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LYNX RESEARCH

IN THE NWT, 1989-90

Northwest
Territories Renewable Resources

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The interpretations presented in this report are those of the author and do not necessarily represent those of the Department.

ABSTRACT

This report summarizes lynx harvest trends, and ongoing research programs conducted during 1989-90 in the NWT. Results of carcass collections, pelt measurements, snowshoe hare indices, and a live-trapping and radio-collaring study are given.

The 1988-89 harvest was 3188 pelts, an increase of 57% over the previous year. Average pelt price dropped 37% to $244. Figures for the 1989-90 season are not yet available.

A total of 273 lynx carcasses were collected from trappers in Fts. Simpson, Providence and Smith, 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. A pelt length of 89 cm (35 inches) appears to be the best dividing point for separating pelts from kittens and older lynx; pelts $\leq$ 89 cm were kits. Kittens (23. 1%) and yearlings (62.3 %) dominated the sample overall. The proportion of kittens increased and yearlings decreased as the season progressed. Most of the lynx taken were males (54.8%). Body condition (as determined by fat indices) did not differ from the 1988-89 sample. There was little difference in reproductive rates among communities.

Lynx pelts from across the NWT were measured to provide an indication of the proportion of kits in the harvest. Twenty-five percent of the 2060 pelts measured were $\leq$ 89 cm, and, therefore, were presumed to be kits. Kitten production and survival were excellent during 1989 across much of the western NWT.

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 increased slightly or stayed the same in all areas sampled. The MBS had the highest overall estimate at just under 4 hares/ha.

A lynx live-trapping and radio-collaring program was initiated in the MBS in March 1989, primarily 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 1989-90, 33 individual lynx were captured 37 times on a 130 km^2 study area. As of April 1990, 22 lynx wore functional radio collars. Dens of four females were located in June 1990, and 16 kittens were ear-tagged. Home range size (95 % minimum convex polygon) averaged 36.3 km^2 for seven males and 20.8 km^2 for four females. Overlap of home ranges between and within sexes was observed. Six lynx 0-1 years of age dispersed from the study area; dispersal distances and direction varied greatly. The only mortalities recorded were from trapping. Survival rate of dispersing lynx was less than that of residents. Meadows and sparsely vegetated areas were avoided and mixed forest types were preferred by lynx. Hare densities to spring 1990 have been high within the study area.

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INTRODUCTION

The lynx (Lynx *canadensis*) harvest in the Northwest Territories (NWT) provides northern trappers with an important source of income and traditional livelihood. Lynx numbers generally cycle following the 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 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 second year of examination of lynx in the NWT (first year summarized in Poole 1989). 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 1988-89, 572 out of 2352 trappers in the NWT sold 3188 lynx pelts worth $779,000. This harvest was 1.57 times that of the previous year, although with decreased pelt prices the overall value of the harvest remained constant. The value of the NWT lynx harvest was second only to marten (*Martes americana*) pelt production. The greatest absolute increase in lynx harvest occurred in the Hay River District, primarily in Ft. Providence (Table 1). Figures for the 1989-90 season are not yet available, but indications are that there will be a slight increase in the harvest. 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 1988-89 season dropped 37% from the previous year to $244. Lynx pelt prices dropped 50-60% during 1989-90, with up to 15% of lynx pelts going unsold.

The fur return system does not account for unsold pelts, or furs used domestically or sold privately. Given the relatively high value of the lynx pelt, most furs were sold through the auction system in 1988-89, and thus were tabulated.

Table 1. Number of NWT lynx sold in 1987-88 and 1988-89 based on fur return records.

Community	1987-88	1988-89	% Change
Aklavik	10	12	+ 20
Arctic Red R.	5	20	+400
Ft. Franklin	19	18	- 5
Ft. Good Hope	19	19	0
Ft. McPherson	7	12	+ 71
Ft. Norman, N. Wells	26	32	+ 23
Inuvik	21	25	+ 19
Tuktoyaktuk	9	0	
Inuvik Region	116	138	+ 19
Ft. Liard	144	85	-41
Ft. Simpson	232	292	+ 26
Jean Marie R.	10	28	+180
Nahanni Butte	54	100	+ 85
Trout L.	64	164	+ 156
Wrigley	21	83	+295
Ft. Simpson Dist.	525	752	+ 43
Ft. Providence	239	625	+161
Hay River	110	144	+ 31
Ka.kiss L.	26	43	+ 65
Hay River Dist.	375	812	+117
Dettah	3	14	+366
Ft. Rae	161	258	+60
Lac La Martre	20	94	+370
Rae Lakes	3	7	+133
Snare L.	1	0	
Yellowknife	86	126	+ 47
Yellowknife Dist.	274	499	+ 47
Ft. Resolution	255	284	+ 11
Ft. Smith	435	626	+ 44
Pine Point	20	39	+ 95
Snowdrift	31	38	+ 23
Alta/Sask Trappers	6	0	
Ft. Smith Dist.	747	987	+ 32
Total NWT	2037	3188	+ 57

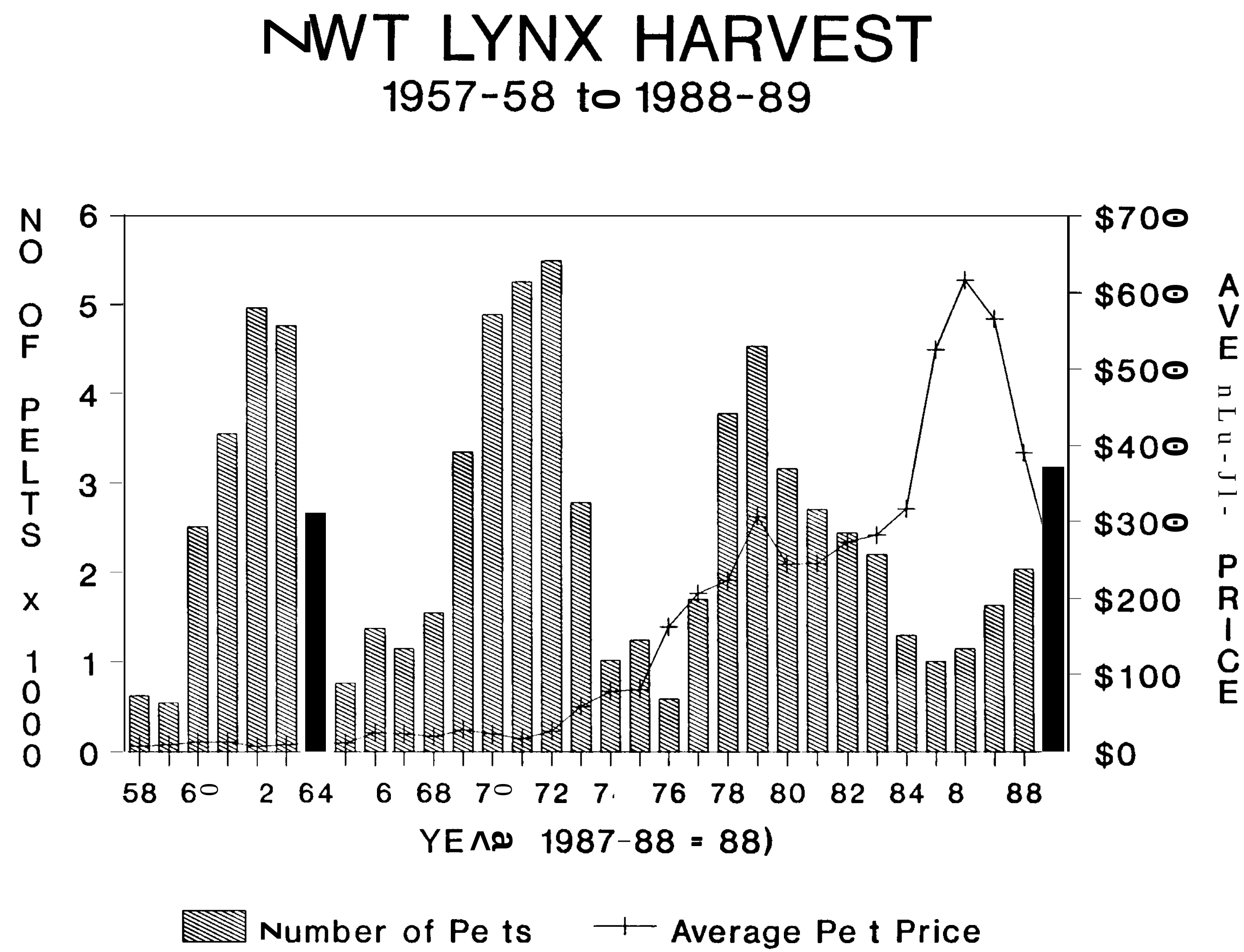


Figure 1 Lynx harvest and average pelt price for the NWT, 1957-58 to 1988-89.

CARCASS COLLECTIONS

Introduction

An examination of lynx carcasses donated by trappers from selected communities in the NWT continued during the 1989-90 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 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 provide 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, Smith 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 microscopically 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 "O" (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 273 lynx carcasses was examined during the 1989-90 season: Ft. Simpson - 113 from 5 trappers; Ft. Providence -137 from 8 trappers; Ft. Smith -19 from 1 trapper; and Yellowknife -4 from 1 trapper. Kittens made up 23.1% of the sample, with more kittens harvested later in the season (Table 2). Yearlings dominated the sample overall (62.3 %). Their proportion in the harvest decreased as the season progressed. Mean age (kit =0, yearling =1, etc.) of the harvest was 1.01, down from 1.19 the previous year. This decreased average age resulted from fewer lynx > 5 years of age in the harvest, down from

Table 2. Percent of kittens, yearlings, and adults (2+ years) each month, and sex ratio in lynx carcasses examined during the 1989-90 season.

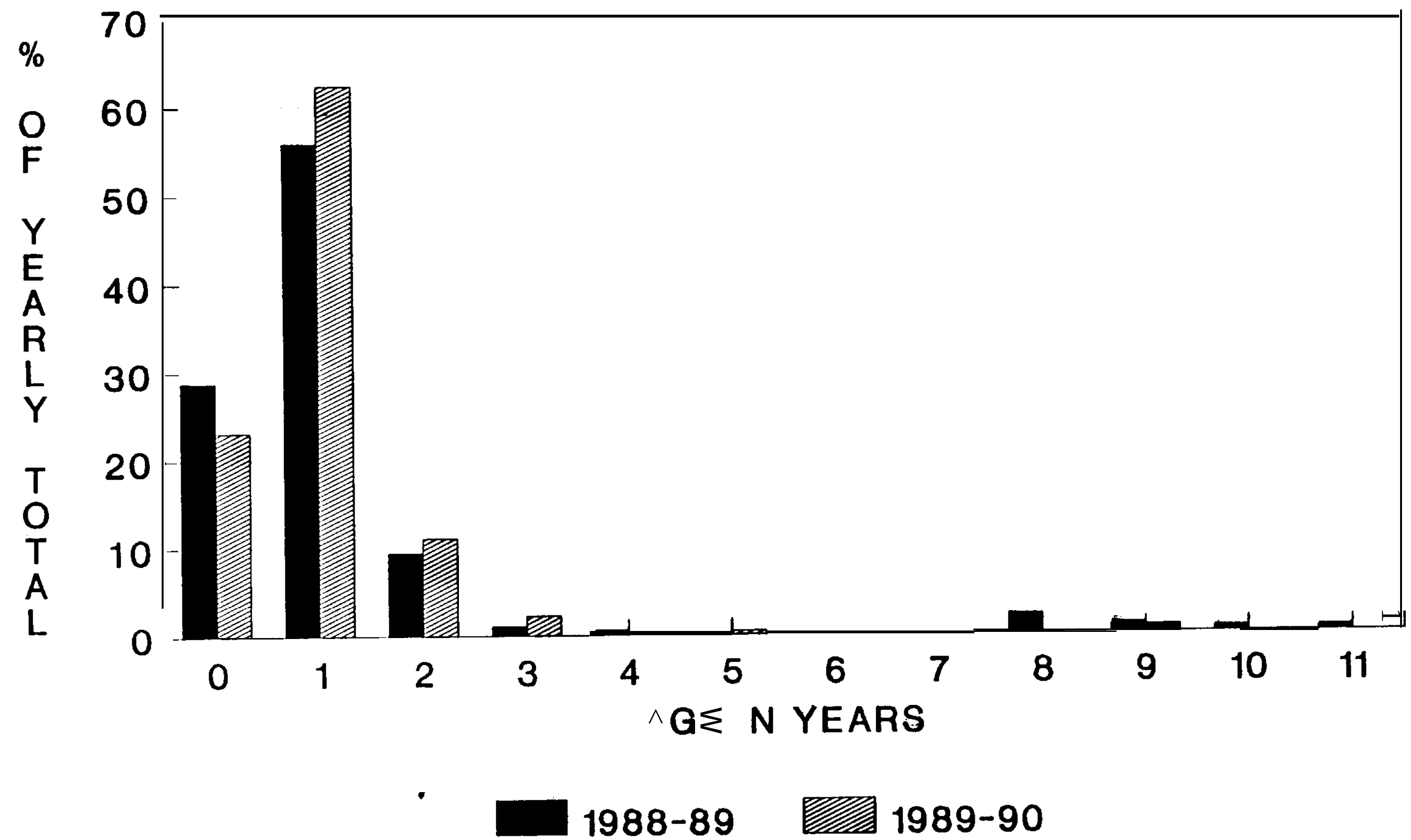
	Month Trapped					
	Nov	Dec	Jan	Feb	Mar	Total
Sample Size	34	105	63	64	7	273
Age Class						
Kitten	2.9	13.3	34.9	37.5	28.6	23.1
Yearling	82.4	73.3	47.6	50.0	42.9	62.3
Adult	14.7	13.3	17.5	12.5	28.6	14.7
Sex Ratio						
M:F	48:52	60:40	43:57	61:39	57:43	55:45

4.5 % in the 1988-89 harvest to < 1 % in the 1989-90 harvest. Most (54.8%) of the lynx examined were males ($P > 0.1$), with proportionately more males taken in November and December (57%) than after 1 January (51%) (Table 2). The age of animals in the collection was heavily skewed towards the O-1 year age classes (Fig. 2).

Pelt lengths paired to carcasses were available for 179 lynx from 1989-90. Pelt length was plotted by age class (kits v. older) to determine the best length to estimate the proportion of kittens in the population. Using $\leq$ 89 cm, none of the kits were incorrectly classified and about 10% of the yearlings and adults were incorrectly classified as kittens. At $\leq$ 88 cm these proportions change to 2% and 3%, respectively. When data from 1988-89 and 1989-90 are combined (n = 286), using $\leq$ 89 cm would result in misclassifying 13% and 7% of the kittens and older lynx, respectively (Fig. 3). At $\leq$ 88 cm 20% of the kits and 2% of the older lynx were misclassified. Given the greater proportion of yearlings and adults in the harvest (roughly 3: 1), $\leq$ 89 cm still appears to be the most appropriate measurement to use

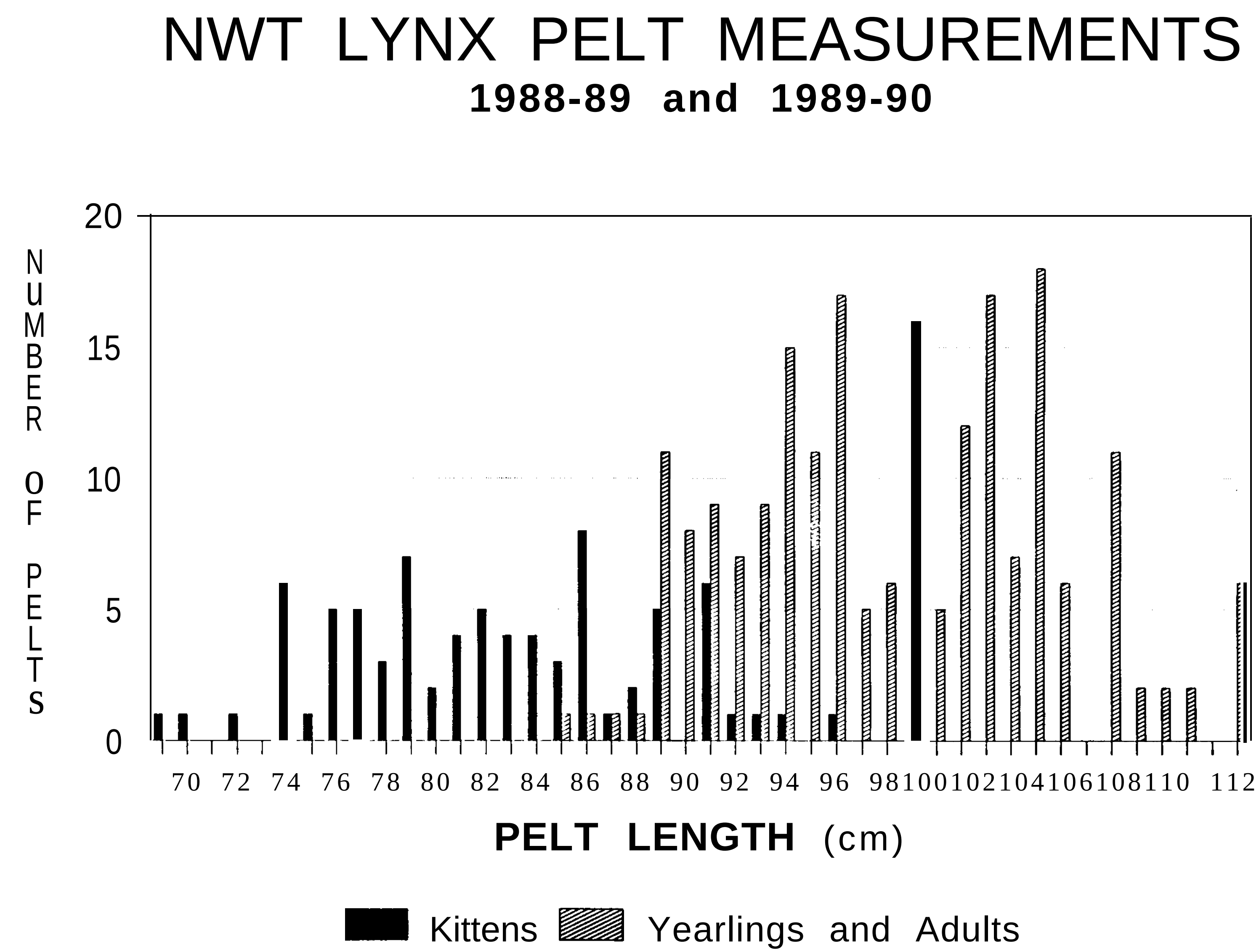
NWT LYNX CARCASS COLLECTIONS

1988-89 and 1989-90



Sample size: 1988-89 181, 1989-90 273

Figure 2. Age structure of lynx carcasses examined during 1988-89 (n = 181) and 1989



Sample size: 286 pelts

Figure 3. Lynx pelt' size by age class, 1988-89-1989-90 (**n** = 286).

Table 3. Kidney fat index and xiphoid fat weight by age class.

Age Class	Kidney Fat Index n	Mean	SD	Xiphoid Fat (g) n	Mean	SD
0	62	16.3	8.82	61	2.6	3.74
1	165	17.8	12.60	165	9.3	9.83
2	26	20.1	17.54	27	14.8	18.63
3 +	9	17.7	9.75	9	17.5	18.00

to determine accurately the proportion of kittens in the harvest. There was only a slight trend for increased kit pelt length as the trapping season progressed.

Both xiphoid fat and kidney fat index (KFI) were available for 258 carcasses. The correlation between the two indices was strong (r = 0.80, P < 0.0001); however, xiphoid fat decreased to zero (no visible xiphoid) before the KFI reached its lower levels (minimum 4.6).

KFI increased among the first three age classes, and dropped slightly with older animals (Table 3); however, the differences were not significant (Kruskal-Wallis test, P = 0.3). The weight of xiphoid fat was low in kittens, increased in yearlings and 2-year-olds, and was highest in the 3 + age class. KFI did not differ between years among age classes (Mann-Whitney U tests, all P > 0.3). While no significant difference in KFI by community was observed in the 1988-89 sample (Kruskal-Wallis test, P = 0.08), Ft. Simpson lynx were fatter than Fts. Providence and Smith lynx in 1989-90 (P < 0.001).

The number of young produced in the spring of 1989, as determined by counts of recent placental scars (RPS), varied with age class, although mean *in utero* litter size of those that bred were similar between yearlings and older lynx (Table 4). Fifty-nine percent of all yearlings bred in their first year, a drop from the 77% of yearlings that bred in the 1988-89 sample. Mean *in utero* litter size decreased between years for 1 and 2 + age classes, but not significantly (P > 0.2). There appeared to be little difference in mean RPS counts among

Table 4. Number of recent placental scars (RPS) by age class, 1988-89 and 1989-90.

Age Class	Year	n	% With RPS	Mean No.RPS	Mean No. RPS Excluding 0s	Min. RPS	Max. RPS
o	89	25	0	0	0		
	90	25	0	0	0		
1	89	35	77	3.3	4.2	2	6
	90	69	59	2.4	4.1	1	7
2+	89	12	92	4.3	4.7	2	7
	90	17	100	4.0	4.0	4	6

communities, although small sample sizes in some age categories precluded statistical comparison.

A total of 37 stomachs was examined (17 from 1988-89 and 20 from 1989-90). Snowshoe hare remains were found in 36 of the stomachs (97%), red squirrel (*Tamiasciurus hudsonicus*) in one stomach (3%) and grouse sp. in five stomachs (14%). There appeared to be no difference in diet between years.

Discussion

The 89 cm (35 in.) pelt length criterion to differentiate pelts from kits and older lynx is currently used by the Yukon (Slough and Ward 1990), British Columbia (Archibald pers. comm.) and Alberta (Neumann pers. comm.). Alaska uses 34 in. (86.5 cm) (Melchior pers. comm.). Additional examination of pelt lengths will be conducted in the NWT to define the cutoff measurements further.

The age and sex ratios reported for this sample compare well with other studies . conducted during years with increasing or high hare densities. Brand and Keith (1979) found 31% kittens and 54% yearlings in a sample of Alberta lynx carcasses, while in an Ontario study Quinn and Thompson (1987) found 19% and 53%, respectively. At times of declining or low hare densities the proportion of kits in the harvest decreased to zero or nearly zero (Brand and Keith 1979, Parker et al. 1983). The shift within a season in the proportion of each age class in the harvest also compares closely with the Ontario study, with the proportion of yearlings decreasing and kits increasing as the season progresses (Quinn and Thompson 1985).

The missing cohorts in the 5-7 year age classes in 1988-89 and the 6-8 year age class in 1989-90 likely indicates that few kittens were produced or survived in spring 1981 to 1983, a period when hares may have been at their cyclic low. Early spring 1981 corresponds with the second winter after the peak lynx harvest of the last cyclic high in 1978-79.

Two factors suggest that, although still relatively high, the peak in kitten production may have passed. The downward shift in the proportion of kittens in the harvest and the increase in yearlings between years suggests that overall productivity may have dropped off slightly. The drop in the proportion of yearlings with RPS (from 77 to 59%) and the overall decrease in *in utero* litter size may indicate slightly less favorable conditions for breeding. Parker et al. (1983) found that during a decline in hare density the proportion of yearlings with scars decreased from 67% to O%, and O'Connor (1984) found 69% and 7% of yearlings had placental scars at high and low hare densities, respectively.

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. It 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 five 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. 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.

Results

Prior to the 1988-89 season, the number of pelts ≤ 84 cm was recorded (Table 5). The **total** percentage of "kits" decreased from 16.7% to 10.0%, then increased to 16.4% in the 1987-88 season. 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 (see Carcass Collections). Using 89 cm, of 2060 lynx pelts that were measured during the 1989-90 season, about 25% were kits, only slightly lower than the previous season (Table 5).

The proportion of kits in the harvest increased from 16.5% before Christmas, to 30-40% during the later part of the season (Table 6), similar to the pattern observed in the 1988-89 sample (Poole 1989). This pattern emphasizes the need to measure pelts consistently throughout the season; samples examined only late in the winter will always show a much larger proportion of kits in the harvest than occurs over the entire season.

Discussion

The continuing high proportion of kits in the 1989-90 harvest indicates that lynx production (number of kits per litter and survival of kits) was good during 1989 across much of the western NWT.

Table 5. Proportion oflynxkittens inthe harvest from **1985-86 to** 1987-88, **based on ≤ 84 cm pelt** length, **and in** 1988-89 and 1989-90 based on ≤ **89 cm** pelt length.

	Trapping Season									
	1985-86		1986-87		1987-88		1988-89		1989-90	
DDR Station	n	% Kits	n	% Kits	n	% Kits	n	% Kits	n	% Kits
Tuktoyaktuk					5	40	-		2	50
Aklavik	22	9	7	0	10	40	8	38		
Inuvik	6	50	32	9	23	26	-		28	50
Ft. McPherson	22	41	-		2	50	8	38		
Ft. Good Hope	27	11	47	17	15	13	19	26	7	43
Ft. Franklin	4	0	6	0	13	31	17	24	42	12
Ft. Norman	24	0	18	17	-		33	27	37	16
Norman Wells					9	33	-			
Ft. Simpson	74	23	112	8	161	11	318	29	548	28
Ft. Liard	110	6	191	9	229	13	276	21	248	24
Trout Lake							24	19		
Ft. Providence	26	12	72	4	-		247	28	436	22
Ft. Rae	32	3	65	3	31	29	28	46	87	33
Yellowknife	23	57	-		61	16	89	19	81	22
Hay River	48	25	-				258	28	199	25
Pine Point	21	19	58	26	-					
Ft. Smith	73	21	-	-	205	18	396	25	258	28
Ft. Resolution	27	7	-						87	15
Year Total (at ≤84 cm)	539	16.7	608	10.0	764	16.4				
Year Total (at ≤89 cm)		27.1		16.2		26.6	1721	25.9	2060	25.1

Table 6. Percentage of lynx kittens by month in pelts measured during 1989-90 based on ≤ 89 cm pelt length.

	Month[a]					
	Nov	Dee	Jan	Feb	Mar	Total
Sample size	209	640	657	346	208	2060
% Kittens	13.4	17.5	26.6	40.2	30.3	25.1

[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.

Because only the number of pelts ≤ 84 cm had been counted in the past, and not all pelt measurements recorded, it is difficult to compare data among years. If I assume 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 resulting population trend suggests strong production and survival of young for the past four years. Although there is no evidence, I continue to be suspicious of the 1985-86 figures; these proportions are much too high for a period when the lynx cycle was at or just starting to climb out of a low. It is possible that in 1985-86, the first year of pelt measurements, some pelts were measured incorrectly or the sample was biased towards lynx taken late in the season (predominately kittens).

The increase in the proportion of kits in the harvest as the season progresses may be due to several factors, including an increasing number of orphaned kits which are susceptible to being trapped as a result of adult females being taken through the winter (Parker et al. 1983). Increased numbers of kits in the harvest may also result from the kits developing independence and the onset of dispersal in late winter (Quinn and Thompson 1985).

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 kitten survival rate declines, resulting in greatly lowered recruitment (Nellis et al. 1972, Brand and Keith 1979, O'Connor 1984). Lynx populations generally peak 1-2 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 southern Mackenzie. This monitoring will be useful in predicting changes in lynx populations, and to assist 'in interpreting trends in lynx population parameters and harvests.

Methods

Two methods were used to index hare populations in the NWT. 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 et al. (1987):

Mean hares/hectare = 0.27(mean no. pellets) + 0.42

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 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 between years using paired t-tests.

Results

Although all between-year confidence limits overlapped considerably, hare densities increased in all areas relative to 1989, with the greatest increases occurring in Yellowknife (Table 7). Of 24 transects surveyed in all areas, only three had lower pellet counts and two remained the same. The MBS had the highest estimate of hare density at just under 4 hares/ha, with the highest transect at 6 hares/ha ($600/km^2$).

Track counts conducted in the MBS lynx study area showed fluctuations over the course of the winter, but November and March/April counts did not differ between years (both P >0. 19) (Table 8).

Discussion

Hare densities in most of the western NWT appear to have increased to varying degrees over the last year. Hare numbers in the Great Slave Lake area appear to have been at or near peak levels for three winters. I expect that given the nature of the snowshoe hare

Table 7. Snowshoe hare density estimates (hares/ha) from pellet counts, 1989 and 1990.

		1989			1990		
		No. Pellets			No. Pellets		
Location	No. Plots	Mean	SD	Hares /Ha	Mean	SD	Hares /Ha
Yellowknife	70	5.3	6.2	1.9	9.4	11.3	3.0
Ft. Smith	80	5.0	9.6	1.8	5.1	7.2	1.8
Pine Point	80				1.1	4.6	0.7
Norman Wells	80	4.1	5.9	1.5	4.8	9.2	1.7
Mackenzie sanctuary	100	10.7	10.5	3.3	13.0	16.0	3.9
Inuvik	101	0.9	3.1	0.7	1.2	2.9	0.7

Table 8. Hare track counts on nine l-km transects in the MBS, 1988 to 1990.

Date	Mean Tracks/ km-day	SD
Nov 88	228.8	110.0
Mar 89	105.0	55.2
Nov 89	186.0	62.4
Jan 90	98.8	25.4
Feb 90	67.0	18.6

cycle (Keith and Windberg 1978), densities should begin to fall in the Great Slave Lake area over the next year. Densities of 0.06-O.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 the means and 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 1 ynx 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 had 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 1990. Some information from the March 1989 session is reported in Poole (1989). 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 indicate that hare densities between 1989 and 1990 have remained high (see previous section). This represents the third winter (1987-88 to 1989-90) that hare densities have been at or near cyclic peaks (see previous section, pers. ohs.).

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. 4). 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. Mined" 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 bums, 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.

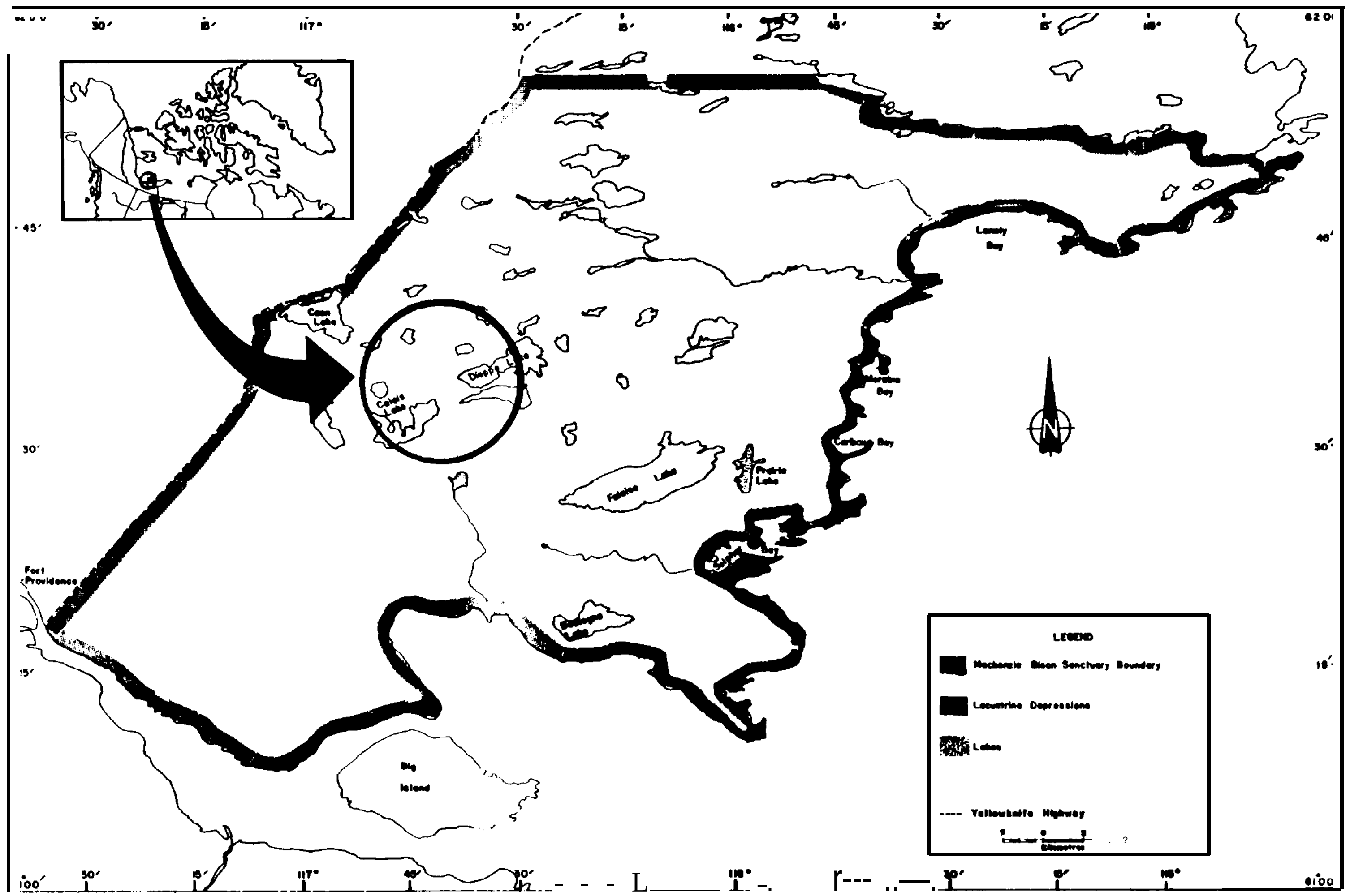


Figure 4. Location of the Sanctuary lynx study (circled).

Methods

Live-trapping was conducted 10-30 November 1989 (early winter) and 19 March-11 April 1990 (spring). Upto70Fremont leg-snares (Fremont Humane Traps, Candle Lake, SK) 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 (13) 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 and MOD-300, Telonics Inc., Mesa, AZ, and HLPM2 140LD and HLPM2 124LD, Wildlife Materials Inc., Carbondale, IL) were attached to all adults and some kittens. MOD-400 collar weight was < 270 g, and the remaining collars weighed < 180 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.

Dens of radio-collared females were visited in late June, and the kittens were weighed, sexed and ear-tagged (Size 1, Style 1005 Monel, National Band & Tag CO., Newport, KY). Survival of kits through the winter was determined by live-trapping, and tracking collared females.

Telonics RA2A (H) antenna for directional bearings and a Telonics model TR2 receiver and TS 1 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, except when ground crews were working. Fixed-wing aircraft (primarily Cessna 172 and Piper Super Cub) were used for aerial locations. All locations were taken during daylight hours. Time between successive bearings from the ground was generally < 45 minutes. Because of the layout of seismic lines, trails and lakebeds in the study, most ground based locations (68%) were taken $\leq$ 1 km from the animal, 93% were taken at $\leq$ 2 km, and only 7% > 2 km (n = 196). In 98% 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 four locations averaged 75 m (range O-150 m). From ground telemetry, average deviation from the true bearing was $\pm 6.5^{\circ}$ (n = 29). At 1 km the error polygon having this error was approximately 5.2 ha, and at 2 km it was about 20 ha.

Lynx home range size was estimated with the minimum convex polygon (MCP) method (Hayne 1949) using Program Home Range (Ackerman et al. 1989). To exclude excursions to areas outside its normal area, 95% MCP were used (White and Garret 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 Garret 1990: 37).

Mean distances between successive locations separated by intervals of 1-6 days were compared 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, P > 0.05); 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 for individuals during the spring field session.

In most cases, 95% MCP home range area appeared to be asymptotic after 20 locations (pers. data). Annual home ranges were determined for four individuals with 20-30 locations; the remaining eight lynx home ranges had > 30 locations. Home range and habitat analysis discussed here includes locations taken up to 10 April 1990, the end of the spring live-trapping session.

Lynx tracks were counted each day during trapping sessions when snow conditions permitted. Thaw and freezing conditions precluded track counts for the spring trapping session. 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 475 km^2 area encompassing the home ranges of the 12 lynx for which home range could be calculated. 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 50 km of line for a total of 693 trap-nights (TN) in November 1989 and 1270 TN in March-April 1990. Twelve individual lynx were captured 13 times in November, and 24 lynx were captured in the spring session. Trap success was S3 TN per lynx in both sessions. One red fox (*Vulpes vulpes*) was captured in November, and one wolverine (*Gulo gulo*), a young female, was captured in the spring.

Including both trapping sessions during winter 1989-90, 33 individual lynx were captured 37 times (Table 9). The sex ratio of captured lynx was nearly even (16 females: 17 males). Twelve individual adult lynx (5F:7M) and no kits were captured in November, and 11 adult lynx (including recaptures, 4F:7M) and 13 kits (7F:6M) were trapped in the spring session. At the end of the spring trapping session 22 lynx were wearing functioning collars on or near the study area, 19 adults and 3 kits (10 months old). All of the lynx known to be on the study area in April 1990 were $\leq$ 5 years old (Table 9).

One capture-related mortality occurred in the spring, a male kit that broke its forearm in the trap. Freezing damage occurred in four captures during the winter, primarily as a result of the lynx twisting and tightening the snare cable so much that blood circulation to the foot was cut off. Subsequent placement of swivels in the trap set appeared to have minimized this type of trap injury.

Body weight of captured lynx did not differ consistently between years (Table 10). There was no difference between years in weight of adult males (*t*-test, P = 0.07), or male kits captured in the spring (P = O. 62). Small sample size precluded examination of female weights between years. Overall, adult males weighed significantly more than adult females (mean 10.7 v. 9.3 kg, respectively, $P < 0.001$).

Table 9. Lynx (> 9 months) captured and kittens (< 2 months) ear-tagged, March 1989-' April 1990. ' "

LYNX ID	NAME	CAPTURE DATE	SEX	AGE	WEIGHT (kg)	COLLAR FREQ.	FATE / DATE LAST LOCATED
1		06MAR89	M	o	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		07 MAR89	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	RESIDING IN STUDY AREA
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	
		01JAN90	F	2	.	150.710	TRAPPED 445 KM SE OF STUDY
10	MAR 10	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	RESIDING IN STUDY AREA
12	NAHANNI	01APR89	F	0	6.7	150.570	
		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	UNKNOWN: LAST LOCATED 05JUN90
16	PAM	29JUN89	F	0	0.8	•	
		24MAR90	F	0	7.2	150.671	DISPERSED TO W, MAY90
17		29JUN89	F	0	0.8	•	UNKNOWN: TAGGED ONLY
18		29JUN89	M	0	008	•	UNKNOWN: TAGGED ONLY

Table 9. (continued)

LYNX ID	NAME	CAPTURE DATE	SEX	AGE	WEIGHT (kg)	COLLAR FREQ.	FATE / DATE LAST LOCATED
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	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	UNKNOWN: LAST LOCATED 08MAY90
24	RHONDA	13NOV89	F	2	9.4	150.430	UNKNOWN: LAST LOCATED 12DEC89
25	DAWN	18NOV89	F	3	9.2	150.610	
		22NOV89	F	3	.	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	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	RESIDING IN STUDY AREA
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
38	JUANETTA	31MAR90	F	0	7.3	150.640	RESIDING IN STUDY AREA
39	BRONSON	01APR90	M	1	9.3	150.660	RESIDING IN STUDY AREA
40		01APR90	F	0	6.7	.	UNKNOWN: TAGGED ONLY
41		01APR90	M	0	6.4	.	UNKNOWN: TAGGED ONLY

Table 9. (continued)

LYNX ID	NAME	CAPTURE DATE	SEX	AGE	WEIGHT (kg)	COLLAR FREQ.	FATE / DATE LAST LOCATED
42		02 APR90	M	0	7.8	.	CAPTURE MORTALITY
43	SEAN	02 APR90	M	1	9.8	150.750	RESIDING IN-STUDY AREA
44		04 APR90	F	0	6.6	.	UNKNOWN: TAGGED ONLY
45	ERIK	06 APR90	M	1	10.2	150.699	RESIDING IN STUDY AREA
46	LAURA	06 APR90	F	1	10.3	150.630	RESIDING IN STUDY AREA
47		21 JUN90	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
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
60		21JUN90	M	0	0.7	.	KIT: TAGGED 21JUN90
61		21JUN90	F	0	0.6	.	KIT: TAGGED 21JUN90
62		21JUN90	M	0	0.6	.	KIT: TAGGED 21JUN90

Table 10. Weight (kg) of lynx captured in the MBS, March 1989-April 1990.

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
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

Based on captured lynx and snow tracking, the number of lynx on the study area has remained high (Table 11). These counts are minimum numbers present, because snow conditions did not always allow accurate determination of the number of untrapped animals. 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 11. Estimated lynx density (/100 krn^2) on the study area, March 1989 to April 1990.'

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

' Number of untrapped lynx determined by track counts; poor snow conditions precluded some estimates of number of untrapped lynx.

Kitten Production and Movements

Seven female lynx with functioning radio-collars remained within the study area in June 1990. All six adults apparently had litters, based on successive radio locations from the same area during late May and June. The one yearling (12 months old) likely did not produce young. Litters of the four adults accessible to camp were found on 21 June. Distance to the nearest neighboring den sites averaged 2.5 km (range 2.1-3.0 km). Litter size averaged 4.0 kittens (sizes of 3 [Cleo's], 4 [Dawn's], 4 [Becky's], and 5 [Anne's]). Kittens in three of the litters weighed 600-900 g each, and were likely 4-5 weeks old; kittens in the fourth litter of five weighed 385-460 g each, and were likely 2-3 weeks old (Jackson 1987). Dens sites were characterized by areas of moderate to heavy deadfall. The one female (Cleo) radio-tracked for two summers moved her den site 1.0 km between years.

Two of Cleo's four kits ear-tagged in June 1989 were captured in late March 1990. Subsequent radio-tracking showed that from 25 March to 8 May, the female kit (Pam) was occasionally associated with the mother (< 300 m away on 3 days), but in general was 0.7-2.5 km (mean = 1.8 km) from Cleo. In mid-May, Pam dispersed to the west, and was last located 5 June 60 km away. The male kit (Caughley) was generally further from the mother (0.8-6. 1 km, mean = 3.5 km) from late March up until collar failure or dispersal in early

May. The other radio-collared female kit (Juanetta) was assumed to be from Dawn, because of extremely close association on several occasions in early April. By early May, Juanetta was generally 2-3.5 km south of her mother, and by June had shown no signs of dispersing.

Home Range and Movements

Home range size (95 % MCP) of male lynx were larger than female range sizes, but the difference was not significant (Mann-Whitney U, P > 0.2) (Table 12). One male lynx (No. 15, Alex), with a 95 % MCP home range size of 126.5 Km^2, was excluded from these calculations since it appeared that he wandered extensively during his first summer as a yearling. A large degree of overlap was observed in home ranges within both sexes (Figs. 5, 6). Core areas (50% MCP) also overlapped between two females (Cleo and Dawn) and three males (Tyson, Mario and Dick).

Distance travelled daily (DTD) in spring 1990 averaged 2105 (±1287) m for females (n = 59) and 2114 (±1398) m for males (n = 56) (J-test, P > 0.95). Insufficient sample size precluded calculation of DTD for the other ground-based telemetry sessions.

The number of lynx tracks counted on the traplines averaged O.111 tracks per km-day over the November trapping session. In March 1989, on average 0.166 tracks per km-day . were observed. 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 1989 (Table 13). Four deaths of radio-collared lynx were attributed to trapping during the winter, lowering the survival rate for the winter and the year to 0.78. Two of these deaths occurred within the study area on lynx taken by a trapper working without permission. The other two deaths occurred in radio-

Table 12. Home range size (minimum convex polygon) of lynx in the MBS, March - 1989- April 1990.

ID/Name	Age	n	Home Range (km^2)	
			95%	100%
Females				
2. Cleo	3-4	58	35.6	40.3
23. Beau	1	27	15.8	16.7
25. Dawn	3	31	24.3	40.3
27. Heather	1	23	7.6	9.8
Mean			20.8	26.8
Males				
5. Tyson	4-5	34	68.1	75.2
6. Old Man	1-2	30	53.1	91.2
10. Mario	1-2	41	21.2	35.2
11. Wayne	1-2	50	39.6	58.5
14. Dick	0-1	46	20.5	44.8
21. Chris	1	26	9.4	12.0
26. John	1	21	42.2	99.8
Mean			36.3	59.5

collared lynx that had dispersed out of the study area. Only one of the three radio-collared lynx known to have dispersed outside the study area was not trapped during the winter. Three of four kits ear-tagged in March 1989 also were known to have been killed by trappers outside the study area during winter 1989-90, suggesting that survival of 1 ynx that dispersed was lower than residents (especially if the lynx taken without permission within the study area are ignored).

Only two of Cleo's four kittens tagged in June 1989 could be accounted for during winter 1989-90, by either live-trapping or examination of tracks associated with the radio-collared mother throughout the winter. The fate of the other two kits is unknown.

Figure 5. Home ranges (95 % MCP) of male lynx in the MBS, March 1989 - April 1990.

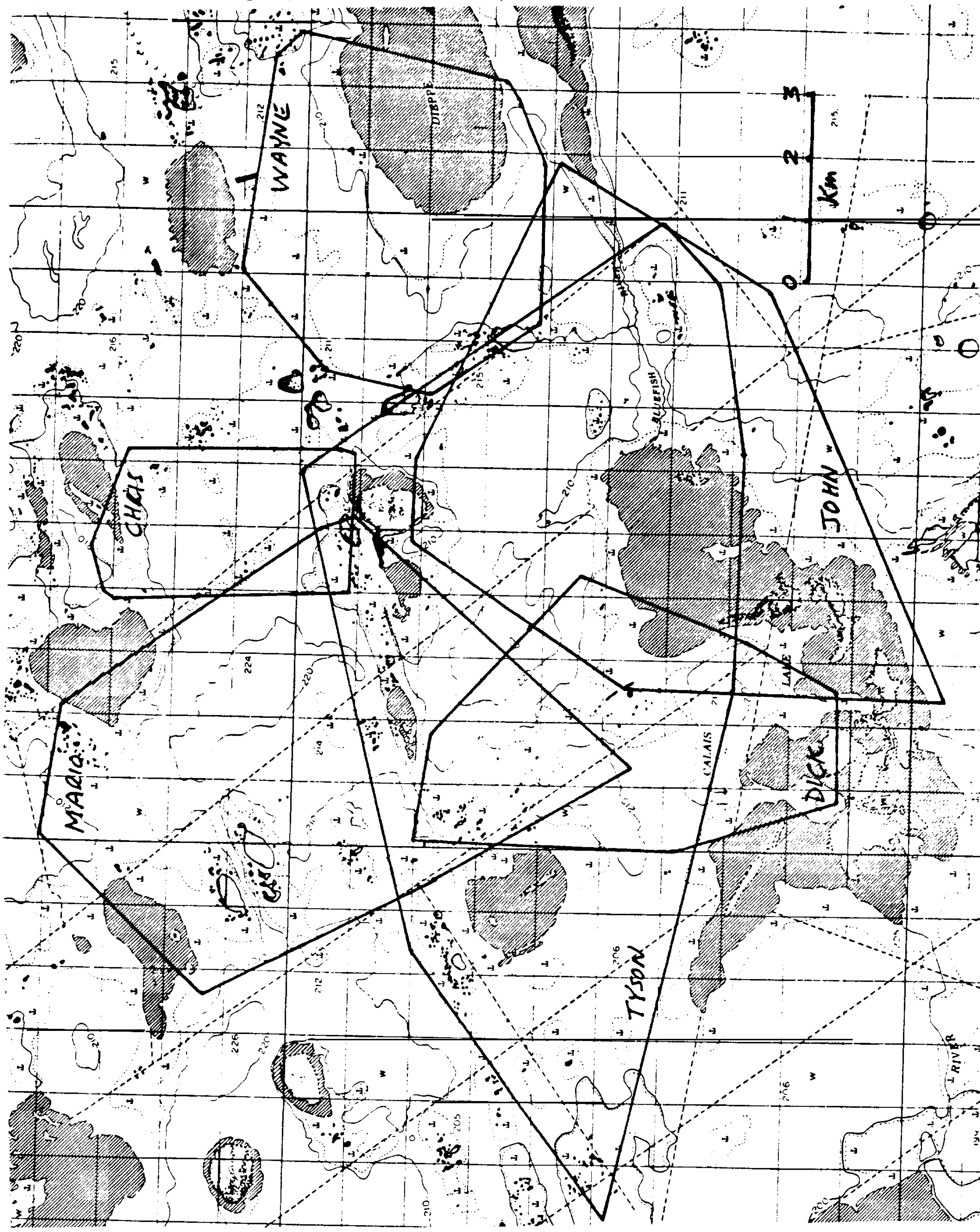
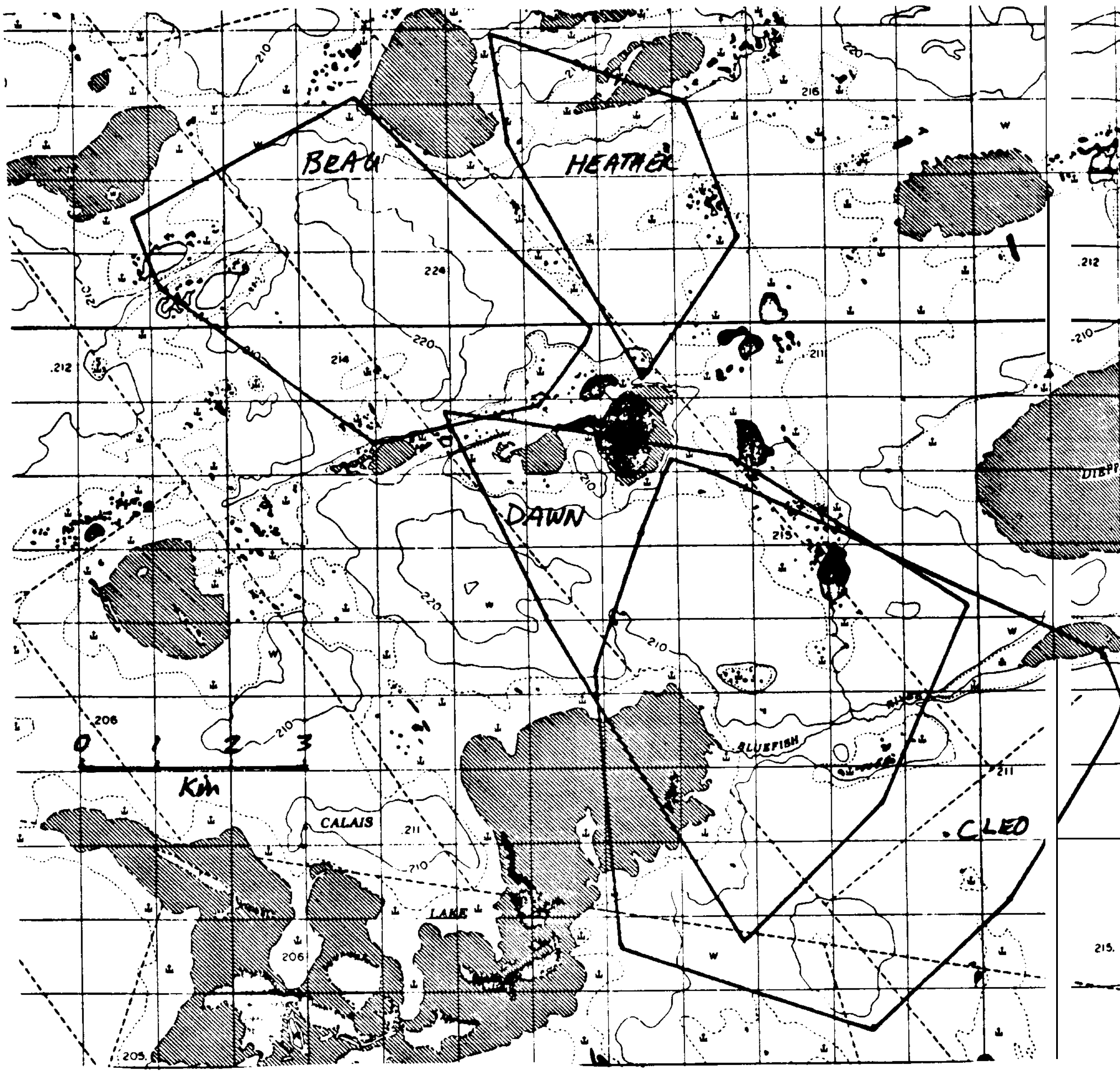


Figure 6. Home ranges (95 % MCP) of female lynx in the MBS, March 1989- April 1990.



" Table 13. Survival of lynx radio-collared in the MBS, March 1989 to March 1990.

Date	No. at Risk	No. of Deaths	No. Censored	No. Added	Survival	Conf. Limits Lower	Conf. Limits Upper
Mar 89	6	0	0	0	1.00	1.00	1.00
Apr 89	10	0	0	0	1.00	1.00	1.00
May 89	10	0	0	0	1.00	1.00	1.00
Jun 89	10	0	0	0	1.00	1.00	1.00
Jul 89	10	0	0	0	1.00	1.00	1.00
Aug 89	10	0	0	0	1.00	1.00	1.00
Sep 89	10	0	0	0	1.00	1.00	1.00
Ott 89	10	0	0	0	1.00	1.00	1.00
N OV 89	10	0	0	9	1.00	1.00	1.00
Dec 89	19	2	1	0	0.89	0.76	1.03
Jan 90	16	2	2	0	0.78	0.60	0.96
Feb 90	12	0	0	0	0.78	0.60	0.96
Mar 90	12	0	0	6	0.78	0.60	0.96

All lynx known to have dispersed from the study area were young animals (Table 14). Dispersal distances and direction varied greatly.

Habitat Utilization

Use of habitat types by all lynx as a group was not proportional to availability ($\underline{X}^2$ = 116.6, $\underline{P}$ < 0.001). Meadows and sparsely vegetated areas were avoided and mixed forest habitat was preferred (Table 15). There was no difference in habitat use patterns between sexes (G-test, $\underline{P}$ = 0.21).

Table 14. 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	O	Mar 89	Trapped 24 km SW, Feb 90
4	E	M	O	Mar 89	Trapped 47 km NNE, Nov 89
8	E	F	O	Mar 89	Trapped 385 km WSW, Jan 90
9	R	F	1	Mar 89	Trapped 445 km SE, Jan 90
12	R	F	O	Apr 89	Trapped 125 km W, Dec 89
13	R	M	O	Apr 89	Dispersed 25 km SW, last located Dec 89

Table 15. Habitat type use relative to availability by male and female lynx, March 1989-April 1990.”

Habitat Type	Proportion Available	Proportion Utilized	Preference/ Avoidance
Meadows	0.111	0.0311	Avoid
Shrubland	0.026	0.0336	ns
Mixed Forest	0.138	0.2823	Prefer
Coniferous Forest	0.473	0.4689	ns
Organic Terrain	0.092	0.1005	ns
Sparsely Vegetated	0.096	0.0167	Avoid
Recent Bums	0.064	0.0670	ns

[a] Preference/avoidance P <0.05.

Discussion

The density of lynx estimated for the study area is similar to densities found in other studies where hares were abundant (range of 7-20 lynx/100 krn^2) (Brand et al. 1976, Parker et al. 1983, Banville 1986, Noiseux and Doucet 1987). Lynx densities during years with low hare numbers are reported to be 1.4-5.5 lynx/100 krn^2 (Brand et al. 1976, Stephenson 1986). As in other studies at high hare densities, a large proportion of the lynx in the area in March were kits. Productivity of lynx through to June 1990 appeared to remain high.

Evidence from MBS radio-collared kits suggests that the period of independence from the mother begins in March, likely at the onset of breeding. Similar observations have been recorded by Parker et al. (1983). Periods of close association with the female decrease through April. Evidence from MBS kit movements in 1989 and 1990 indicates long-distance movement out of the study area occurred between mid-April and early May. Most previous long-distance movements of young lynx have been associated with declining hare densities (summarized in Hatler 1988). However, the observations recorded here suggest that even at high hare densities, dispersal far from the natal area may be a regular occurrence.

Brittell et al. (1989) suggest that young animals disperse into "vacant" habitats, i.e., suitable habitat uninhabited by 1 ynx. Others factors may be at play, however. Two of the dispersals from the MBS were close to 400 km, crossing areas that had been trapped heavily and which presumably had large areas of "vacant" lynx habitat.

Home range size reported here are similar to results from other studies conducted in suitable habitat at high hare densities (Slough and Ward 1990, summary in Hatler 1988: 13). Extensive home range overlap between sexes, and partial overlap within sexes was evident, even at the 50% core area level. 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).

Although the activities of a trapper within the “untrapped” study area clouded the results somewhat, the mortality rate of lynx that dispersed was substantially higher than those that remained. Assuming that unreported lynx are still alive, only two of seven animals (four ear-tagged and three radio-collared) that dispersed from the study area survived the trapping season. This trapping-related mortality rate (71 %) is comparable to other areas of harvesting (Ward and Krebs 1985, Bailey et al. 1986). No natural mortality of lynx >9 months old was observed or suspected, although this was expected given the plentiful food supply and young age of most individuals.

Little has been published on lynx habitat requirements or preferences in the boreal forest. In the MBS, areas supporting a patchy mosaic of thick coniferous and mixed forest regrowth adjacent to wet habitats appeared to harbour the highest concentrations of hares (pers. ohs.). Forest cover types with heavy deadfall were also of importance to denning females.

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PERSONAL COMMUNICATIONS

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