LYNX RESEARCH IN THE NORTHWEST TERRITORIES, 1991-92

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ABSTRACT

This report summarizes lynx harvest trends, and ongoing research programs conducted during 1991-92 in the Northwest Territories (NWT). Results of carcass collections, pelt measurements, snowshoe hare indices, and a live-trapping and radio-collaring study are given.

The 1991-92 harvest was 2230 pelts, an increase of 6% over the previous year. Average pelt price rose for the first time since the mid-1980s to $80.

A total of 113 lynx carcasses was collected from trappers in Fts. Simpson, Providence, and Good Hope 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. Only 8 (7.5%) of the collection were kittens; yearlings dominated the sample overall (38%) and 48% of the carcasses were males. During declining or low hare cycles a pelt length of 82 cm may be the best length to distinguish kittens from older lynx. Body condition increased significantly over the previous year for all age and sex classes except yearling males. The proportion of female yearling and adult lynx pregnant and the mean *in utero* litter size for yearlings decreased compared to the previous year. The mean litter size for adults remained stable. Eighty-two percent of the lynx stomach contents examined contained snowshoe hare, a steady decline over the past 4 seasons.

Lynx pelts from across the NWT were measured to provide an indication of the proportion of kits in the harvest. A total of 1255 pelts were measured. Seven and a half percent of pelts measured in the western NWT south of the Inuvik District (declining or low hare cycle) were $\leq$ 82 cm, and were presumed to be kittens. In the Inuvik District (high hare populations) 49% of the pelts were $\leq$ 89 cm and were presumed to be kittens.

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, where densities almost doubled over the previous year. Hare track counts conducted in the MBS were consistently low throughout the winter of 1991-92, on average 2% of peak levels.

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 1991-92, 7 individual lynx were captured on a 130 km^2 study area, totalling 59 lynx captured 76 times since the start of the study. As of April 1992, only 2 lynx wore functional radio collars in or near the study area, and only 3 lynx were resident in the area. No kittens were present. Home range size (95% minimum convex polygon) prior to dispersals or death averaged 25.6 km^2 for males and 25.3 km^2 for females, a non-significant increase from the previous year. The period from December 1991 to March 1992 was marked by dispersal and/or death of all resident lynx in the study area. Dispersal direction and distance varied greatly. The main causes of death were predation and/or starvation. Annual survival rate declined from approximately 0.90 in previous years to 0.21 during 1991-92.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

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'Connor 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 northern lynx are not being overharvested.

This report details the fourth year of examination of lynx in the NWT (first 3 years summarized in Poole 1989, 1990, 1991). 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 1991-92, 564 out of 1914 trappers in the NWT sold 2230 lynx pelts worth $179,000. The harvest was 6% higher than the previous year. The value of the NWT lynx harvest was third only to marten (*Martes americana*) and wolf (*Canus lupus*) pelt production. Ft. Smith and Yellowknife District showed modest gains in lynx harvests, but the greatest increase in the harvest was in the Inuvik Region, where 2½ times as many lynx were taken compared to the previous year (Table 1). Cliff Cook (pers. comm.), Renewable Resources Officer in Aklavik, regularly saw groups of up to 4 lynx while travelling through the Mackenzie Delta, the most lynx he has seen during many years in the area. The number of lynx pelts harvested annually 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 decreased steadily since the peak of $616 in the 1985-86 season (Fig. 1). The pelt price for the 1991-92 season marked an increase for the first time since the mid-1980s, up from $62 to $80. The current NWT fur return system does not account for unsold pelts, or furs used domestically or sold privately, but few lynx pelts likely would fall into these categories.

Table 1. Number of NWT lynx sold in 1990-91 and 1991-92 based on fur return records.

Community	1990-91	1991-92	% Change
Aklavik	21	179	+752
Arctic Red R.	16	45	+181
Ft. Franklin	8	14	+75
Ft. Good Hope	17	51	+200
Ft. McPherson	54	76	+41
Ft. Norman, N. Wells	29	46	+59
Inuvik	16	135	+744
Tuktoyaktuk	1	1	0
Inuvik Region	162	547	+238
Ft. Liard	189	249	+32
Ft. Simpson	358	299	-16
Jean Marie R.	22	2	-91
Nahanni Butte	144	91	-37
Trout L.	111	138	+24
Wrigley	123	111	-10
Ft. Simpson Dist.	947	890	-6
Ft. Providence	437	185	-58
Hay River	66	90	+36
Kakisa L.	75	21	-72
Hay River Dist.	578	296	-49
Dettah	0	12	--
Ft. Rae	84	80	-5
Lac La Martre	32	28	-13
Rae Lakes	4	9	+125
Snare L.	1	2	+100
Yellowknife	22	35	+59
Yellowknife Dist.	143	166	+16
Ft. Resolution	106	100	-6
Ft. Smith	128	172	+34
Pine Point	7	1	-86
Snowdrift	10	15	+50
Alta/Sask Trappers	13	43	+231
Ft. Smith Dist.	264	331	+25
Total NWT	2094	2230	+6

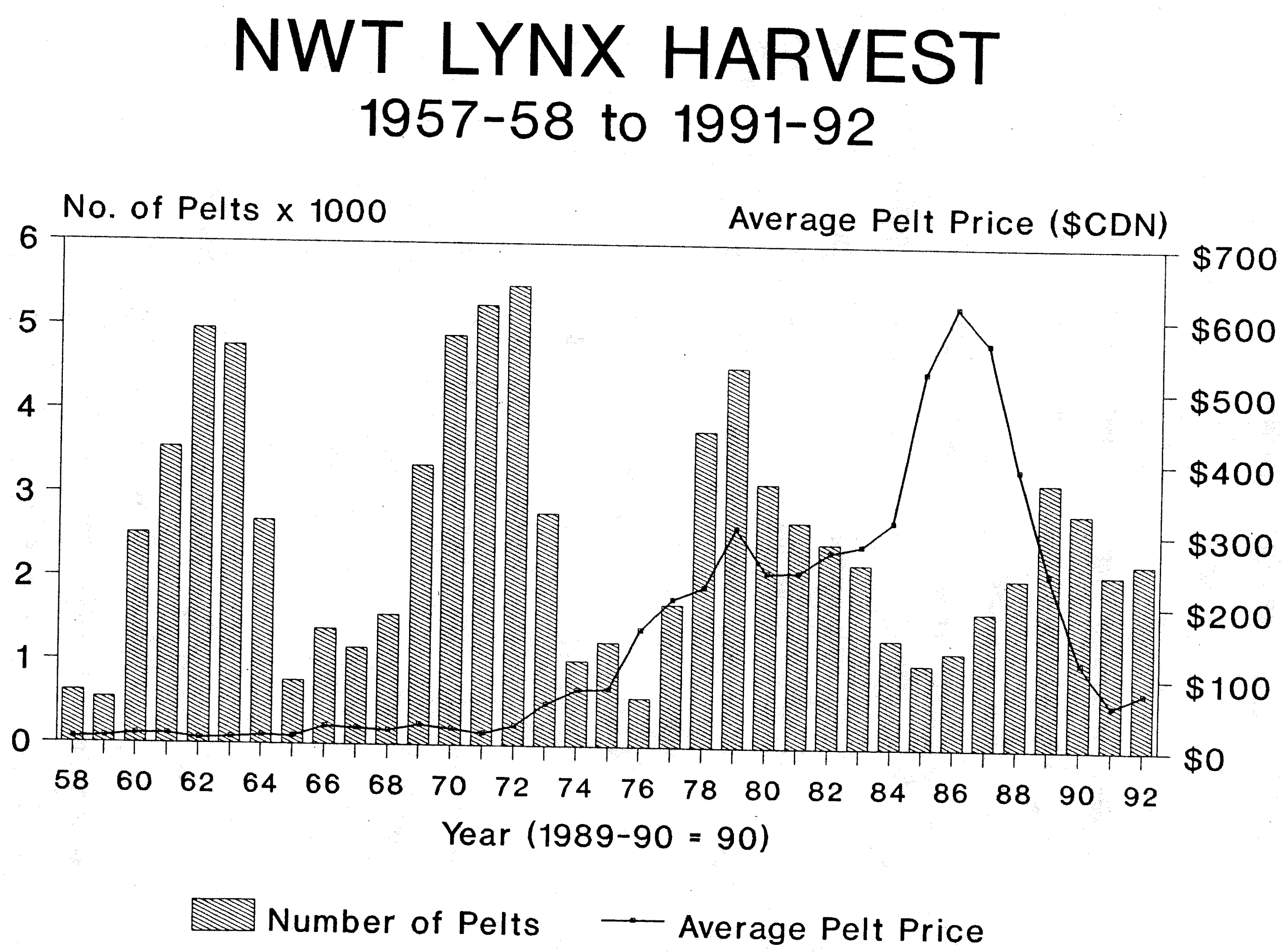


Figure 1. Lynx harvest and average pelt price for the NWT, 1957-58 to 1991-92.

CARCASS COLLECTIONS

Introduction

For the fourth year, lynx carcasses donated by trappers from selected communities in the NWT were examined during the 1991-92 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 what stage the lynx cycle is at 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 for dividing kittens from older animals.
2. Age and sex ratios of lynx in the harvest provide an indication of which age and sex classes 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, and also enabled us to "track" the lynx cycle.

Methods

With the assistance of Department of Renewable Resources (DRR) field staff in Fts. Providence, Simpson and Good Hope, 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, when 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 113 lynx carcasses was examined during the 1991-92 season: Ft. Simpson - 30 from 1 trapper; Nahanni Butte - 15 from 1 trapper; Ft. Providence - 42 from 8 trappers; Ft. Good Hope - 25 from 1 trapper; Yellowknife - 1 from 1 trapper. (Six of the carcasses were collected in association with the Sanctuary study, and were removed from many of the subsequent analyses.) Kittens made up only 7.5% of the sample and yearlings dominated (38.3%)(Fig. 2). The age of animals in the collection was heavily skewed towards the 1 and 2 year age classes. Mean age (kit=0, yearling=1, etc.) of the harvest increased to 1.93, up

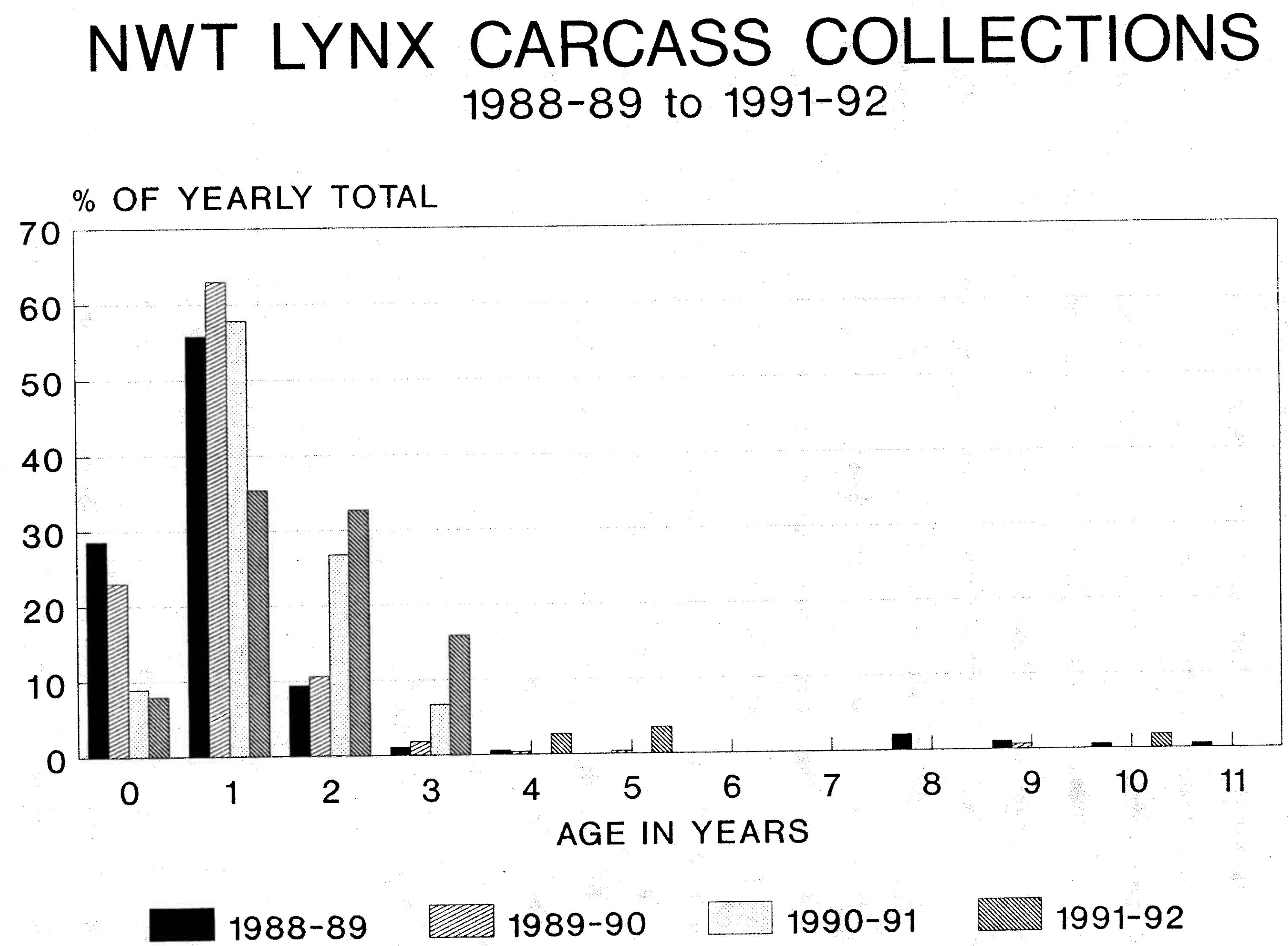


Figure 2. Age structure of lynx carcasses examined during 1988-89 (n = 181), 1989-90 (n = 273), 1990-91 (n = 45), and 1991-92 (n = 107).

Table 2. Percent of kittens, yearlings, and adults (2+ years) and sex ratio harvested in lynx carcasses examined during the 1991-92 season.

	Month					
	Nov	Dec	Jan	Feb	Mar	Total
Sample Size	12	24	18	34	3	91
Age Class						
Kitten	8.3	4.2	16.7	11.8	0.0	9.9
Yearling	50.0	50.0	16.7	38.2	0.0	37.4
Adult	41.7	45.8	66.7	11.8	100.0	52.7
Sex Ratio						
M:F	42:58	48:52	38:62	54:46	3:1	48:52

from 1.33 the previous year. For the first time since carcasses were examined, less than half (48%) of the lynx carcasses were males (Table 2).

Pelt lengths paired to carcasses were available for 44 lynx from the 1991-92 harvest; 6 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 1991-92, 5 of the kitten pelts were $\leq$ 80 cm in length, and adult pelts were as low as 83 cm long. Body length within sex and age classes (male and female, kitten and yearling) declined up to 4.5 cm, often significantly, when examined by region from the 1988-89 to 1991-92 (ANOVA, Duncan multiple range test). It appears that an overall decrease occurs in body length, and corresponding pelt size, during declining lynx and hare cycles.

Kidney fat index (KFI) and xiphoid fat increased in 1991-92 over the previous year in all age and sex classes except yearling males (Kruskal-Wallis tests, $\underline{P} < 0.02$)(Table 3), and generally were double levels found during 1988-89 and 1989-90.

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

Age Class	Sex	Kidney Fat Index n	Mean	SD	Xiphoid Fat (g) n	Mean	SD
0	F	5	13.8	8.62	5	2.2	3.31
	M	4	37.8	13.22	4	12.4	9.25
1	F	21	35.7	36.32	21	16.2	17.85
	M	19	34.1	25.85	18	18.2	16.07
2+	F	32	48.1	33.39	28	27.4	22.12
	M	32	60.2	41.30	25	48.1	28.46

The number of young produced in the spring of 1991, as determined by counts of recent placental scars (RPS), declined compared to previous years (Table 4). Only 26% of yearlings and 61% of adults bred. Mean *in utero* litter size declined for yearlings but remained stable for adults. No relationship was observed between RPS and KFI.

Twenty-eight stomachs contained material and were examined. Snowshoe hare remains were found in 23 (82%) of the stomachs. The remaining stomachs contained caribou (*Rangifer tarandus*), duck sp., grouse sp., lynx hairs (from grooming?), shrew sp., squirrel (*Tamiasciurus hudsonicus*), and red fox (*Vulpes vulpes*), sometimes in addition to hare. The red fox was found in the stomach of a lynx shot eating a fox caught in a trap. Another lynx was trapped after it was suspected of eating another lynx caught in a trap. The proportion of stomachs containing hare has decreased over the past 4 winters (1988-89 - 100%, 1989-90 - 95%, 1990-91 - 86%, 1991-92 - 82%).

Discussion

An 89 cm (35 in.) pelt length criterion to differentiate pelts of kits and older lynx is currently used by the Yukon (Slough and Ward 1990), British Columbia (Archibald pers.

Table 4. Number of recent placental scars (RPS) by age class, 1988-89 to 1991-92.

Age Class	Year	n	% With RPS	Mean No.RPS	Mean No. RPS Excluding 0s	Min. RPS	Max. RPS
1	89	35	77	3.3	4.2	2	6
	90	69	59	2.4	4.1	1	7
	91	10	30	1.4	4.7	4	5
	92	19	26	1.0	3.6	3	5
2+	89	12	92	4.3	4.7	2	7
	90	17	100	4.0	4.0	4	6
	91	6	83	3.2	3.8	2	5
	92	28	61	2.3	3.8	1	6

comm.) and Alberta (Neumann pers. comm.). Alaska uses 34 in. (86.5 cm) (Melchior pers. comm.). From data presented here, it would appear that the pelt length cut-off must change with the hare cycle. During declining and low hare levels, lynx body length, and thus pelt length, decline substantially, the former up to 4 cm and the latter up to 7 cm. Reviewing the previous 4 seasons of collections, it would appear that 89 cm may be the most appropriate length during increasing and peak hare levels, while 82 cm may be the best division during declining and low hare levels. Continuing collections will be conducted to further examine this relationship.

The low proportion of kittens in this sample suggests that hare densities are low over much of the region. At times of declining or low hare densities in other studies, the proportion of kits in the harvest decreased to zero or nearly zero (Brand and Keith 1979, Parker et al. 1983).

Two factors suggest that the peak in kitten production may have passed. The low proportion of kittens in the harvest and the increase in older animals suggests that overall productivity has declined. The drop in the proportion of yearlings with RPS (down to 30%) and the overall decrease in *in utero* litter size indicate less favourable 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 0%, and O'Connor (1984) found 69% and 7% of yearlings had placental scars at high and low hare densities, respectively.

The carcass collections suggest that winter 1990-91 marked the start of declining lynx productivity and recruitment, and lower population levels over much of the western NWT. This trend should continue for several years, with continued low lynx productivity, few kittens in the harvest, and older cohorts making up the majority of the animals harvested.

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 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 the proportion of kittens in the harvest 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 4 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 1991). 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 more accurately determined (see Carcass Collections), the proportion of kits in the harvest can be estimated retrospectively. Data from the 1988-89 to 1991-92 seasons are presented.

Results

Pelt measurements were analyzed by assuming that ≤ 89 cm should be the most appropriate cutoff during increasing and peak hare numbers, while ≤ 82 cm should be used for declining and low hare levels. The attached figure (Fig. 3) assumes hares began declining during 1990-91 in all of the western NWT with the exception of the Inuvik area, which in winter 1991-92 had not yet declined (see next section). The proportion of kittens in the harvest has steadily declined in all of the western NWT, with the exception of the Inuvik District, over the past 3 seasons. These results are in general agreement with the results of the carcass collections.

Discussion

Data collected over the past 4 winters suggests that the hare cycle must be considered when interpreting pelt measurement data. Since the hare cycle is not in synchrony across the NWT (see next section), all pelt measurements from the NWT cannot be examined using the same pelt criteria each year. Unfortunately, all of the carcass collections matched to pelt measurements in the past have been conducted in the South Mackenzie, thus I do not know if pelt criteria for kits and older lynx in the Inuvik area are substantially different than those determined elsewhere in the NWT.

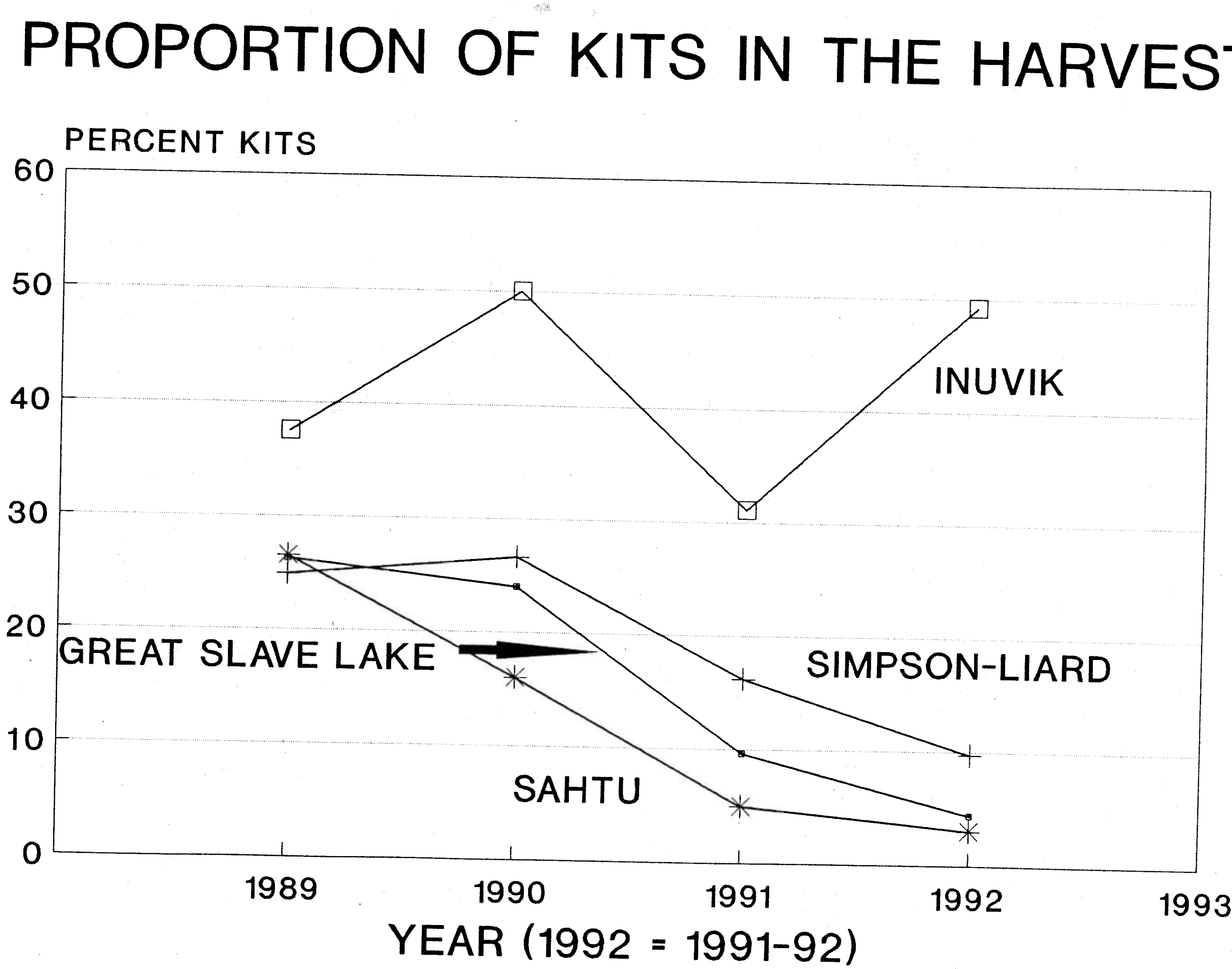


Figure 3. Proportion of lynx kittens in the harvest by district as determined from pelt measurements from 1988-89 to 1991-92 (see text for background on assumptions).

SNOWSHOE HARE CYCLE

Introduction

Lynx populations cycle directly with population levels of the snowshoe hare, their main prey (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). 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 average hare density over the preceding year. An estimate of hare density may be derived from Krebs' formula (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 the availability of that habitat. 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 24-72 hours after a snowfall using the same nine 1-km transects 24-72 hours each time. Track counts are expressed as tracks/km-day (km travelled X days since last snowfall). Runways (places where the exact number of tracks 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.

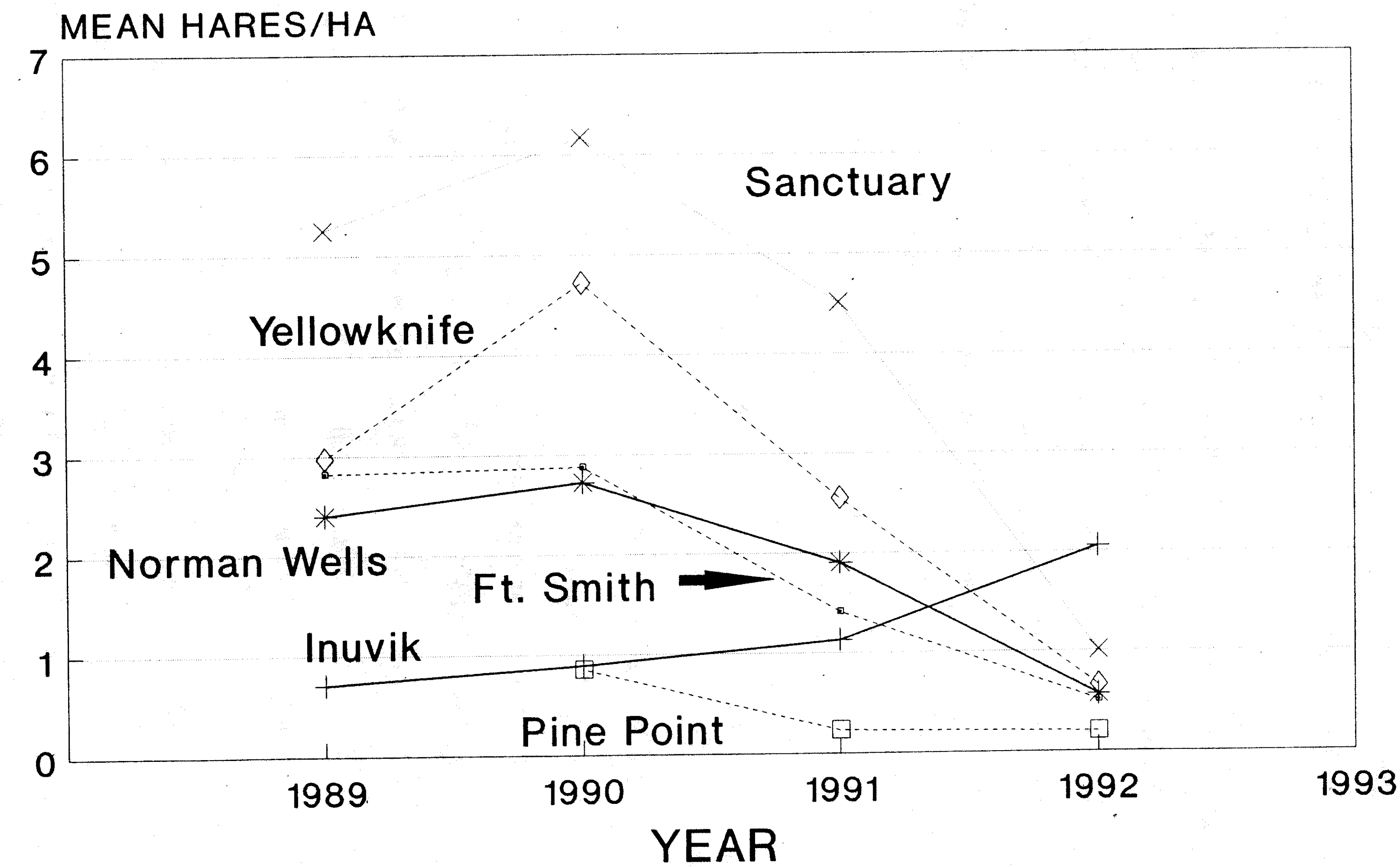
Results

Estimates of hares per ha derived from turd counts indicated that hare densities over 1991-92 decreased in all communities surveyed, except for Inuvik (Fig. 4). Significant decreases over the previous year were observed in all communities except Pine Point, which remained at the same low level since the 1991 count, and Inuvik, which increased significantly over the previous year. Among areas south of Inuvik, the MBS still had the highest overall estimate of hare density at 1.0 hares/ha, with the highest transect density at 2.6 hares/ha (260/km^2). Individual transects in the Inuvik area had up to 4.2 hares/ha (420/km^2).

Track counts conducted in the MBS lynx study area fluctuated over the course of each winter. There was a significant overall decline when the same month was compared among years (ANOVA, $\underline{P} < 0.001$) (Fig. 5). The number of hare tracks in March 1992 were 10% of counts taken the previous March, and < 2% of levels found in March 1989 and 1990.

HARE DENSITY FROM TURD COUNTS

From: Krebs et al. (pers. comm.)



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

Figure 4. Mean density (hares/ha) derived from turd counts on permanent transects, 1989-92.

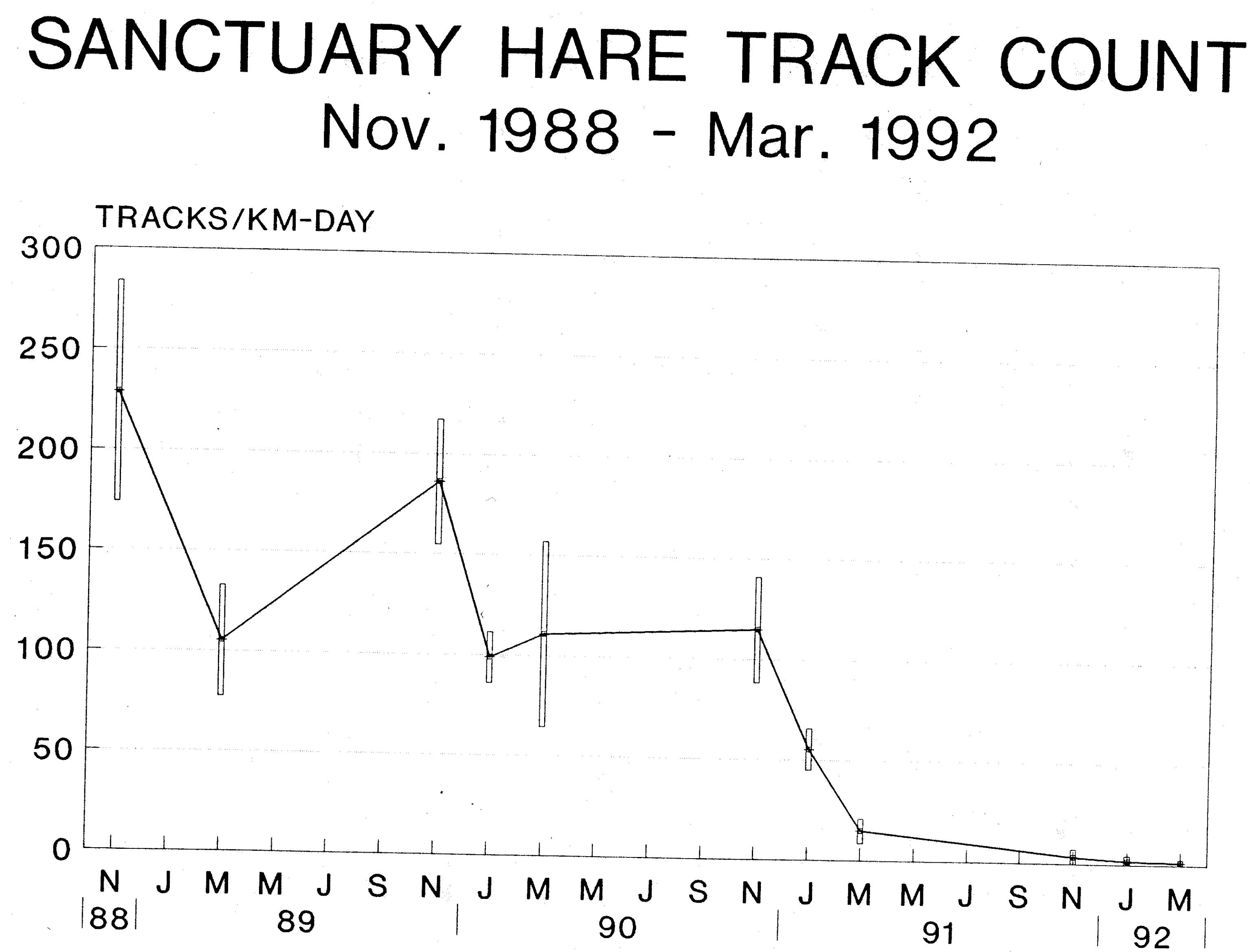


Figure 5. Sanctuary hare track counts (mean $\pm$ 1 SD), Nov 1988 - March 1992.

Discussion

Hare densities in all of the western NWT with the exception of the northern Mackenzie Valley appear to have decreased or remained low over the past year. Given that the density estimates from turd counts give the average density of the preceding 12 months, winter 1991-92 likely marks the first year of the low in the hare cycle throughout most of the western NWT. The consistent low numbers of tracks in the MBS over the winter supports this contention. I expect that given the nature of the snowshoe hare cycle (Keith and Windberg 1978, Keith 1990), densities should drop in the north Mackenzie during 1992-93, and remain relatively low in most of the western NWT from 1992-93 to about 1994-95. 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).

The increase in hare turd counts in the Inuvik area supports observations of very high numbers of hares and lynx (with kits) in the Inuvik and Aklavik areas during winter 1991-92 (C. Cook and K. Hickling, pers. comm.). The turd counts show that the hare cycle is not in synchrony across the NWT, and may be out of phase by 2 years from southeast to northwest.

MACKENZIE BISON SANCTUARY LYNX STUDY

Introduction

Lynx trapping in the NWT is not regulated by quotas. 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 1992. Previous information is reported in Poole (1989, 1990, 1991). 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 were very low during winter 1991-92 (see previous section), following a winter of sharply declining hare numbers (1990-91).

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. 6), an area comprised primarily of coniferous forest and mixed forest, interspersed by large lacustrine depressions. Live-trapping was conducted in an area of approximately 130 km^2, near the Calais Lake Research Centre. Most of the area had not been kill-trapped for at least 5 years prior to the start of the study. Information on the geography, vegetation cover and climate of the area has been given previously (Poole 1989).

Methods

Live-trapping was conducted 3-27 November 1991 (early winter) and 14 March - 6 April 1992 (spring). Up to 78 Fremont leg-snares (Fremont Humane Traps, Candle Lake, SK) and 13 Godwin leg-snares (Godwin 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 (Lambs Dark Navy, 151 proof). Visual attractants included flagging tape, pie plates, 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 length, 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 and MOD-315 Telonics Inc., Mesa, AZ)

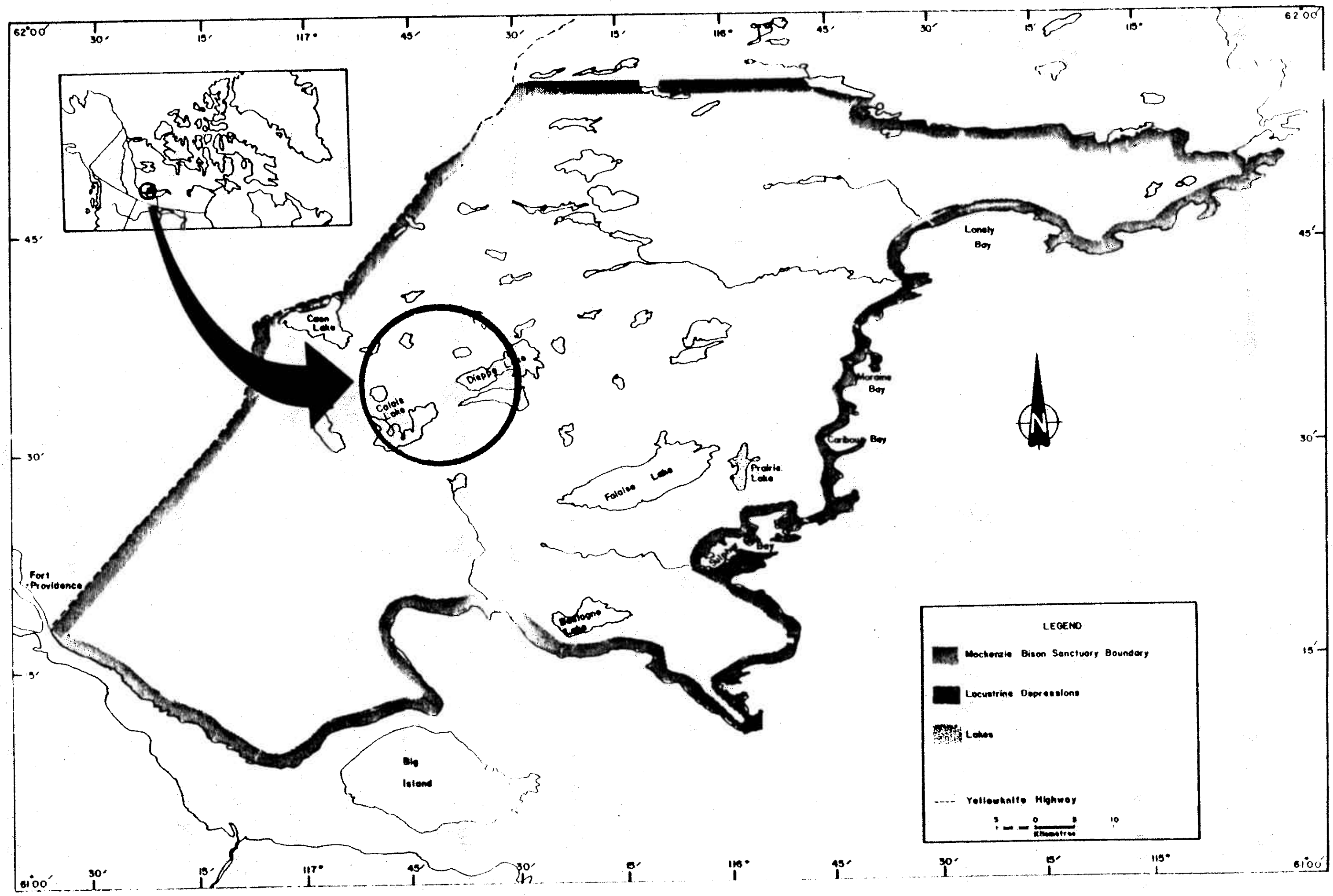


Figure 6. Location of the Sanctuary lynx study (circled).

were attached to all adults ($\geq$ 1 year) and most kittens. 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 laid on a bed of boughs for recovery.

Telonics RA2A (H) antennae 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), plotted on a UTM grid to the nearest 50 m. Lynx were located 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 185) using a Global Positioning System were used for aerial locations. All locations were taken during daylight hours. Time between successive bearings from the ground was generally $<$ 45 minutes. In all 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 15 locations averaged 58 m (range 0-175 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. 1990). Obvious outliers were removed (Ackerman et al. 1990). 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 acclimatize to being collared before locations were used for home range estimation (White and Garrott 1990:37).

Successive locations separated by 1 day were considered to be mutually independent and were included in the home range calculations (Poole 1991). 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 16 individuals with an average of 34 locations (range 15-48). Home range and habitat analyses discussed here include locations taken up to 06 April 1992, 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 for the year (April to April). Animals were assumed to be alive on the last day of radio contact, thus estimated survival rates are the maximum possible.

A geographic information system (GIS) computer using SPANS software has been used to determine habitat utilization by lynx (Poole 1990, 1991). However, habitat analysis was not performed for the 1991-92 data set because mapping using LANDSAT II Thermal Mapping (TM) imagery (30x30 m pixel size) is currently (fall 1992) being ground-proofed and brought on line.

The Ft. Providence Hunters' and Trappers' Association was contracted to provide a map of the Ft. Providence trapping area (which includes the Sanctuary study area) showing all traplines where traps were set at least once during the 1991-92 trapping season. The map (at 1:250,000 scale) was digitized using SPANS software, and the proportion of the area greater than 2.5 km, 5 km, and 10 km from trapline was calculated.

Results

Trapping Success

Traps were set on up to 59 km of line for a total of 2057 trap-nights (TN) in November 1991 and 2071 TN in March-April 1992. Four lynx were captured in November, and 3 lynx were captured during the spring session. Trap success was 514 and 690 TN per lynx in November and spring, respectively. One red fox (*Vulpes vulpes*) and 1 wolverine (*Gulo gulo*) were trapped in the spring. One capture-related mortality occurred in the spring, a 3-year-old male (lynx #73) that broke its radius and ulna of the trapped leg.

Since the start of the study in March 1989, 59 lynx were captured 76 times (Table 5). The sex ratio of captured lynx was biased towards males (35 males:24 females). Thirty-three individual adult lynx (19M:14F) and 26 individual kittens ($\leq$10 months old at initial capture)(18M:10F) have been captured. No kittens were captured during 1991-92. By early April 1992, only 2 lynx were wearing functional collars on or near the study area, a male and a female, both captured during the spring.

Based on captured lynx and snow tracking, the number of lynx in the study area during November 1991 was 18 lynx (Table 6). Lynx dispersed or died throughout the winter (see below) and by early March 1992 no lynx were resident in the study area. The 3 lynx captured during the spring session were caught on the peripheries of the study area, and it is not clear whether they were resident lynx just coming in contact with the traps (as a result of expanding home ranges), or newly settled transients.

Kitten Production

Only 1 female lynx (#74) was resident near the study area in June 1992, and it is doubtful she had kittens, or if she did, whether the kittens survived more than a week. There was no detectable localization of her movements during the denning period.

Table 5. Lynx (> 9 months) captured and kittens (< 2 months) ear-tagged, March 1989 - April 1992.

LYNX ID	NAME	CAPTURE DATE	SEX	AGE	WEIGHT (kg)	COLLAR FREQ.	FATE / DATE LAST LOCATED
1		06MAR89	M	0	6.5	.	TAGGED ONLY
		05FEB90	M	1	.	.	TRAPPED 24 KM SW OF STUDY
2	CLEO	06MAR89	F	3	9.1	150.630	DISPERSED 150 KM SW, DEC91
		20MAR90	F	4	8.1	150.530	LOCATED DEAD OCT92
3		07MAR89	M	0	7.2	.	UNKNOWN: TAGGED ONLY
4		07MAR89	M	0	6.2	.	TAGGED ONLY
		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	.	TAGGED ONLY
		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	DISPERSED TO S, JAN92
		20MAR90	M	2	11.5	150.500	LOCATED DEAD 73 KM SSW, AUG92
11	WAYNE	28MAR89	M	1	9.7	150.650	
		21NOV89	M	2	11.2	150.650	DISPERSED TO ?, APR91
		22MAR90	M	2	10.0	150.600	LOCATED DEAD 102 KM SE, AUG92
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	
		01FEB92	M	3	6.6	150.740	DIED ON STUDY FEB92, STARVED
15	ALEX	03APR89	M	0	6.5	150.780	RESIDING 20 KM SW OF STUDY
		02AUG91	M	3	.	150.780	UNKNOWN: LAST LOCATED 02AUG91
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, DEC90

Table 5. (continued)

LYNX ID	NAME	CAPTURE DATE	SEX	AGE	WEIGHT (kg)	COLLAR FREQ.	FATE / DATE LAST LOCATED
17		29JUN89	F	0	0.8	.	UNKNOWN: TAGGED ONLY
18		29JUN89	M	0	0.8	.	UNKNOWN: TAGGED ONLY
19	CAUGHLEY	29JUN89	M	0	0.9	.	
		26MAR90	M	0	7.9	150.409	UNKNOWN, COLLAR FAILED 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	DISPERSED 200 KM WSW, NOV91
		01APR91	M	2	10.0	150.360	DIED DEC91, LIKELY STARVED
22	HORTON	13NOV89	M	1	9.8	150.390	UNKNOWN: LAST LOCATED 12JAN90
23	BEAU	13NOV89	F	2	9.7	150.441	DISPERSED 30 KM SW, JAN92
		21MAR91	F	3	8.2	150.440	DIED 05FEB92, CAUSE UNKNOWN
24	RHONDA	13NOV89	F	2	9.4	150.430	
		14NOV90	F	3	10.5	150.570	DISPERSED TO ?, JAN92
		01FEB92	F	4	.	150.570	SHOT 160 KM NE OF STUDY
25	DAWN	18NOV89	F	3	9.2	150.610	
		22NOV89	F	3	9.2	150.610	DIED FEB92, CAUSE UNKNOWN
26	JOHN	21NOV89	M	1	10.0	150.550	UNKNOWN: LAST LOCATED 30MAR90
27	HEATHER	23NOV89	F	1	8.9	150.490	
		14NOV91	F	3	9.4	150.390	DIED JAN92, CAUSE UNKNOWN
28	ED	30NOV89	M	1	10.8	150.470	RESIDED 15-20 KM W OF STUDY
		15OCT91	M	3	.	150.470	DIED OCT91, CAUSE UNKNOWN
29	BECKY	21MAR90	F	1	8.4	150.580	
		16NOV90	F	2	8.9	150.580	DISPERSED TO S, DEC91
		15JAN92	F	3	.	150.580	SHOT 70 KM SW OF STUDY
30		22MAR90	M	0	7.0	.	TAGGED ONLY
		11JAN92	M	2	.	.	TRAPPED 280 KM WSW, JAN92
31		26MAR90	M	0	8.0	.	UNKNOWN: TAGGED ONLY
32		26MAR90	M	0	5.6	.	UNKNOWN: TAGGED ONLY
33	ANNE	27MAR90	F	8	10.6	150.621	DISPERSED TO ?, MAY91
		10JAN92	F	10	.	150.621	TRAPPED 900 KM NW, JAN92

Table 5. (continued)

LYNX ID	NAME	CAPTURE DATE	SEX	AGE	WEIGHT (kg)	COLLAR FREQ.	FATE / DATE LAST LOCATED
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	DISPERSED 45 KM W, LATE FEB92
		15MAR92	M	3	.	150.730	DIED 15MAR92, CAUSE UNKNOWN
37		30MAR90	F	0	5.5	.	UNKNOWN: TAGGED ONLY
38	JUANETTA	31MAR90	F	0	7.3	150.640	DISPERSED TO ?, NOV90
39	BRONSON	01APR90	M	1	9.3	150.660	DISPERSED 95 KM S, JAN92
		26MAR91	M	2	9.8	150.650	LAST LOCATED ALIVE IN OCT92
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	DISPERSED 58 KM S, JAN92
		19NOV91	M	3	11.5	150.760	LAST LOCATED ALIVE OCT92
44		04APR90	F	0	6.6	.	UNKNOWN: TAGGED ONLY
45	ERIK	06APR90	M	1	10.2	150.699	DISPERSED 65 KM SW, JAN92
		24AUG92	M	4	.	150.699	ALIVE TIL AUG92, COLLAR FAILED
46	LAURA	06APR90	F	3	10.3	150.630	COLLAR FAILED JUN91
		16FEB92	F	5	.	.	TRAPPED 4 KM NW OF STUDY
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

Table 5. (continued)

LYNX ID	NAME	CAPTURE DATE	SEX	AGE	WEIGHT (kg)	COLLAR FREQ.	FATE / DATE LAST LOCATED
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	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, JUL91
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	
		01DEC91	F	2	9.1	150.710	DIED OF PREDATION (LYNX) DEC91
64	NODA	13NOV90	M	1	9.1	150.770	DISPERSED 25 KM TO N, FEB92
		28FEB92	M	3	.	150.770	DIED LATE FEB92, CAUSE UNKNOWN
65	NEVIK	29NOV90	M	2	10.0	150.480	DISPERSED TO 230 KM W, 25MAR91
		06OCT92	M	4	.	150.480	LAST LOCATED OCT92, DEAD?
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	LOCATED 223 KM NE (APR92)
68		23MAR91	M	0	7.0	.	UNKNOWN: TAGGED ONLY
69	DENNIS	25MAR91	M	2	8.9	150.350	DISPERSED 195 KM SW, MAY91
		06OCT92	M	4	.	150.350	LAST LOCATED ALIVE OCT92
70		28MAR91	F	0	5.7	.	UNKNOWN: TAGGED ONLY
71	LYN	09NOV91	F	2	10.1	150.460	DISPERSED 118 KM TO NNE DEC91
		01FEB92	F	2	.	150.460	DIED FEB92: CAUSE UNKNOWN
72	MERCY	16NOV91	M	2	9.0	150.660	DISPERSED 108 KM NNE, 25NOV91
		15JAN92	M	2	6.1	150.660	DIED JAN92: STARVED
73		16MAR92	M	3	7.8	.	CAPTURE MORTALITY
74	BARB	29MAR92	F	1	8.7	150.509	RESIDING IN STUDY AREA
75	DAVID	01APR92	M	1	8.3	150.589	RESIDING IN STUDY AREA

Table 6. Estimated lynx density (/100 km^2) in the study area, March 1989 to April 1992.[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
Nov 1991	16	2	18	14
Apr 1992	3	0	3	2

[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.

Home Range and Movements

Mean home range size (95% MCP) of male lynx (25.6 km^2) was similar to females (25.3 km^2) (t-test, $P > 0.9$) (Table 7). Home range sizes increased for both sexes between 1990-91 and 1991-92, but not significantly (t-test, $P > 0.14$).

Distance travelled daily (DTD) in November 1991 increased significantly for females ($P = 0.004$), but decreased slightly for males ($P = 0.13$) over the previous year (Table 8).

The number of lynx tracks counted on the traplines averaged 0.191 tracks per km-day during the November 1991 trapping session, similar to that observed in November 1990 (0.211). In spring 1991, an average of 0.010 tracks per km-day were observed, considerably lower than previous years. An evaluation of track counts conducted since March 1989 suggests that there is little direct correlation between track counts and population density. It appears likely that factors including stage of the hare cycle and season may confound the use of track counts to index population density.

Table 7. Home range size (minimum convex polygon) of lynx in the MBS, April 1991 - April 1992.

ID/Name	Age	n	Home Range (km^2)	
			95%	100%
Females				
2. Cleo	5-6	41	34.9	41.2
23. Beau	3-4	48	31.3	36.2
24. Rhonda	3-4	45	10.9	17.8
25. Dawn	4-5	48	27.2	31.8
27. Heather	2-3	40	53.8	55.0
29. Becky	2-3	35	17.8	24.8
63. Ubia	1-2	25	16.6	22.6
71. Lyn	1-2	16	9.5	14.0
Mean		37	25.3	30.4
Males				
10. Mario	3-4	18	17.7	19.1
14. Dick	2-3	44	11.4	17.8
21. Chris	2-3	15	10.2	10.9
36. Mitch	2-3	43	22.0	25.5
39. Bronson	2-3	38	49.7	64.1
43. Sean	2-3	26	19.2	25.3
45. Erik	2-3	20	37.9	48.5
64. Noda	2-3	47	36.4	40.4
Mean		31	25.6	31.5

Table 8. Distance travelled daily (m) for lynx in the MBS, March 1990 - April 1992.

	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
Nov 91	119	1838	1390.1	77	1983	1262.3

Survival and Dispersal

Prior to March 1991, all lynx known to have dispersed from the study area were kittens or yearlings (Poole 1990). Beginning in March 1991, a larger proportion of older lynx in the study area also dispersed, and all of those that did not disperse died. Dispersal of resident lynx took place primarily during 2 periods. The first period was from late March - June 1991, after the dramatic drop in hare numbers, when 28% (7/25) of the yearlings and older lynx that were present in March had left. No further dispersals took place between June and early winter. The second period of dispersal was December 1991 - February 1992, when all remaining live lynx dispersed. Non-collared lynx were tracked and observed moving through the study area in January and February 1992, but little movement was observed during the spring trapping session (March and early April).

Dispersal direction and distance varied greatly (Fig. 7). An assumption was made that failure to pick up a radio signal that had been located previously in 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.

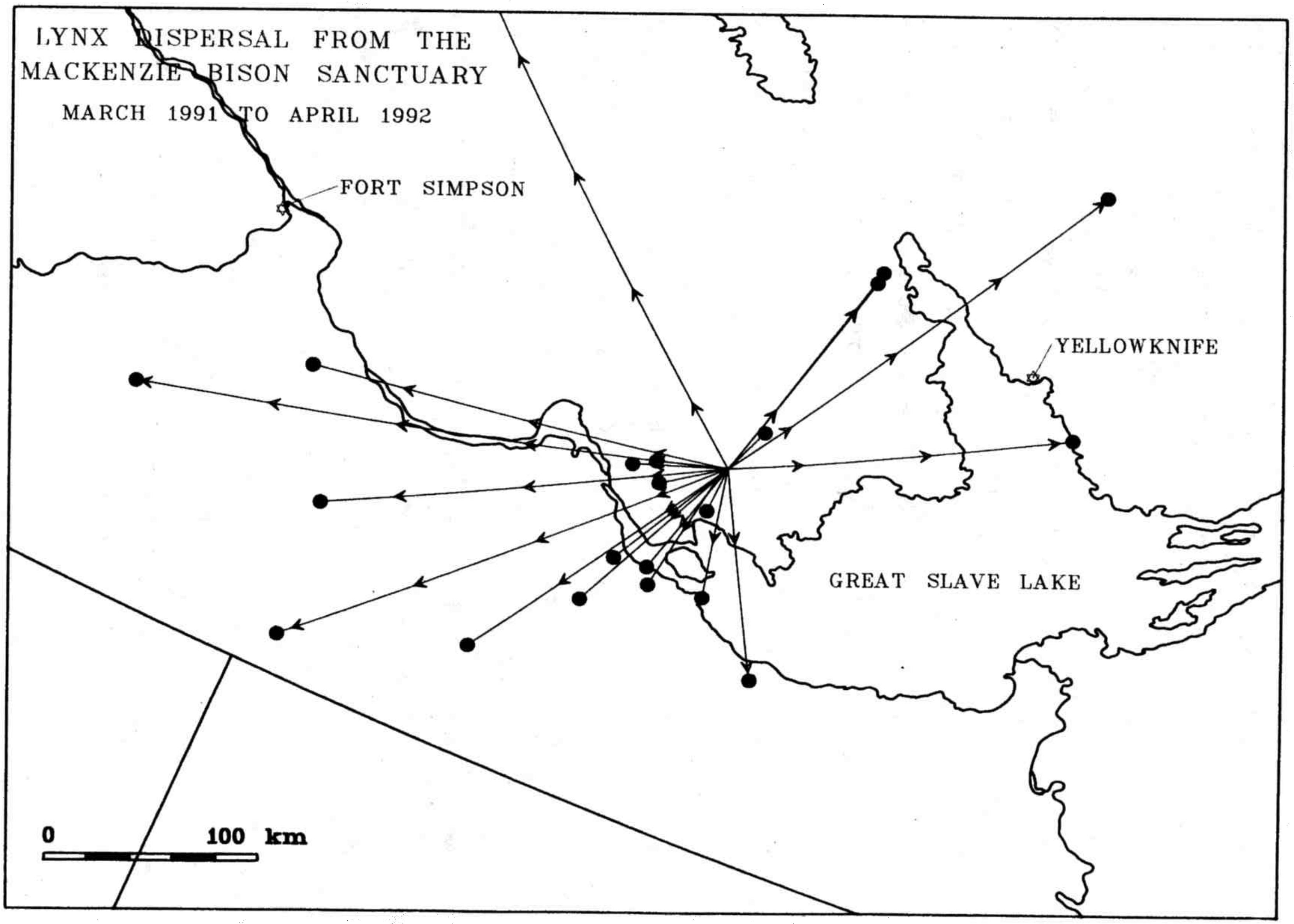


Figure 7. Dispersal of lynx from the MBS, April 1991 - August 1992. The line extending above the top of the page represents a 900 km dispersal to 100 km north of Ft. Good Hope.

The majority of lynx mortality took place during winter 1991-92, the first full year of the low in hare numbers (Fig. 8). Trapping was the major cause of death when hare numbers were high or dropping, but natural causes predominated during the first year of the hare low. Lynx mortality increased by late fall 1991, with the peak of mortality in January - February 1992. Some of the lynx died in the study area, while others died during dispersal. In many cases the cause of mortality was impossible to determine, because only the collar and pieces of fur were found or the carcass was heavily scavenged. In 2 instances entire carcasses were found, and starvation likely was the proximate cause of death. A non-collared lynx, found dead in the MBS, likely died of pneumonia (H. Philibert, pers. comm.). One lynx (#63) was located dead in mid-winter, with puncture wounds to the neck and disarticulated cervical vertebrae. The wounding pattern was suggestive of attack by another lynx.

Survival rates have changed dramatically since the study began. Examining all lynx (including dispersing lynx where their fate was known), survival rates are as follows: April 1989 - April 1990, 0.78 (0.88 if 2 lynx "illegally" trapped on the study area are excluded); 1990-1991, 0.91; 1991-1992, 0.21). Only 5 of the lynx that dispersed from the study area were known to be alive well after dispersal; 3 males (previous long-term residents) that by August 1992 were 60-95 km south or southwest of the study area, south of the Mackenzie River, a male resident 200 km to the southwest, and a female who moved 220 km northeast of the study.

<u>Trapline Mapping</u>

The Ft. Providence trapping area encompasses approximately 23,000 km^2 (excluding major water bodies). The proportion of the area further than corridors 2.5 km, 5 km, and 10 km from any trapline were 63%, 40%, and 19%, respectively.

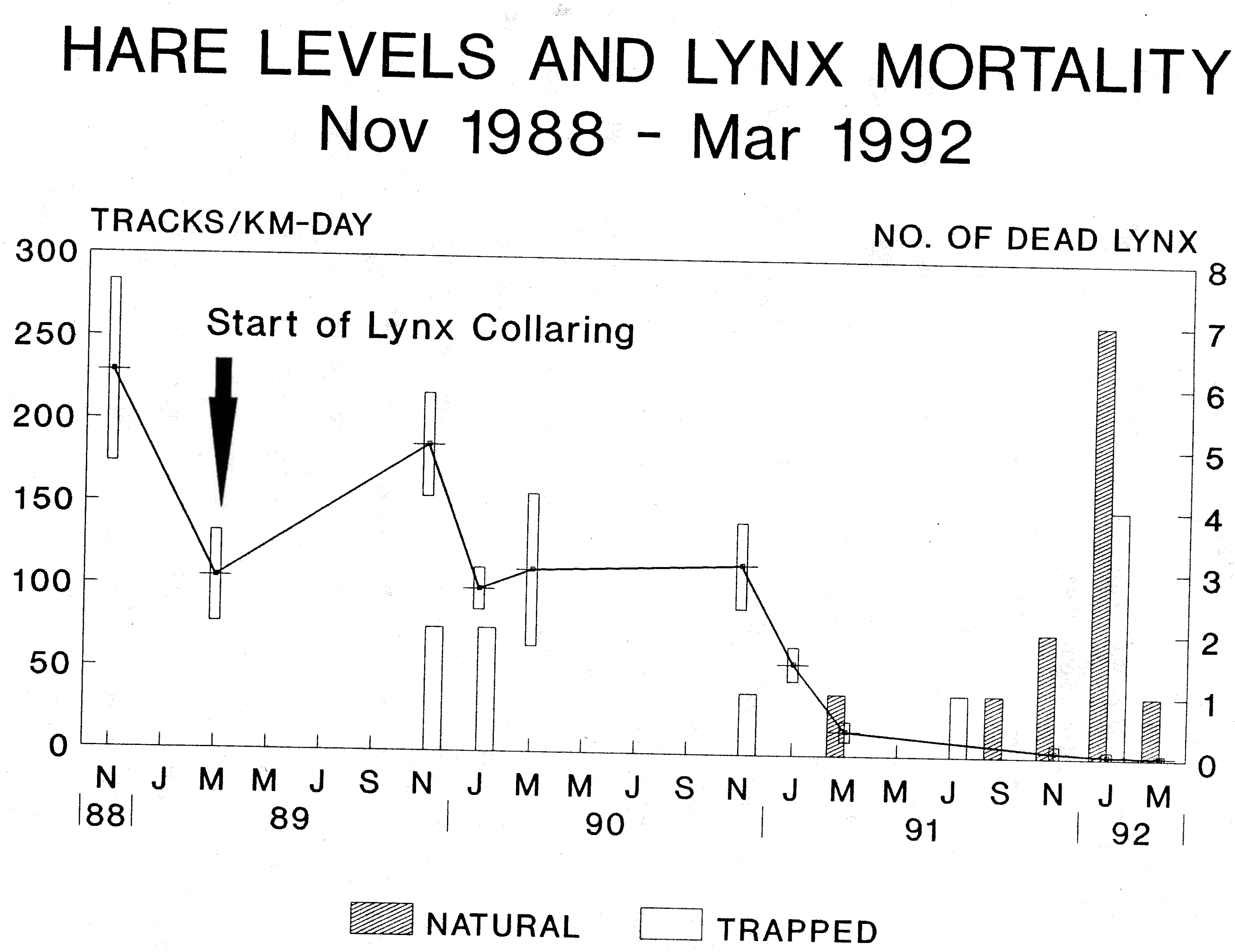


Figure 8. Snowshoe hare levels and the timing of lynx mortality, MBS, November 1988 - March 1992. (Hare tracks represented by means ± 1 SD).

Discussion

Hare numbers in the study area during late winter 1990-91 dropped dramatically, and were at consistent low levels throughout winter 1991-92. It was after the drop in hare numbers, not during, that dispersal and/or death occurred for a majority of the resident lynx. In the summer, fall and early winter leading up to winter 1991-92 we saw the following reactions by the resident lynx: home range sizes increased slightly, no kittens were produced or survived for any period after birth, dispersal intensified (in 2 main periods), and mortality increased.

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 confirmed that no kittens had survived to early winter, as potential recruits into the population.

I had hypothesized that once hare numbers had declined, a majority of the resident lynx would disperse or die, leaving a core of individuals (perhaps 5) occupying enlarged home ranges within the study area. This did not happen. All radio-collared lynx, even those that had been resident for over 2.5 years, dispersed or died, leaving no previously-resident radio-collared lynx by early March 1992. Track counts suggested that no lynx were resident in the core of the study area throughout the spring trapping session. By early April, 3 lynx were captured, and currently (December 1992) the 2 radio-collared lynx are occupying expanded home ranges near or on the periphery of the study area. It will be interesting to see whether any more lynx are found to be resident in the core of the study area during winter 1992-93.

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LITERATURE CITED

Ackerman, B.B, F.A. Leban, M.D. Samuel, and E.O. Garton. 1990. User's manual for Program Home Range. Second Ed. Tech. rept. 15, Contribution No. 259, Forestry, Wildlife and Range Exper. Station, U. of Idaho, Moscow, ID. 80 pp.

Bailey, T.N, E.E. Bangs, M.F. Portner, J.C. Malloy and R.J. McAvinchey. 1986. An apparent overexploited lynx population in the Kenai Peninsula, Alaska. J. Wildl. Manage. 50:279-290.

Brand, C.J. and L.B. Keith. 1979. Lynx demography during a snowshoe hare decline in Alberta. J. Wildl. Manage. 43:827-849.

Brand, C.J., L.B. Keith and C.A. Fischer. 1976. Lynx responses to changing snowshoe hare densities in central Alberta. J. Wildl. Manage. 40:416-428.

Caughley, G. 1977. Analysis of vertebrate populations. John Wiley & Sons, New York. 234 pp.

Crowe, D.M. 1972. The presence of annuli in bobcat tooth cementum layers. J. Wildl. Manage. 36:1330-1332.

Elton, C., and M. Nicholson. 1942. The ten-year cycle in numbers of the lynx in Canada. J. Anim. Ecol. 11:215-244.

Hatler, D.F. 1988. A lynx management strategy for British Columbia. Wildlife Working Report No. WR-34. B.C. Min. Envir. and Parks, Victoria, BC. 115 pp.

Hayne, D.W. 1949. Calculation of size of home range. J. Mamm. 30:1-18.

Keith, L.B. 1963. Wildlife's ten-year cycle. Univ. of Wisconsin Press, Madison, WI. 201 pp.

Keith, L.B. 1990. Dynamics of snowshoe hare populations. Pp. 119-195. In: H.H. Genoways (ed.). Current Mammalogy, Vol. 2. Plenum Press, New York.

Keith, L.B. and L.A. Windberg. 1978. A demographic analysis of the snowshoe hare cycle. Wildl. Monogr. 58:1-70.

Kenward, R. 1987. Wildlife radio tagging: equipment, field techniques and data analysis. Academic Press, London. 222 pp.

Krebs, C.J., G.S. Gilbert, S. Boutin, and R. Boonstra. 1987. Estimation of snowshoe hare population density from turd transects. Can. J. Zool. 65:565-567.

Mech, L.D. 1983. Handbook of animal radio-tracking. Univ. of Minn. Press, Minneapolis, MN. 107 pp.

Nellis, C.H., S.P. Wetmore, and L.B. Keith. 1972. Lynx-prey interactions in central Alberta. J. Wildl. Manage. 36:320-329.

O'Connor, R.M. 1984. Population trends, age structure and reproductive characteristics of female lynx in Alaska, 1963 through 1973. M.Sc. thesis, Univ. of Alaska, Fairbanks, AK. 111 pp.

Parker, G.R., J.W. Maxwell, L.D. Morton, and G.E.J. Smith. 1983. The ecology of the lynx (Lynx canadensis) on Cape Breton Island. Can. J. Zool. 61:770-786.

Pollock, K.H., S.R. Winterstein, C.M. Bunck and P.D. Curtis. 1989. Survival analysis in telemetry studies: the staggered entry design. J. Wildl. Manage. 53:7-15.

Poole, K.G. 1989. Lynx management and research in the NWT, 1988-89. Mans. Rept. Dept. of Renewable Resources, Yellowknife, NT. 46 pp.

Poole, K.G. 1990. Lynx research in the NWT, 1989-90. Mans. Rept. No. 37. Dept. of Renewable Resources, Yellowknife, NT. 46 pp.

Poole, K.G. 1991. Lynx research in the NWT, 1990-91. Mans. Rept. No. 52. Dept. of Renewable Resources, Yellowknife, NT. 48 pp.

Quinn, N.W.S. and J.F. Gardner. 1984. Relationships of age and sex to lynx pelt characteristics. J. Wildl. Manage. 48:953-956.

SAS Inst., Inc. 1988. SAS/STAT user's guide, Release 6.03 edition. Cary, NC. 1028 pp.

Saunders, J.K. Jr. 1964. Physical characteristics of the Newfoundland lynx. J. Mamm. 45:36-47.

Slough, B.G. and R.M.P. Ward. 1990. Lynx harvest study, 1988/1989 progress report. Unpubl. mans. rept. Yukon Dept. of Renewable Resources, Whitehorse, YT. 74 pp.

Stephenson, R.O. 1986. Development of lynx population estimation techniques. Alaska Dept. Fish and Game, Job 7.12, Juneau, AK. 84 pp.

Stephenson, R.O. and P. Karczmarczyk. 1989. Development of techniques for evaluating lynx population status in Alaska. Alaska Dept. Fish and Game, unpubl. final rept. Proj. W-23-1, Study 7.13. Juneau, AK. 95 pp.

Thompson, I.D., I.J. Davidson, S. O'Donnell, and F. Brazeau. 1989. Use of track transects to measure the relative occurrence of some boreal mammals in uncut forest and regeneration stands. Can. J. Zool. 67:1816-1823.

Todd, A.W. 1983. Dynamics and management of lynx populations in Alberta. Unpubl. rep., Alberta Fish and Wildlife, Edmonton, AB. 23 pp.

Todd, A.W. 1985. The Canada lynx: ecology and management. Canadian Trapper 13:15-20.

Ward, R.M.P. and C.J. Krebs. 1985. Behavioural responses of lynx to declining snowshoe hare abundance. Can. J. Zool. 63:2817-2824.

Ward, R.M.P., and B.G. Slough. 1987. Lynx management progress report 1986/87. Pp. 33-56. In: B.G. Slough and R.M.P. Ward. Furbearer management program, 1986/87 annual progress report. Yukon Dept. Renewable Resources, Whitehorse, YT. 59 pp.

White, G.C. and R.A. Garrott. 1990. Analysis of wildlife radio-tracking data. Academic Press, Inc., San Diego, CA. 383 pp.