreased compared to previous years.

Lynx pelts from across the NWT were measured to provide an indication of the proportion of kits in the harvest. Twenty-six percent of the 890 pelts measured were $\leq$ 89 cm and, therefore, were presumed to be kits.

Lynx populations cycle in relation to their main prey, the snowshoe hare. An indication of hare densities from several areas in the western NWT were provided by counts of hare pellets on permanent transects, and winter track counts in the Mackenzie Bison Sanctuary (MBS). Hare densities declined in all areas except Inuvik. Track counts conducted in the MBS documented a significant decline in hare densities during mid to late winter 1990-91.

A lynx live-trapping and radio-collaring program was initiated in the MBS in March 1989, to examine lynx home range size, habitat use, dispersal and movement patterns, and survival rates at high, declining and low hare densities, in an effort to identify requirements and characteristics of lynx refugia (untrapped areas). During winter 1990-91, 18 individual lynx were captured on a 130 km^2 study area, bringing to total 54 lynx captured 69 times since the start of the study. As of April 1991, 26 lynx wore functional radio collars on or near the study area. Although survival to winter of kittens born in June 1990 was excellent, none of the nine females present on the study area in June 1991 had kittens by mid-August. Home range size (95% minimum convex polygon) averaged 16.6 km^2 for 13 males and 17.1 km^2 for 11 females, a non-significant decrease from the previous year. Extensive overlap among female home ranges was observed, but most males had mutually exclusive home ranges. Seven lynx $\geq$ 1 year of age dispersed from the study area from March to June 1991. The first natural mortality of a lynx on the study area was recorded. Meadows and sparsely vegetated areas were avoided and mixed forest types were preferred by lynx.

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INTRODUCTION

Lynx (*Lynx canadensis*) continue to be an important source of income and traditional lifestyle for Northwest Territories (NWT) trappers. Lynx numbers generally cycle following population levels of their main prey, the snowshoe hare (*Lepus americanus*) (Brand et al. 1976, Brand and Keith 1979). Because of this cycle in prey availability, lynx reproductive parameters, survival rates and movement patterns vary considerably depending upon the stage of the prey cycle (Brand and Keith 1979, O'Conner 1984, Ward and Krebs 1985, Hatler 1988).

Trapping pressure on lynx is believed to increase relative to increases in pelt price (Brand and Keith 1979). With high pelt prices during the late 1970s and through much of the 1980s, including through the last low in the hare cycle, many lynx populations in Canada, especially in jurisdictions south of 60°N, appear to be low or recovering poorly.

Survival data from recent radio-collaring studies show that 55% of collared lynx died from human-related causes, primarily trapping (Ward and Krebs 1985). Many managers have called for controlled or reduced harvesting during periods of decreased numbers of hares and low recruitment into the lynx populations (Brand and Keith 1979, Parker et al. 1983, Todd 1985). Given this level of concern and interest in lynx populations in Canada, there is a need to examine NWT populations and trapping patterns to ensure that our northern lynx are not being overharvested.

This report details the third year of examination of lynx in the NWT (first 2 years summarized in Poole 1989, 1990). Some analyses and interpretation of the data have been conducted, but the primary purpose of the report is to summarize ongoing research, and as such the information and conclusions provided here should be considered preliminary. The following areas of study will be covered:

1. harvest trends;

2. carcass collections conducted primarily to:

   a) correlate age to pelt measurements,

   b) determine age and sex structure in the harvest, and

   c) provide body and reproductive condition indices;

3. pelt measurements to determine the proportion of kits in the harvest;

4. snowshoe hare pellet counts to index the hare cycle; and

5. Mackenzie Bison Sanctuary lynx study, primarily concerned with examining habitat use, home range size and dispersal patterns during a period of declining and low hare densities.

LYNX HARVEST

During 1990-91, 437 out of 1551 trappers in the NWT sold 2094 lynx pelts worth $130,000. The harvest was 26% lower than the previous year, and with decreased pelt prices the overall value of the harvest dropped by more than half. Even so, the value of the NWT lynx harvest was still third only to marten (*Martes americana*) and wolf (*Canus lupus*) pelt production. The greatest decrease in lynx harvest occurred in the Ft. Smith District, while the Inuvik Region and Ft. Simpson District had substantial gains in harvest (Table 1). The pattern of lynx harvest in the NWT since the late 1950s (Fig. 1) has generally followed the 10-year cycle described for most populations (Elton and Nicholson 1942, Keith 1963).

The average price of a lynx pelt has decreased steadily since the peak of $616 in the 1985-86 season (Fig. 1). The average pelt price for the 1990-91 season dropped by half from the previous year to $62. The current NWT fur return system does not account for unsold pelts, or furs used domestically or sold privately.

Table 1. Number of NWT lynx sold [redacted] records.

Community
Aklavik
Arctic Red R.
Ft. Franklin
Ft. Good Hope
Ft. McPherson
Ft. Norman, N. Wells
Inuvik
Tuktoyaktuk
Inuvik Region
Ft. Liard
Ft. Simpson
Jean Marie R.
Nahanni Butte
Trout L.
Wrigley
Ft. Simpson Dist.
Ft. Providence
Hay River
Kakisa L.
Hay River Dist.
Dettah
Ft. Rae
Lac La Martre
Rae Lakes
Snare L.
Yellowknife
Yellowknife Dist.
Ft. Resolution
Ft. Smith
Pine Point
Snowdrift
Alta/Sask Trappers
Ft. Smith Dist.
Total NWT

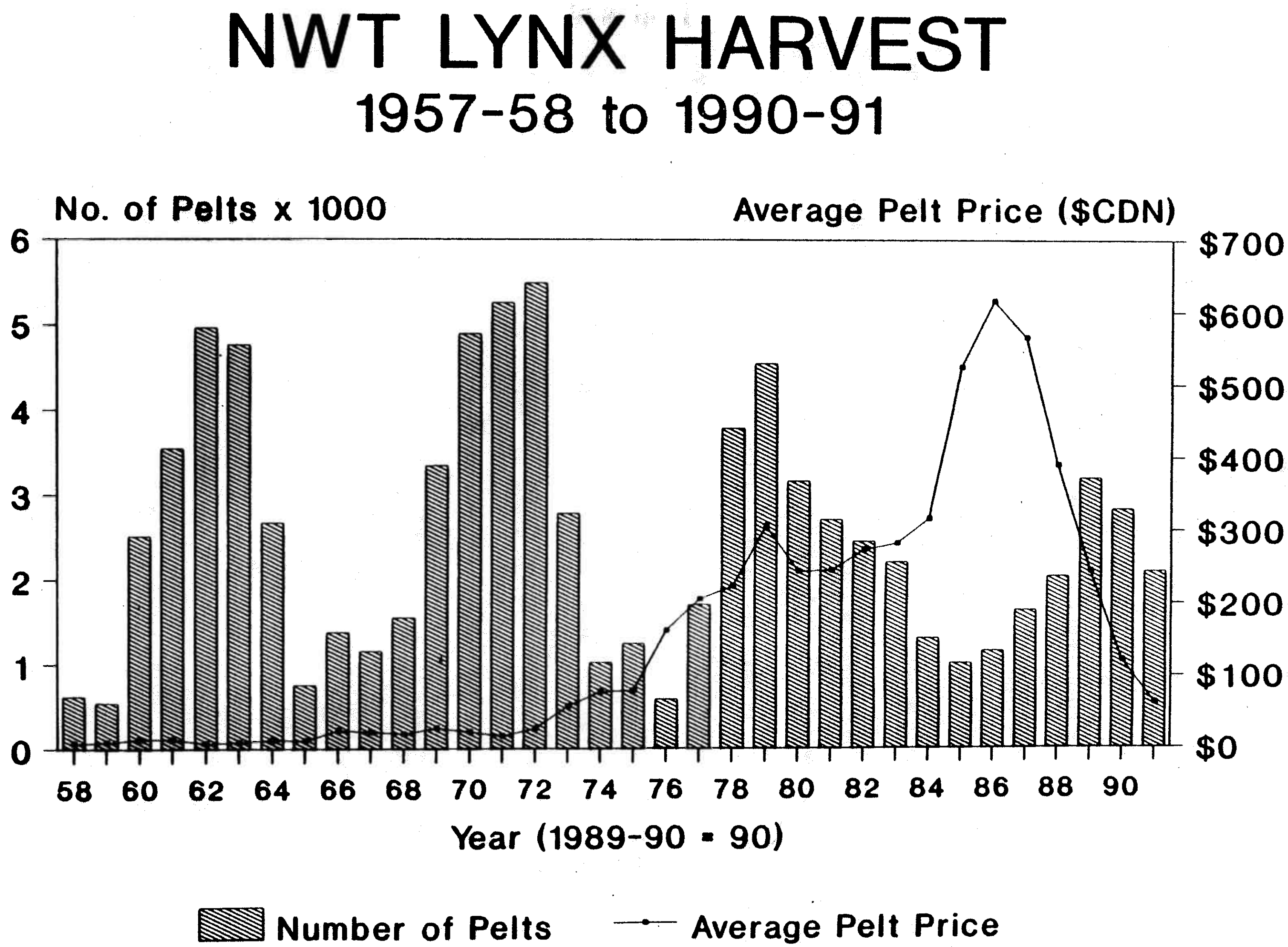


Figure 1. Lynx harvest and average pelt price for the NWT, 1957-58 to 1990-91.

CARCASS COLLECTIONS

Introduction

An examination of lynx carcasses donated by trappers from selected communities in the NWT continued during the 1990-91 season. Briefly, the purpose of this collection is several-fold (further background is available in Poole [1989]):

1. Pelt measurements provide a rapid and accurate estimate of the proportion of kittens in the harvest, an indication of where the lynx cycle is in a particular area, and of lynx productivity during the summer prior to the harvest. This information is valuable in interpreting harvest trends and making management decisions to maximize harvest return. Pelt lengths from known-age animals will enable determination of the most accurate pelt length measurement dividing kittens from older animals.
2. Age and sex ratios of lynx in the harvest provide an indication of which segments of the population are harvested during the trapping season.
3. Examination of carcasses provides a comparison of lynx body condition and reproductive rates among various areas and among years.

Methods

With the assistance of Department of Renewable Resources (DRR) field staff in Fts. Providence and Simpson, cooperative trappers with a history of high lynx harvests were provided with paired number tags, and were asked to affix one tag to the carcass and one to the pelt, noting location and date taken. Pelt length (tip of the nose to base of the tail) was measured on dried pelts by DRR staff or the trapper prior to shipment to auction. Pelt width was not measured since it was found to be of little value in determining the age of the pelt

(Poole 1989, Stephenson and Karczmarczyk 1989). Trappers were asked to turn in their entire season's catch so that the complete chronology of age and sex over the trapping season would be obtained.

The carcasses were examined in Yellowknife, documenting body and tail length and chest girth, weight (complete carcasses only), sex and reproductive condition (uteri soaked overnight in water, uterine horns split and examined macroscopically for placental scars over a light source), and fat indices (weight of xiphoid [sternal] fat, and perirenal fat indexed to kidney weight) (Brand and Keith 1979, Stephenson 1986). Stomach contents, where present, were examined by washing them over a sieve and identifying bones, fur and feathers using a reference collection. Age was determined by tooth development and incomplete closure of apical canine root foramen (kittens) (Saunders 1964) or by standard cementum aging of a lower canine (conducted by Matson's Laboratory, Milltown, MT) (Crowe 1972, Brand and Keith 1979). Age class "0" (kitten) denotes a lynx in its first winter of life; a yearling (in its second winter of life) is designated by age class "1". Adults are lynx $\geq$ 2 years of age. Analyses were conducted using the SAS system (SAS Inst., Inc. 1988). Differences among data sets were considered significant when $\underline{P} \leq 0.05$.

Results

A total of 45 lynx carcasses was examined during the 1990-91 season: Ft. Simpson - 38 from 3 trappers; Ft. Providence - 7 from 1 trapper. Kittens made up only 8.9% of the sample and yearlings dominated the sample overall (55.6%) (Table 2). Mean age (kit=0, yearling=1, etc.) of the harvest increased to 1.33, up from 1.01 the previous year and 1.19 in 1988-89. No lynx older than 3 years old were harvested. Most (60.0%) of the lynx examined were males (Table 2). The age of animals in the collection was heavily skewed towards the 1 and 2 year age classes (Fig. 2).

Table 2. Percent of kittens, yearlings, and adults (2+ years) each month, and sex ratio in lynx carcasses examined during the 1990-91 season.

	Month				
	Dec	Jan	Feb	Mar	Total
Sample Size	18	12	7	8	45
Age Class					
Kitten	0.0	25.0	0.0	12.5	8.9
Yearling	50.0	66.7	85.7	25.0	55.6
Adult	50.0	8.3	14.3	62.5	35.6
Sex Ratio					
M:F	56:44	75:25	57:43	50:50	60:40

Pelt lengths paired to carcasses were available for only 30 lynx from the 1990-91 harvest, and only four of these were kittens. In previous years, 89 cm has appeared to be the best length for distinguishing pelts of kittens and older lynx (Poole 1990). However, in 1990-91, all four kitten pelts were < 78 cm in length, and 10/26 of the adult pelts were between 83-88 cm. Sample sizes will be increased over the next two seasons to verify whether an overall decrease in pelt size occurs within both age classes during declining lynx and hare cycles.

Kidney fat index (KFI) and xiphoid were similar for yearling and 2+ age classes for females, but increased with age in males (Table 3). KFI increased in 1990-91 over the previous 2 years in all age and sex classes, significantly so for yearling and 2+ year old males (Kruskal-Wallis tests, $P < 0.013$).

The number of young produced in the spring of 1990, as determined by counts of recent placental scars (RPS), declined compared to previous years (Table 4), but not significantly (Kruskal-Wallis test, all $P \geq 0.1$). Only 30% of yearlings bred in their first

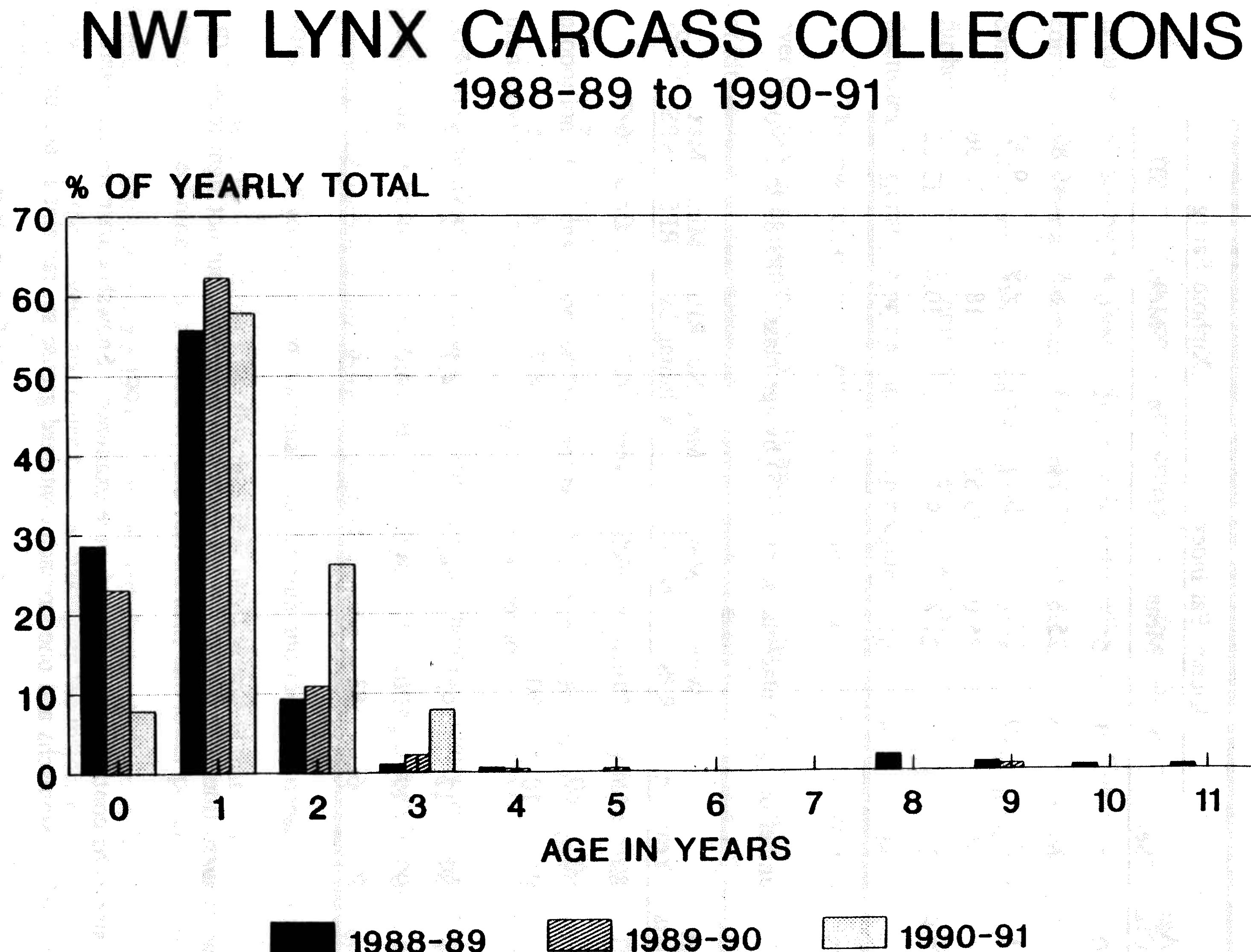


Figure 2. Age structure of lynx carcasses examined during 1988-89 (n = 181), 1989-90 (n = 273) and 1990-91 (n = 45).

LYNX PELT MEASUREMENTS

Introduction

As noted in the previous section, the proportion of lynx kittens in the population, as reflected in the harvest, fluctuates widely over the 10 year lynx cycle. Peaks in the proportion of kits in the harvest generally occur before lynx populations and harvests peak (O'Connor 1984). Thus, a decrease in kits in the harvest should precede a decrease in actual lynx populations. Many studies stress the importance of curtailment of trapping during the cyclic low (tracking harvest strategy [Caughley 1977]), to ensure that sufficient numbers of adults remain as seed stock to begin the cyclic increase (Brand and Keith 1979, Todd 1983, Hatler 1988). Monitoring of the proportion of kits in the harvest will enable trappers to identify when lynx production has fallen off, a period when they may wish to decrease trapping pressure. Monitoring may also be useful in assessing the relative strength of the high phase in the lynx productivity cycle in a given area (Stephenson and Karczmarczyk 1989).

Quinn and Gardner (1984) pointed out that pelt size is useful for distinguishing kits from older animals. Many jurisdictions in North America now routinely measure pelts prior to shipment to auction, to estimate the proportion of kits in the harvest. This section reports on lynx pelt measurements taken in the NWT over the past six trapping seasons.

Methods

Measurement of lynx pelt length (tip of nose to base of tail) was initiated in the NWT during the 1985-86 season (Poole 1990). The pelt length used to assign kit status was $\leq$ 84 cm (33 in.), modified from the results of an Ontario lynx study (Quinn and Gardner 1984).

DRR staff in all communities were asked to measure pelts prior to shipment to auction and record the number of "kits" (based on ≤ 84 cm) in each shipment. Beginning in the 1988-89 season, officers were asked to record all pelt measurements so that once the most reliable dividing point to separate age classes is determined (see Carcass Collections), the proportion of kits in the harvest may be estimated retrospectively. Data from the 1986-87 to 1990-91 seasons are presented.

Results

Prior to the 1988-89 season, the number of pelts ≤ 84 cm was recorded (Table 5). During the 1988-89 and 1989-90 seasons, carcass collections matched with pelt measurements indicated that ≤ 89 cm (35 in.) may be the most reliable length to determine the proportion of kits in the harvest from pelt measurements (Poole 1990). Using 89 cm, of 890 lynx pelts that were measured during the 1990-91 season, about 26% were kits, only slightly lower than in the previous two years (Table 5).

The proportion of kits in the harvest increased from 17.8% before Christmas, to about 30% during mid-winter and the later part of the season (Table 6), similar to the pattern observed in previous samples (Poole 1989, 1990). This pattern emphasizes the need to measure pelts consistently throughout the season; samples examined only late in the winter will generally show a much larger proportion of kits in the harvest than occurs over the entire season.

Discussion

Because only the number of pelts ≤ 84 cm had been counted prior to 1988-89, and not all pelt measurements recorded, it is difficult to compare data among years. If I assume

Table 5. Proportion of lynx kittens in the harvest from 1985-86 to 1987-88, based on ≤ 84 cm pelt length, and from 1988-89 to 1990-91 based on ≤ 89 cm pelt length.

	Trapping Season									
	1986-87		1987-88		1988-89		1989-90		1990-91	
DRR Station	n	% Kits	n	% Kits	n	% Kits	n	% Kits	n	% Kits
Tuktoyaktuk	-	-	5	40	-	-	2	50	0	-
Aklavik	7	0	10	40	8	38	-	-	15	13
Inuvik	32	9	23	26	-	-	28	50	18	22
Ft. McPherson	-	-	2	50	8	38	-	-	28	46
Ft. Good Hope	47	17	15	13	19	26	7	43	12	33
Ft. Franklin	6	0	13	31	17	24	42	12	9	33
Ft. Norman	18	17	9	33	33	27	37	16	39	23
Ft. Simpson	112	8	161	11	318	29	548	28	387	27
Ft. Liard	191	9	229	13	276	21	248	24	100	31
Trout Lake	-	-	-	-	24	19	-	-	-	-
Ft. Providence	72	4	-	-	247	28	436	22	195	20
Ft. Rae	65	3	31	29	28	46	87	33	-	-
Yellowknife	-	-	61	16	89	19	81	22	-	-
Hay River	-	-	-	-	258	28	199	25	16	25
Pine Point	58	26	-	-	-	-	-	-	-	-
Ft. Smith	-	-	205	18	396	25	258	28	71	25
Ft. Resolution	-	-	-	-	-	-	87	15	-	-
Year Total (at ≤84 cm)	608	10.0	764	16.4						
Year Total (at ≤89 cm)		**16.2**		**26.6**	1721	**25.9**	2060	**25.1**	890	**26.2**

Table 6. Percentage of lynx kittens by month in pelts measured during 1990-91 based on ≤ 89 cm pelt length.

	Month[a]					
	Nov	Dec	Jan	Feb	Mar	Total
Sample Size	71	232	190	227	170	890
% Kittens	11.3	19.8	31.6	30.4	29.4	26.2

[a] Note that month corresponds to date measured at the DRR office upon receipt from the trapper. The delay between trapping a lynx and pelt measurement generally spans days to several weeks.

the ratio of pelts ≤ 89 cm to pelts ≤ 84 cm (1.62:1) found in the pelts examined in 1988-89 and 1989-90 is consistent, then multiplying previous estimates of kits in the harvest by 1.62 should approximate the 89 cm measurements (Table 5). The continuing high proportion of kits in the 1990-91 harvest suggests that lynx production (number of kits per litter and survival of kits) remained good during 1990 across much of the western NWT. The resulting population trend suggests strong production and survival of young for the past 4 years.

Data from the 1990-91 carcass collections indicate a lower proportion of kittens in the harvest (9%) than suggested from the pelt measurements. This inconsistency may be due to two factors. First, relatively few carcasses were donated by only four trappers, and it is not clear whether or not the entire year's harvest was obtained from three of them. By chance alone few kittens might have been trapped by these four trappers compared with all the NWT trappers. Secondly, the limited pelt measurements from the carcass collections suggest that the pelt length division between kittens and adults may be lower than 89 cm during declining hare and lynx cycles. Using a ≤ 85 cm cutoff, 18% of the NWT pelts measured would be classified as kittens. Further data are needed to examine this relationship.

SNOWSHOE HARE CYCLE

Introduction

Lynx populations cycle directly with population levels of their main prey, the snowshoe hare (Brand et al. 1976). When hare populations drop dramatically, lynx reproduction is depressed and the kitten survival rate declines, resulting in greatly lowered recruitment (Nellis et al. 1972, Brand and Keith 1979, O'Connor 1984). Lynx populations generally peak 1 or 2 years after the peak in hare populations (Brand and Keith 1979, O'Connor 1984). Given the importance of hares to lynx populations, hare populations are being indexed in several areas of the western NWT. This monitoring will be useful in predicting changes in lynx populations, and in assisting the interpretation of trends in lynx population parameters and harvests.

Methods

Two methods were used to index hare populations. The first index to the hare cycle, and one that provides actual hare density estimates, involved faecal pellet plots established near Yellowknife, the Mackenzie Bison Sanctuary (MBS), Ft. Smith, Pine Point, Norman Wells and Inuvik. The technique follows those outlined in Krebs et al. (1987). Briefly, in June of the initial year, 2-inch x 10-foot plots (0.155 m^2 area), spaced at 25-m intervals, were set up on 4-6 transects in each area, and all pellets were removed from the plots. In June of subsequent years, all faecal pellets on plots were counted and removed. These counts provide an assessment of actual hare density over the preceding year. An estimate of hare density may be derived from the formula from Krebs (Slough pers. comm.):

LOG(hares/hectare) = 0.812727(LOG turds) - 0.235869

The transects were placed in representative habitat types in each area in rough proportion to their availability. Satellite imagery was used in selecting habitat types and transect locations.

As a second index, track counts (Thompson et al. 1989) were conducted during the winter in the MBS. Counts were conducted along the same nine 1-km transects 24-72 hours after a snowfall. Track counts are expressed as tracks/km-day (km travelled X days since last snowfall). Runways (places where the exact number of track could not be determined) were assigned seven tracks for calculation purposes (Ward and Slough 1987). Differences in track counts in the same month (November and March/April) were compared among years using an ANOVA.

Results

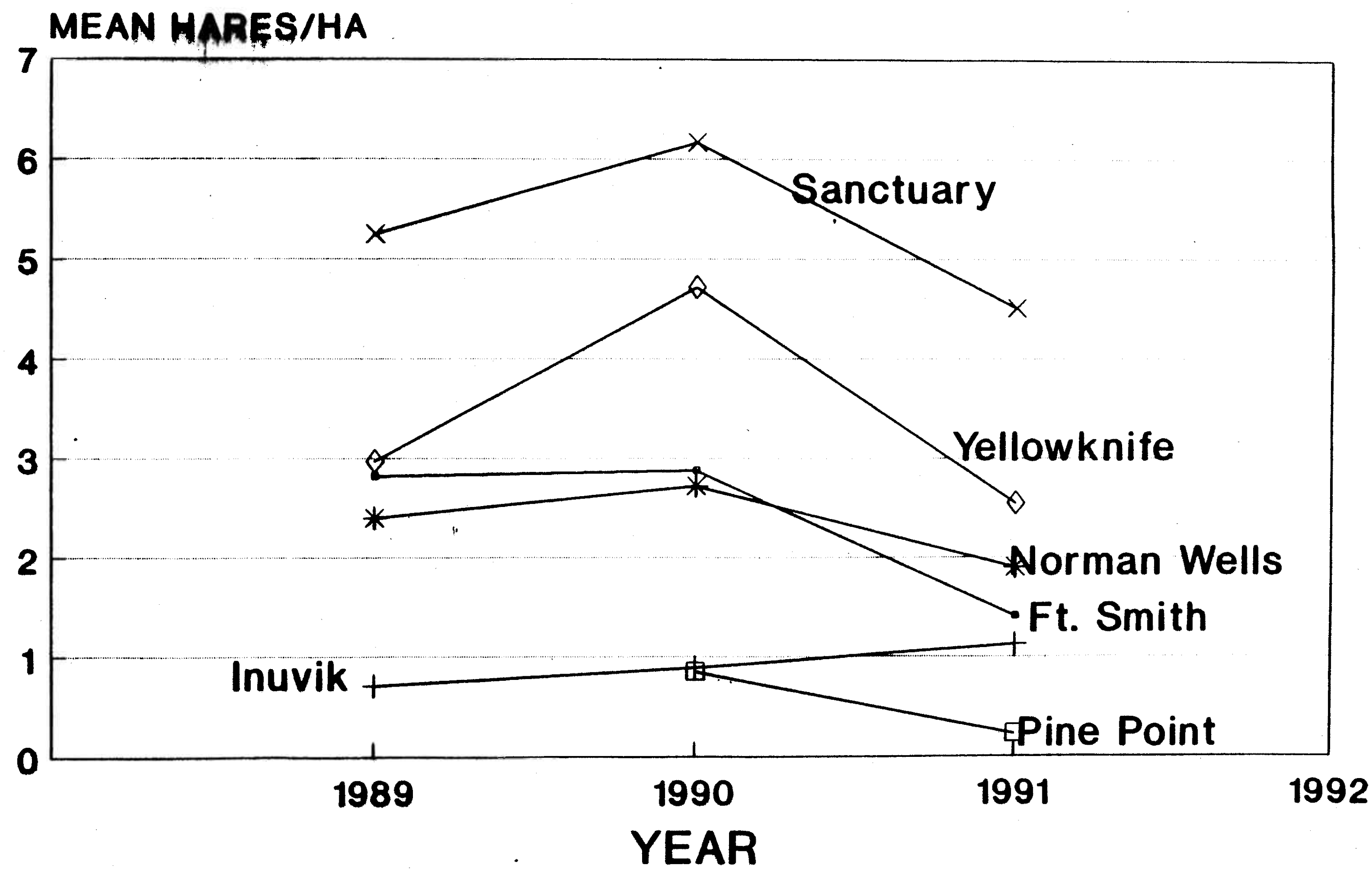
Estimates of hares per ha derived from turd counts indicated that hare densities over 1990-91 decreased in all communities surveyed, except for Inuvik (Fig. 3). Significant decreased were observed in Pine Point, Ft. Smith and Yellowknife. The MBS had the highest overall estimate of hare density at 4.5 hares/ha, with the highest transect at 6.7 hares/ha (670/km^2).

Track counts conducted in the MBS lynx study area showed fluctuations over the course of each winter, and a significant overall decline when the same month was compared among years (ANOVA, all $\underline{P} < 0.02$) (Fig. 4). The number of hare tracks in March 1991 were 86% lower than counts taken the previous March.

Discussion

Hare densities in all of the western NWT with the exception of the northern Mackenzie Valley appear to have decreased over the past year. The most significant

HARE DENSITY FROM TURD COUNTS



LOG(Hares)=0.812727(LOG Turds)-0.235869

Figure 3. Mean density (hares/ha) derived from turd counts on permanent transects, 1989-91.

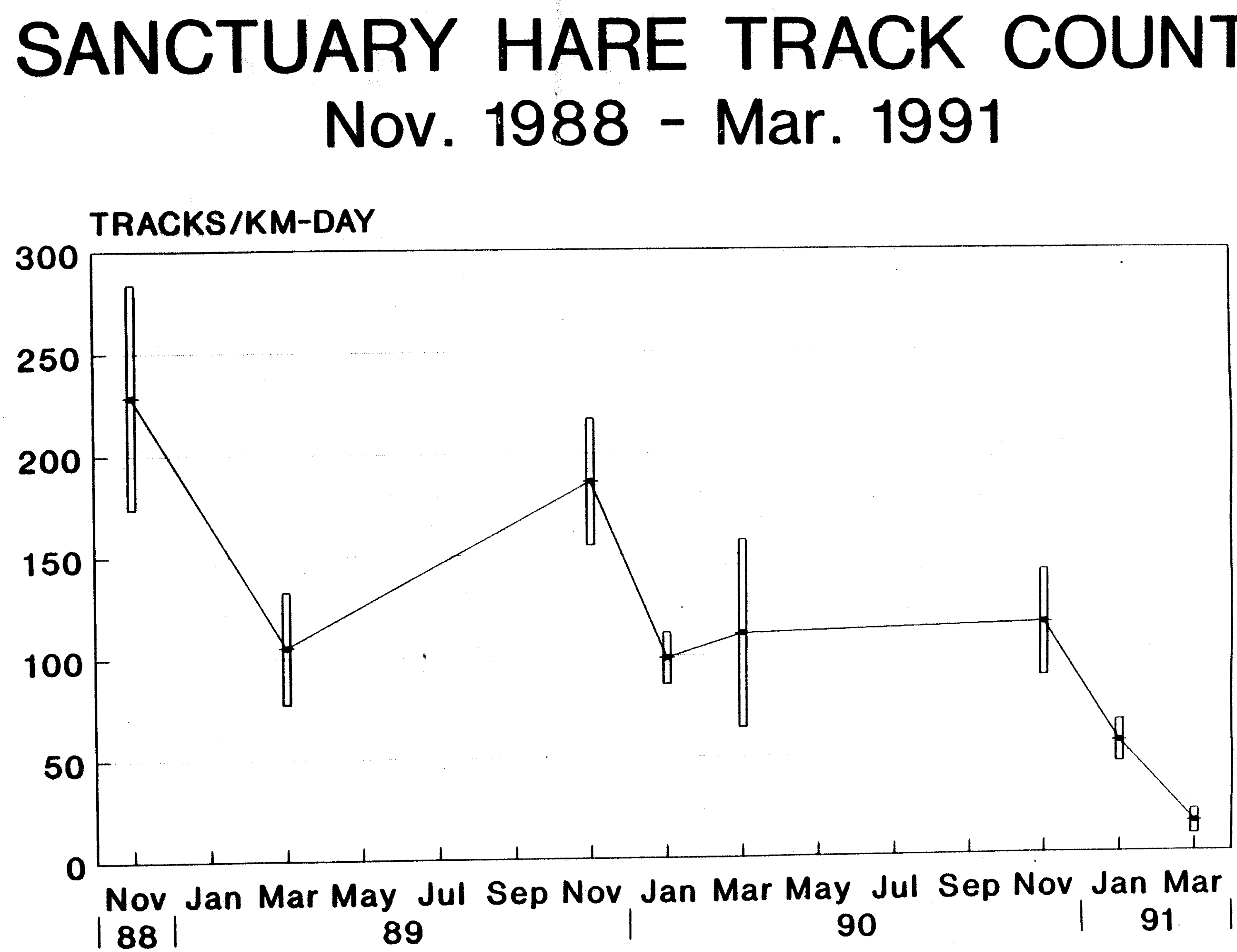


Figure 4. Hare track counts for the Sanctuary (mean $\pm$ 1 SD).

decreases were in the Great Slave Region east and south of Great Slave Lake. Given that the density estimates from turd counts give the average density of the preceding 12 months, hare densities in late winter or spring 1991 likely were lower than those estimated from turd counts. The dramatic drop in the MBS track counts may more realistically indicate the actual pattern and intensity of the decline. I expect that given the nature of the snowshoe hare cycle (Keith and Windberg 1978), densities should continue to fall in most of the western NWT over the next year. Densities of 0.06-0.3/ha at lows in the hare cycle have been reported by other researchers (Brand and Keith 1979, Ward and Krebs 1985, Bailey et al. 1986).

MACKENZIE BISON SANCTUARY LYNX STUDY

Introduction

Lynx trapping in the NWT is not regulated by quotas or closed seasons. The trapping season (1 November - 15 March in most areas) is one of the longest in North America, and only about 20 registered traplines exist (primarily in the Ft. Smith area) where individual trapline management can be practised. Improved access from seismic cut lines and the use of snowmachines, coupled with high pelt prices for much of the past decade have given trappers both the means and the incentive to increase trapping pressure on lynx.

Lynx researchers have suggested two ways to manage lynx during their cyclic fluctuations. One strategy is that trapping be curtailed or eliminated for 3-4 years during the low in the snowshoe hare cycle (a tracking harvesting strategy - Caughley [1977]), when recruitment into the lynx population is almost negligible (Brand and Keith 1979, Parker et al. 1983, Todd 1985, Stephenson and Karczmarczyk 1989). However, Todd (1985) correctly noted the difficulties that some trappers would face if required to forego selling valuable lynx pelts for several years. Other researchers, citing the high trapping mortality of lynx determined from radio-collaring studies (Ward and Krebs 1985), suggested that refugia or untrapped reservoirs of habitat be maintained to sustain sufficient numbers of lynx through the low in the hare cycle to provide the "seed stock" for the next increase in hare numbers and lynx production (Ward and Krebs 1985, Bailey et al. 1986, Ward and Slough 1987, Slough and Ward 1990). Should a large portion of lynx habitat be untrapped from year to year, trapping restrictions during the low phase of the cycle may not be necessary.

In response to these factors, I developed a study to examine several aspects of lynx ecology in the NWT. The study will examine lynx home range size, habitat use, dispersal and movement patterns, and survival rates at high, declining and low hare densities in an effort to identify requirements and characteristics of lynx refugia. Given this information, traplines in selected communities will be mapped and the proportion of available habitat that could act as lynx refugia will be determined. It is hoped that this study will enable development of effective long-term management strategies for lynx in the NWT.

A study of lynx refugia has been on-going in the Yukon since 1986 (Ward and Slough 1987, Slough and Ward 1990). While comparisons between the NWT and Yukon studies will be valuable, differences in habitat (generally mountainous in the Yukon) and trapping regimes (the Yukon has a system of registered trapping concessions and group areas) warrant both studies.

This report provides details on the progress of the Mackenzie Bison Sanctuary (MBS) lynx study, since the first live-trapping session in March 1989, to June 1991. Previous information is reported in Poole (1989, 1990). The MBS is ideally suited to a long-term study: historical lynx harvests are high, the habitat is similar to that found over much of the southern Mackenzie, and the relatively flat landscape simplifies radio-tracking. Evidence from track and pellet counts indicates that hare densities dropped dramatically during winter 1990-91 (see previous section), following three winters (1987-88 to 1989-90) during which hare densities have been at or near cyclic peaks (see previous section, pers. obs.).

Specific objectives for the study include the following:

- estimate population density,
- determine home range size,
- examine habitat use,
- examine lynx survival and dispersal patterns,
- determine kitten production and survival, and
- examine lynx track counts as an index of population density.

Study Area

The study is located in the MBS approximately 50 km northeast of Ft. Providence (Fig. 5). Live-trapping was conducted in an area of approximately 130 km^2, near the Calais Lake Research Centre. Most of the area has not been kill-trapped for at least 5 years. Information on the geography and climate of the area has been given previously (Poole 1989).

According to Rowe (1972), the study area is on the border between the Upper Mackenzie Section and the Northwestern Transition Section of the Boreal Forest Region. LANDSAT II Multispectral Scanner (MSS) imagery (80x80 m pixel size data, geometrically corrected and resampled to 50x50 m pixel size) was used to classify the habitat into vegetation cover types, with a classification accuracy of about 81% (Mychasiw and Moore, in prep.). The main cover type is **coniferous forest** (about 46% of the area), consisting of pine forest community (Jack pine - *Pinus banksiana*, balsam poplar - *Populus balsamifera*, and trembling aspen - *P. tremuloides* dominating the tree canopy), spruce forest community comprising primarily white spruce (*Picea glauca*) and tamarack (*Larix laricina*), and mixed pine and spruce forests with jack pine and black spruce (*P. mariana*) dominating. **Mixed forest**, primarily trembling aspen, occurs in about 14% of the area. **Organic terrain** (primarily sphagnum peat) and **sparsely vegetated** areas occupy 9% each of the total ground cover. **Sedge meadows** (primarily *Carex* spp.) and **shrub meadow**, covering about 11% of the area, were combined for habitat analysis. These meadows are found within larger lacustrine depressions. **Burns** of various ages (generally < 10 years old) cover another 6% of the study. Deadfall, evidence of older burns, are found throughout the forest habitat types. The remainder of the area (3%) is composed of **shrublands**, predominantly willow, typically found on lakebeds adjacent to the coniferous forest. Standing water (1%) and unclassified areas (1%) were removed from the calculations. Since the imagery was taken,

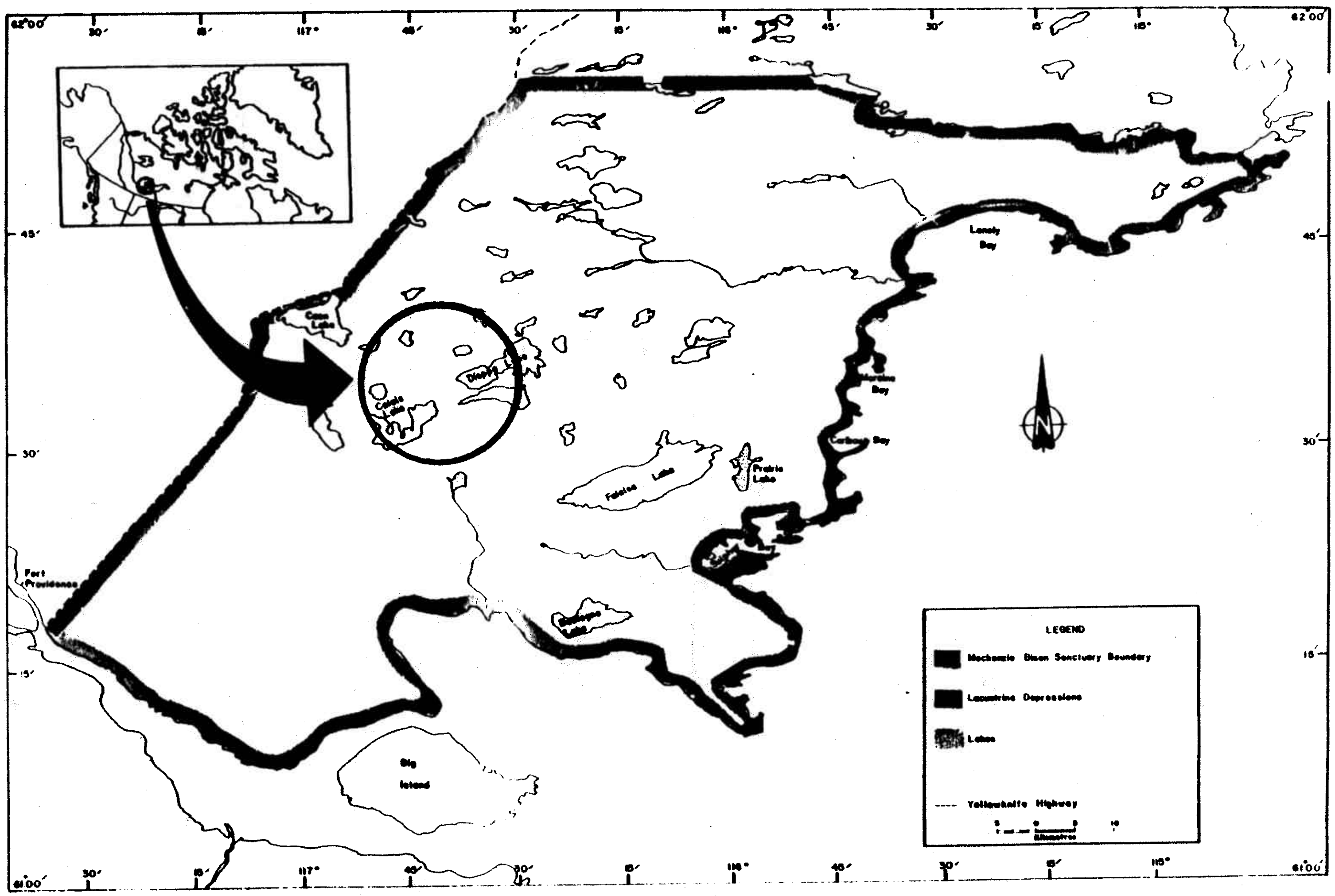


Figure 5. Location of the Sanctuary lynx study (circled).

water levels in the MBS have risen, a result of greater than normal annual precipitation, several late and rapid spring melts, and a creek flowing through the centre of the study area recently dammed by a beaver (*Castor canadensis*), partially flooding an estimated 2-3 km^2.

Methods

Live-trapping was conducted from 8 November to 4 December 1990 (early winter) and from 18 March to 11 April 1991 (spring). Up to 73 Fremont leg-snares (Fremont Humane Traps, Candle Lake, SK) were used during both sessions. During spring trapping up to 10 Godwin leg-snares (Godwin Humane Traps, Candle Lake, SK) also were used. The traps were set in standard open cubby sets, using baits which varied from commercial lures to a homemade mixture of lynx organs, catnip, beaver castor and rum. Visual attractants included flagging tape and bird wings. The traps were checked at least once daily.

Captured lynx were immobilized using Telazol (A.H. Robins Co., Richmond, VA) administered intramuscularly by blow-gun at a dose of 5-6 mg drug per kg estimated body weight. The lynx were sexed and weighed, and body and tail length, heart girth and neck circumference were measured. A lower incisor (I3) was extracted for aging (Matson's Laboratory, Milltown, MT) unless the animal was obviously a kit (based on body measurements, weight, and ear tuft length [Stephenson and Karczmarczyk 1989]), and all lynx were ear-tagged with two numbered tags (Size 3, Style 1005 Monel, National Band & Tag Co., Newport, KY). Radio-collars (MOD-400, MOD-300 and MOD-315 Telonics Inc., Mesa, AZ) were attached to all adults and one kitten. MOD-400 collar weight was 230-270 g, and MOD-300/315 collars weighed 140 g. A subcutaneous injection of 0.75-1.0 ml penicillin (Penlong XL, Roger/STB Inc., London, ON) was given to reduce infection from any trap-related injuries. Drugged lynx were allowed to recover for about 2 hours in a box trap (Model 609.5, Tomahawk Live Trap Co., Tomahawk, WI) prior to release.

Attempts were made to locate dens of radio-collared females in late June. Survival of kits through the winter was determined by tracking collared females.

Telonics RA2A (H) antenna for directional bearings and a Telonics model TR2 receiver and TS1 scanner were used. Collared lynx were located using standard radio-telemetry techniques (Mech 1983, Kenward 1987) to the nearest 50 m, at irregular intervals from the ground during winter, and every 2 weeks year-round from the air, except when ground crews were working. Fixed-wing aircraft (Cessna 172 and Cessna 185) were used for aerial locations. All locations were taken during daylight hours. Time between successive bearings from the ground was generally < 45 minutes. In 99% of locations, $\geq$ 3 bearings were used.

The accuracies of the ground and air locations were tested using transmitters located in positions unknown to the observer. Accuracy of aerial radio-tracking from a sample of 10 locations averaged 40.1 m (range 0-150 m). From ground telemetry, average deviation from the true bearing was $\pm 8.2°$ ($\underline{n}$ = 48). At 1 km the error polygon having this error was approximately 8.3 ha, and at 2 km it was about 33 ha.

Lynx home range size was estimated with the minimum convex polygon (MCP) method (Hayne 1949) using Program Home Range (Ackerman et al. 1989). Obvious outliers were removed (Ackerman et al. 1989), usually 0-3 points per lynx. To exclude excursions to areas outside its normal area, 95% MCP were used (White and Garrott 1990:146); however, 100% MCP will also be given to facilitate comparisons with other studies. Three days were allowed for trapped lynx to acclimate to the collar before locations were used for home range estimation (White and Garrott 1990:37).

Mean distances between successive locations separated by intervals of 1-6 days were compared for 1989-90 and 1990-91 data to determine the interval where distance between locations was independent of elapsed time (Harrison and Gilbert 1985). There was no difference between distance travelled for any of the intervals (Tukey's test, both $\underline{P}$ > 0.1);

therefore, successive locations separated by 1 day were considered to be mutually independent and were included in the home range calculations. Daily travel distances, an indication of the time and effort spent searching for prey (Brand et al. 1976), were calculated.

In most cases, 95% MCP home range area appeared to be asymptotic after 20 locations (pers. data). Annual home ranges were determined for nine individuals with 16-25 locations; the remaining 14 lynx home ranges had > 45 locations. Home range and habitat analyses discussed here include locations taken up to 11 April 1991, the end of the spring live-trapping session.

Lynx tracks were counted each day during trapping sessions when snow conditions permitted. Track count techniques follow Stephenson (1986) and Ward and Slough (1987). Track counts were expressed as tracks/km-day (km travelled x days since last snowfall). Using track counts concurrent with daily movements of collared animals, we were able to estimate the number of lynx residing in the study area (Brand et al. 1976, Ward and Slough 1987).

Survival rates were estimated for radio-collared lynx (Pollock et al. 1989), first for monthly intervals, and then grouped into summer (1 Apr.-31 Oct.) and winter (1 Nov.-31 Mar.). Animals were assumed to be alive on the last day of radio contact, thus estimated survival rates are the maximum possible. The legal trapping season covers most of the winter period (1 Nov.-15 Mar.).

A geographic information system (GIS) computer using SPANS software was used to determine habitat utilization by lynx. Habitat type availability was defined on a 245 km^2 area encompassing most (>98%) of the lynx locations obtained. Preference for or avoidance of a habitat type was calculated from the location points using a X^2 test, computing Bonferroni confidence intervals (Neu et al. 1974, Byers et al. 1984).

Results

Trapping Success

Traps were set on up to 51 km of line for a total of 1787 trap-nights (TN) in November 1990 and 1965 TN in March-April 1991. Eight lynx, including one kitten, were captured in November, and nine lynx, including three kittens, were captured during the spring session. Trap success was 218 and 223 TN per lynx in November and spring, respectively. One red fox (*Vulpes vulpes*) was captured in the spring, and three wolverines (*Gulo gulo*) were trapped, two in November and one in the spring.

No lynx were captured by the Godwin trap. During the spring session, lynx escaped capture eight times from Fremont traps by either springing the trap and not getting caught, or by escaping after capture. Most misses were attributed to poor trap set-up or to the short piece of surgical tubing placed on the snare to minimize the risk of freezing damage. The surgical tubing subsequently was removed from all snares. One capture-related mortality occurred in early winter, a male kit that broke its forearm in the trap.

Since the start of the study in March 1989, 54 lynx were captured 69 times (Table 7). The sex ratio of captured lynx was biased towards males (32 males:22 females). Twenty-eight individual adult lynx (16F:12M) and 26 individual kittens ($\leq$10 months old at initial capture)(18M:10F) have been captured. The number of kittens captured dropped from 9 and 13 during spring 1989 and 1990, respectively, to three during spring 1991. At the end of March 1991, 26 lynx were wearing functioning collars on or near the study area, 25 adults and 1 kitten.

There appears to be a general trend of decreasing body weight of captured lynx since the beginning of the study (Table 8); however, small sample sizes preclude detailed examination of trends among years. Nevertheless, mean body weights in all age and sex classes in spring 1991 were the lowest recorded thus far.

Table 7. Lynx (> 9 months) captured and kittens (< 2 months) ear-tagged, March 1989 - April 1991.

LYNX ID	NAME	CAPTURE DATE	SEX	AGE	WEIGHT (kg)	COLLAR FREQ.	FATE / DATE LAST LOCATED
1		06MAR89	M	0	6.5	.	
		05FEB90	M	1	.	.	TRAPPED 24 KM SW OF STUDY
2	CLEO	06MAR89	F	3	9.1	150.630	
		20MAR90	F	4	8.1	150.530	RESIDING IN STUDY AREA
3		07MAR89	M	0	7.2	.	UNKNOWN: TAGGED ONLY
4		07MAR89	M	0	6.2	.	
		24NOV89	M	1	.	.	TRAPPED 47 KM NNE OF STUDY
5	TYSON	08MAR89	M	4	12.7	150.510	
		16NOV89	M	5	12.2	150.510	
		13JAN90	M	5	.	150.510	TRAPPED ON STUDY AREA
6	OLDMAN	16MAR89	M	1	11.1	150.690	
		05MAR91	M	3	.	150.690	DIED MAR91, CAUSE UNKNOWN
7		17MAR89	M	0	7.4	.	CAPTURE MORTALITY
8		18MAR89	F	0	7.4	.	
		15JAN90	F	1	.	.	TRAPPED 385 KM WSW OF STUDY
9	STEPHANIE	26MAR89	F	1	9.3	150.710	DISPERSED TO W, APR89
		01JAN90	F	2	.	150.710	TRAPPED 445 KM SE OF STUDY
10	MARIO	26MAR89	M	1	11.8	150.760	
		20MAR90	M	2	11.5	150.500	RESIDING IN STUDY AREA
11	WAYNE	28MAR89	M	1	9.7	150.650	
		21NOV89	M	2	11.2	150.650	
		22MAR90	M	2	10.0	150.600	DISPERSED (?) APR91
12	NAHANNI	01APR89	F	0	6.7	150.570	DISPERSED TO W, APR89
		27DEC89	F	1	.	150.570	TRAPPED 125 KM W OF STUDY
13	TOM	01APR89	M	0	6.8	150.540	UNKNOWN: LAST LOCATED 28DEC89
14	DICK	01APR89	M	0	7.7	150.740	
		12NOV89	M	1	11.7	150.740	RESIDING IN STUDY AREA
15	ALEX	03APR89	M	0	6.5	150.780	RESIDING 20 KM SW OF STUDY
16	PAM	29JUN89	F	0	0.8	.	
		24MAR90	F	0	7.2	150.671	DISPERSED TO W, MAY90
		21DEC90	F	1	.	150.671	TRAPPED 68 KM W OF STUDY
17		29JUN89	F	0	0.8	.	UNKNOWN: TAGGED ONLY

Table 7. (continued)

LYNX ID	NAME	CAPTURE DATE	SEX	AGE	WEIGHT (kg)	COLLAR FREQ.	FATE / DATE LAST LOCATED
18		29JUN89	M	0	0.8	.	UNKNOWN: TAGGED ONLY
19	CAUGHLEY	29JUN89	M	0	0.9	.	
		26MAR90	M	0	7.9	150.409	UNKNOWN: LAST LOCATED 23APR90
20	MIKA	11NOV89	F	1	9.3	150.409	
		28DEC89	F	1	.	150.409	TRAPPED ON STUDY AREA
21	CHRIS	11NOV89	M	1	10.4	150.370	
		23MAR90	M	1	9.9	150.370	
		01APR91	M	2	10.0	150.360	RESIDING IN STUDY AREA
22	HORTON	13NOV89	M	1	9.8	150.390	UNKNOWN: LAST LOCATED 12JAN90
23	BEAU	13NOV89	F	1	9.7	150.441	
		21MAR91	F	2	8.2	150.440	RESIDING IN STUDY AREA
24	RHONDA	13NOV89	F	2	9.4	150.430	
		14NOV90	F	3	10.5	150.570	RESIDING IN STUDY AREA
25	DAWN	18NOV89	F	3	9.2	150.610	
		22NOV89	F	3	9.2	150.610	RESIDING IN STUDY AREA
26	JOHN	21NOV89	M	1	10.0	150.550	UNKNOWN: LAST LOCATED 30MAR90
27	HEATHER	23NOV89	F	1	8.9	150.490	RESIDING IN STUDY AREA
28	ED	30NOV89	M	1	10.8	150.470	DISPERSED 10-15 KM W OF STUDY
29	BECKY	21MAR90	F	1	8.4	150.580	
		16NOV90	F	2	8.9	150.580	RESIDING IN STUDY AREA
30		22MAR90	M	0	7.0	.	UNKNOWN: TAGGED ONLY
31		26MAR90	M	0	8.0	.	UNKNOWN: TAGGED ONLY
32		26MAR90	M	0	5.6	.	UNKNOWN: TAGGED ONLY
33	ANNE	27MAR90	F	5	10.6	150.621	DISPERSED (?) MAY91
34		27MAR90	F	0	5.9	.	UNKNOWN: TAGGED ONLY
35		28MAR90	F	0	5.2	.	UNKNOWN: TAGGED ONLY
36	MITCH	29MAR90	M	1	10.4	150.730	RESIDING IN STUDY AREA
37		30MAR90	F	0	5.5	.	UNKNOWN: TAGGED ONLY

Table 7. (continued)

LYNX ID	NAME	CAPTURE DATE	SEX	AGE	WEIGHT (kg)	COLLAR FREQ.	FATE / DATE LAST LOCATED
38	JUANETTA	31MAR90	F	0	7.3	150.640	DISPERSED (?) NOV90
39	BRONSON	01APR90	M	1	9.3	150.660	
		26MAR91	M	2	9.8	150.650	RESIDING IN STUDY AREA
40		01APR90	F	0	6.7	.	UNKNOWN: TAGGED ONLY
41		01APR90	M	0	6.4	.	UNKNOWN: TAGGED ONLY
42		02APR90	M	0	7.8	.	CAPTURE MORTALITY
43	SEAN	02APR90	M	1	9.8	150.750	
		12NOV90	M	2	11.6	150.750	RESIDING IN STUDY AREA
44		04APR90	F	0	6.6	.	UNKNOWN: TAGGED ONLY
45	ERIK	06APR90	M	1	10.2	150.699	RESIDING IN STUDY AREA
46	LAURA	06APR90	F	1	10.3	150.630	DISPERSED (?) JUN91
47		21JUN90	F	0	0.9	.	KIT: TAGGED 21JUN90
48		21JUN90	F	0	0.8	.	KIT: TAGGED 21JUN90
49		21JUN90	M	0	0.8	.	KIT: TAGGED 21JUN90
50		21JUN90	F	0	0.6	.	KIT: TAGGED 21JUN90
51		21JUN90	M	0	0.7	.	KIT: TAGGED 21JUN90
52		21JUN90	M	0	0.7	.	KIT: TAGGED 21JUN90
		22NOV90	M	0	5.7	.	CAPTURE MORTALITY
53		21JUN90	M	0	0.7	.	KIT: TAGGED 21JUN90
54		21JUN90	F	0	0.4	.	KIT: TAGGED 21JUN90
55		21JUN90	F	0	0.4	.	KIT: TAGGED 21JUN90
56		21JUN90	M	0	0.5	.	KIT: TAGGED 21JUN90
57		21JUN90	M	0	0.4	.	KIT: TAGGED 21JUN90
58		21JUN90	M	0	0.5	.	KIT: TAGGED 21JUN90
59		21JUN90	M	0	0.7	.	KIT: TAGGED 21JUN90

Table 7. (continued)

LYNX ID	NAME	CAPTURE DATE	SEX	AGE	WEIGHT (kg)	COLLAR FREQ.	FATE / DATE LAST LOCATED
60	FELIX	21JUN90	M	0	0.7	.	KIT: TAGGED 21JUN90
		21MAR91	M	0	5.5	150.310	DISPERSED MAY91
		13JUL91	M	1	.	150.310	SHOT 74 KM WSW OF STUDY
61		21JUN90	F	0	0.6	.	KIT: TAGGED 21JUN90
62		21JUN90	M	0	0.6	.	KIT: TAGGED 21JUN90
63	UBIA	12NOV90	F	1	8.9	150.710	RESIDING IN STUDY AREA
64	NODA	13NOV90	M	1	9.1	150.770	RESIDING IN STUDY AREA
65	NEVIK	29NOV90	M	2	10.0	150.480	DISPERSED TO W, 25MAR91
66	PETER	01DEC90	M	2	9.1	150.789	
		18MAR91	M	2	10.0	150.789	DISPERSED TO S, 28MAR91
67	RANDI	20MAR91	F	2	7.6	150.420	DISPERSED (?) JUN91
68		23MAR91	M	0	7.0	.	UNKNOWN: TAGGED ONLY
69	DENNIS	25MAR91	M	2	8.9	150.350	DISPERSED TO SW, MAY91
70		28MAR91	F	0	5.7	.	UNKNOWN: TAGGED ONLY

Table 8. Weight (kg) of lynx captured in the MBS, March 1989 - April 1991.

Age Class	Sex	n	Weight	SD
Kittens (<12 months)				
Mar/Apr 89	M	7	6.9	0.55
	F	2	7.1	0.50
Mar/Apr 90	M	6	7.1	0.97
	F	7	6.3	0.82
Mar/Apr 91	M	2	6.3	1.06
	F	1	5.7	.
Adults (>18 months)				
Mar/Apr 89	M	4	11.3	1.27
	F	2	9.2	0.14
Nov 89	M	7	10.9	0.88
	F	6	9.2	0.45
Mar/Apr 90	M	7	10.2	0.69
	F	4	9.4	1.28
Nov 90	M	4	9.9	1.19
	F	3	9.4	0.92
Mar/Apr 91	M	4	9.7	0.53
	F	2	7.9	0.42

Based on captured lynx and snow tracking, the number of lynx on the study area reached 27 lynx/100 km^2, the highest level observed since the start of the study (Table 9). These counts indicate the minimum numbers present, because snow conditions did not always allow accurate determination of the number of untrapped animals, especially during November. Similarly, bounding the area considered for density estimates was subjective given the uniform nature of the habitat surrounding the trapping area. The April 1989 estimate is likely low, since this was the first trapping session in the study and some problems were encountered with the Fremont trap (Poole 1989).

Table 9. Estimated lynx density (/100 km^2) on the study area, March 1989 to April 1991.[a]

Date	No. Collared/ Ear-tagged	Untrapped Lynx	Estimated Total	Estimated Density
Apr 1989	15	2-3	17-18	14
Nov 1989	18	-	18	14
Apr 1990	29	-	29	21
Nov 1990	17	7	24	18
Apr 1991	22	13	35	27

[a] Number of untrapped lynx determined by track counts; poor snow conditions precluded some estimates of number of untrapped lynx. The number of kittens present during November usually is greatly underestimated.

Kitten Production and Movements

Nine adult female lynx with functioning radio-collars were found within the study area in June 1991. Six radio-telemetry flights were conducted during the denning period, as well as two ground-based attempts to walk to den sites. Visuals on four of the females were obtained in early July. No litters were located. Based on non-localization of lynx, I believe that only one of the nine females had young in mid- to late June, at which time the kits would have been 2-3 weeks of age. I was unable to locate two of the females after mid-June, and I presume these lynx dispersed from the area. Breeding likely did take place in the spring, since male and female lynx often were located (by telemetry) together or in very close proximity during the last week of March and the first two weeks of April.

Only one kitten was radio-collared in March 1991. This male (no. 60) was loosely associated with its mother (no. 29) until early May, when he dispersed to the west. The male was subsequently shot at a camp (it was attacking a dog) in July, 74 km west of the study area.

Home Range and Movements

Mean home range size (95% MCP) of male lynx (16.6 km^2) was similar to females (17.1 km^2) (t-test, $P > 0.8$) (Table 10). Home range sizes decreased in both sexes between 1989-90 and 1990-91, but not significantly (t-test, $P = 0.14$). A large degree of overlap was observed in home ranges among females, but not among males (Figs. 6, 7).

Distance travelled daily (DTD) in spring 1991 decreased slightly for both sexes over the previous year, but not significantly (t-tests, $P > 0.35$) (Table 11).

The number of lynx tracks counted on the traplines averaged 0.210 tracks per km-day during the November 1990 trapping session, almost double that observed in November 1989 (0.111). In spring 1991, on average 0.573 tracks per km-day were observed, considerably higher than the 0.166 tracks observed in spring 1989. No track counts were available from spring 1990. More data are required to evaluate whether or not track counts can be used as a means of assessing population density.

Survival and Dispersal

No deaths were recorded during the summer of 1990 (Table 12). One death of a radio-collared lynx was attributed to trapping during the winter, and one lynx died of unknown natural causes in March 1991, lowering the survival rate for the winter and the year to 0.91. The trapped lynx was taken 68 km west of the study area.

Three litters containing a total of 11 kittens in June 1990 were believed to contain 9-10 kittens in November based on winter tracking. A female kit/yearling (no. 38) that remained on the study area and may have denned in July 1990 did not have kittens accompanying her in November.

Prior to March 1991, all lynx known to have dispersed from the study area were kittens or yearlings (Table 13). Between March and June 1991, a larger proportion of older lynx on the study area also dispersed. An assumption was made with suspected dispersing

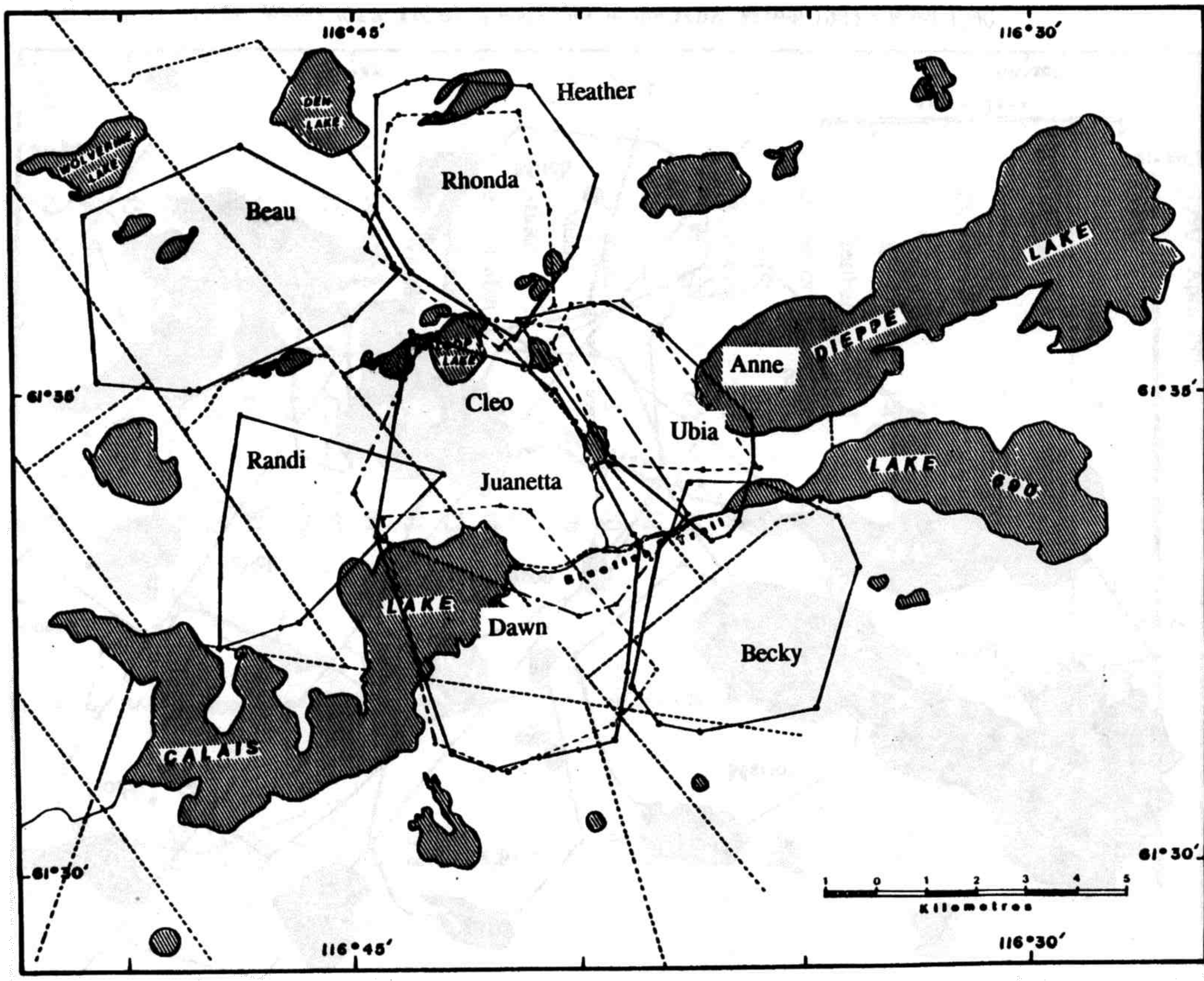


Figure 7. Home ranges (95% MCP) of female lynx in the MBS, March 1989 - April 1990.

Table 11. Distance travelled daily (m) for lynx in the MBS, March 1990 - March 1991.

	Females			Males		
Season	n	Mean	SD	n	Mean	SD
Spring 90	53	2162	1334.4	54	2084	1414.0
Nov 90	87	1378	897.4	60	2321	1327.0
Jan 91	17	2158	1153.4	14	1670	767.6
Feb 91	21	1404	857.6	26	1560	952.7
Spring 91	156	1992	1203.1	133	2006	1330.5

Table 12. Survival of lynx radio-collared in the MBS, April 1990 to March 1991.

						Conf. Limits	
Date	No. at Risk	No. of Deaths	No. Censored	No. Added	Survival	Lower	Upper
Apr 90	17	0	1	4	1.00	1.00	1.00
May 90	20	0	0	0	1.00	1.00	1.00
Jun 90	20	0	0	0	1.00	1.00	1.00
Jul 90	20	0	0	0	1.00	1.00	1.00
Aug 90	20	0	0	0	1.00	1.00	1.00
Sep 90	20	0	0	0	1.00	1.00	1.00
Oct 90	20	0	0	0	1.00	1.00	1.00
Nov 90	20	0	1	4	1.00	1.00	1.00
Dec 90	23	1	0	1	0.96	0.88	1.04
Jan 91	23	0	0	0	0.96	0.88	1.04
Feb 91	23	0	0	0	0.96	0.88	1.04
Mar 91	23	1	2	3	0.91	0.81	1.02

Table 13. Fate of radio-collared (R) and ear-tagged (E) lynx which dispersed >20 km from the study.

Lynx ID	Marking	Sex	Age	Capture Date	Fate
1	E	M	0	Mar 89	Trapped 24 km SW, Feb 90
4	E	M	0	Mar 89	Trapped 47 km NNE, Nov 89
8	E	F	0	Mar 89	Trapped 385 km WSW, Jan 90
9	R	F	1	Mar 89	Trapped 445 km SE, Jan 90
11	R	M	1-2	Mar 89	Dispersed Apr 91, location unknown
12	R	F	0	Apr 89	Trapped 125 km W, Dec 89
13	R	M	0	Apr 89	Dispersed 25 km SW, last located Dec 89
16	R	F	0-1	Mar 90	Dispersed May 90, trapped 68 km W Dec 90
26	R	M	1	Nov 89	Dispersed Mar 90, location unknown
33	R	F	5-6	Mar 90	Dispersed May 91, location unknown
38	R	F	0-1	Mar 90	Dispersed Nov 90, location unknown
46	R	F	1-2	Apr 90	Dispersed Jun 91, location unknown
60	R	M	0-1	Mar 91	Dispersed May 91, shot 74 km WSW Jul 91
65	R	M	2	Nov 90	Dispersed to W Mar 91, location unknown
66	R	M	2	Dec 90	Dispersed Mar 91, location unknown
67	R	F	2	Mar 91	Dispersed Jun 91, location unknown
69	R	M	2	Mar 91	Dispersed to SW May 91, location unknown

animals that failure to pick up a radio signal that had been located previously on the study area meant that the lynx had dispersed, rather than the collar had failed. With the exception of five Wildlife Material Inc. radio-collars (three of which have been accounted for), no Telonics collars have been shown to have failed prematurely. Known dispersal distances and direction varied greatly.

Habitat Utilization

Use of habitat types by all lynx as a group was not proportional to availability (X^2 = 263.8 , $P < 0.001$). Meadows, sparsely vegetated areas and recent burns were avoided and mixed forests and coniferous forest habitats were preferred (Table 14). There was a significant difference in habitat use patterns between sexes (G-test, $P = 0.016$), with females showing more preference for mixed forest types and more avoidance of recent burns.

Table 14. Habitat type use relative to availability by male and female lynx, April 1990 - April 1991.[a]

Habitat Type	Proportion Available	Proportion Utilized	Preference/ Avoidance
Meadows	0.135	0.028	Avoid
Shrubland	0.030	0.028	ns
Mixed Forest	0.171	0.304	Prefer
Coniferous Forest	0.434	0.481	Prefer
Organic Terrain	0.110	0.124	ns
Sparsely Vegetated	0.089	0.021	Avoid
Recent Burns	0.031	0.014	Avoid

[a] Preference/avoidance $P < 0.05$.

Discussion

Hare numbers on the study area during late winter 1990-91 dropped dramatically. The timing and consequences of this drop is important as it relates to the reaction of resident lynx. Hare numbers on the study area likely reached their lowest levels fairly late in the winter. As the winter progressed, actual hare densities decreased but the proportion of the hare population vulnerable to predation may have increased, thus the actual density of hares at risk to predation may have increased or remained high for much of the winter (Keith 1990:160). Therefore, with the exception of very late in the winter, we see little overt reaction by the lynx to declining hares: home range sizes remained small, no increased dispersal patterns were observed, DTD did not increase, and kitten survival, at least until late November, was high.

In the latter stage of the winter, however, the critical lower hare density (Ward and Krebs 1985) may have been approached. Lynx weights were the lowest recorded for the spring. The number of lynx tracks observed more than tripled in March 1991 compared with the previous March, while the lynx population density was only slightly higher. Dispersal of older lynx began in late March, and by late June 28% (7/25) of the yearling and older lynx present in March had left. The first natural mortality of a lynx on the study area was recorded in March. Kitten production in June 1991 was dismal compared with previous years. These observations may be the reaction by the lynx population to greatly reduced densities of their main prey.

The decrease in trapping success observed in 1990-91 may have been related to two factors. A majority of the lynx on the study area have been trapped at least once, and there may be a learned avoidance of the sets, which may be passed on to the kittens. In addition, the drop in hare numbers and the resulting nutritional stress may have affected the vulnerability of the animals to traps.

Telemetry data suggest that breeding took place in late March and early April 1991. If indeed few or no kittens were present in late June, it is unclear when the mortality occurred: failure of the females to ovulate or implant, resorption of fetuses, death of the kittens at birth, or death at 1-3 weeks of age. Snow tracking in November 1991 should confirm whether or not any kittens have survived to early winter, as potential recruits into the population.

Extensive home range overlap between sexes and among individual females was evident. The non-overlap among most males is distinct. It is interesting to note that the three males that dispersed in March and April overlapped with other lynx. With removal of these lynx the males return to a non-overlap pattern. Although previous studies have shown no consistent pattern of range overlap (summarized in Hatler 1988:18), the inability to capture and monitor all lynx in a given area may lead to erroneous conclusions regarding range overlap, underestimating the degree to which overlap occurs (Ward and Krebs 1985). Alternatively, the spatial distribution of lynx may be affected by environmental factors (primarily prey availability) which dictate the degree to which range overlap, both within and between sexes, is tolerated (Ward and Krebs 1985).

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