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THE NORTHWEST TERRITORIES SMALL MAMMAL SURVEY: 1990 - 1996

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ABSTRACT

This paper reports results form the first 7 years of a program designed to monitor small mammal population abundance throughout the Northwest Territories. Standardized methods were designed to provide sufficient accuracy to establish major between-year/within-site trends at minimal effort and expense. In total, 126 snap-trapping sessions were undertaken in 27 locations comprising over 86,600 trap nights of effort.

Collared and brown lemming numbers were roughly correlated at eastern and central arctic locations. Peaks in collared lemming abundance occurred in 1993 and 1996 and possibly in 1990 in some areas. Brown lemming numbers peaked in 1996 with equivocal evidence for peaks in 1993 and 1990. Rough-legged Hawk numbers from 1981 - 1996 correlate with small mammal capture indices and indicate regular small mammal peaks at intervals of 4 years.

In the Keewatin, collared lemmings peaked in 1994; one year after the eastern/central arctic. Very few brown lemmings were caught in the Keewatin.

Below treeline, voles peaked at all locations in either 1994 or 1995 but the abrupt peak and decline seen in tundra locations was not apparent. White-footed deer mice showed no geographic synchrony in numbers.

It is suggested that June trapping be undertaken in the Keewatin to determine whether lemming populations are declining over the summer.

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INTRODUCTION

In 1996, the Northwest Territories Small Mammal Survey undertook its seventh year of data collection. The study is designed to monitor major trends in microtine populations in the Northwest Territories with the aim of a) developing the capacity to predict small mammal abundance at particular locations, and b) to describe the geographic scale of population synchrony.

This informal report updates the previous 6 reports with results obtained during summer 1996. It summarizes 7 years of effort comprising 18,600 trap nights in 126 trapping sessions at 27 locations. More than 70 persons cooperated in collecting data including government biologists, Renewable Resource Officers, casual government employees, academic researchers, and environmental consultants.

METHODS

The basic protocol has not changed since inception of the project in 1990. The methods are designed to produce results adequate to characterize major population trends at minimal levels of expense, effort, and expertise. The intent is to make the study extensive but not intensive; i.e., to put effort and resources into getting adequate data from as many areas and for as many years as possible rather than emphasizing the accuracy of data collection techniques.

The study depends upon the willingness of a large number of cooperators, both inside the Government of the NWT and outside it, to trap small mammals and to allow their results to be pooled. Each cooperator has the flexibility to alter methods to suit local circumstances.

The recommended procedures are as follows:

1) Trapping is to be done solely with "Museum Special" snap traps.
2) Traplines are to be two parallel lines ca. 100m apart running 250 m through typical habitat. Traplines should be close enough to the investigators work station as possible.
3) Traplines are to be marked and consistently used from one year to the next.
4) A basic ecological description of the traplines should be made.
5) Trapping stations are to be 10 m apart and consist of one or two traps placed at the best location within 2 m of the station.
6) Bait is to consist of a mixture of peanut butter and rolled oats.
7) Traps should be checked once per day before 10AM. If the line cannot be checked on a particular day, the traps should be sprung the night before.
8) Data sheets should be filled out daily and submitted at the end of the trapping period.
9) Captured animals are to be identified to species. It is useful but not necessary to collect other data such as weight, sex, reproductive condition. If convenient, the specimens should be labeled and frozen for possible use in future studies.

10) The goal is to achieve 500 trap-nights (TN) each year.
11) The trapping period should be consistent between years. August is the recommended month.

Appendices I and II summarize information on each trapping session undertaken. Available data are included on area location, ecological description, dates, problems encountered, significant observations, and persons doing the work. More detailed information can be found in the files held by the Department of Resources, Wildlife, and Economic Development.

Field workers are responsible for making species identifications. It should be recognized that the accuracy of identification may be inconsistent.

Rough-legged Hawks were monitored at Hope Bay and Kuglugtuk during regular surveys for Peregrine Falcons and Gyrfalcons undertaken in early- to mid July. Standardized study areas were flown by helicopter following similar routes and employing similar survey efforts. Only nests with young, eggs, or incubating adults were counted.

The term "small mammal" is meant to include voles, mice, lemmings, and shrews.

Capture indices were calculated as number of captures per 100 "effective trap nights" (ETN) to control for differing levels of effort. Effective trap nights are defined as total trap nights less misfires, lost traps and capture of non-target species (e.g., birds). Capture indices were calculated to include and exclude shrews. All analyses use the "no-shrew" indices.

RESULTS

Figure 1 shows the areas investigated since the project began in 1990. Results for sites below and above treeline are presented separately. Treeline is depicted as a dotted line in Figure 1.

Above Treeline

Table 1 summarizes 1990 -1996 data on trapping effort, numbers of each species captured, and summary indices for tundra locations.

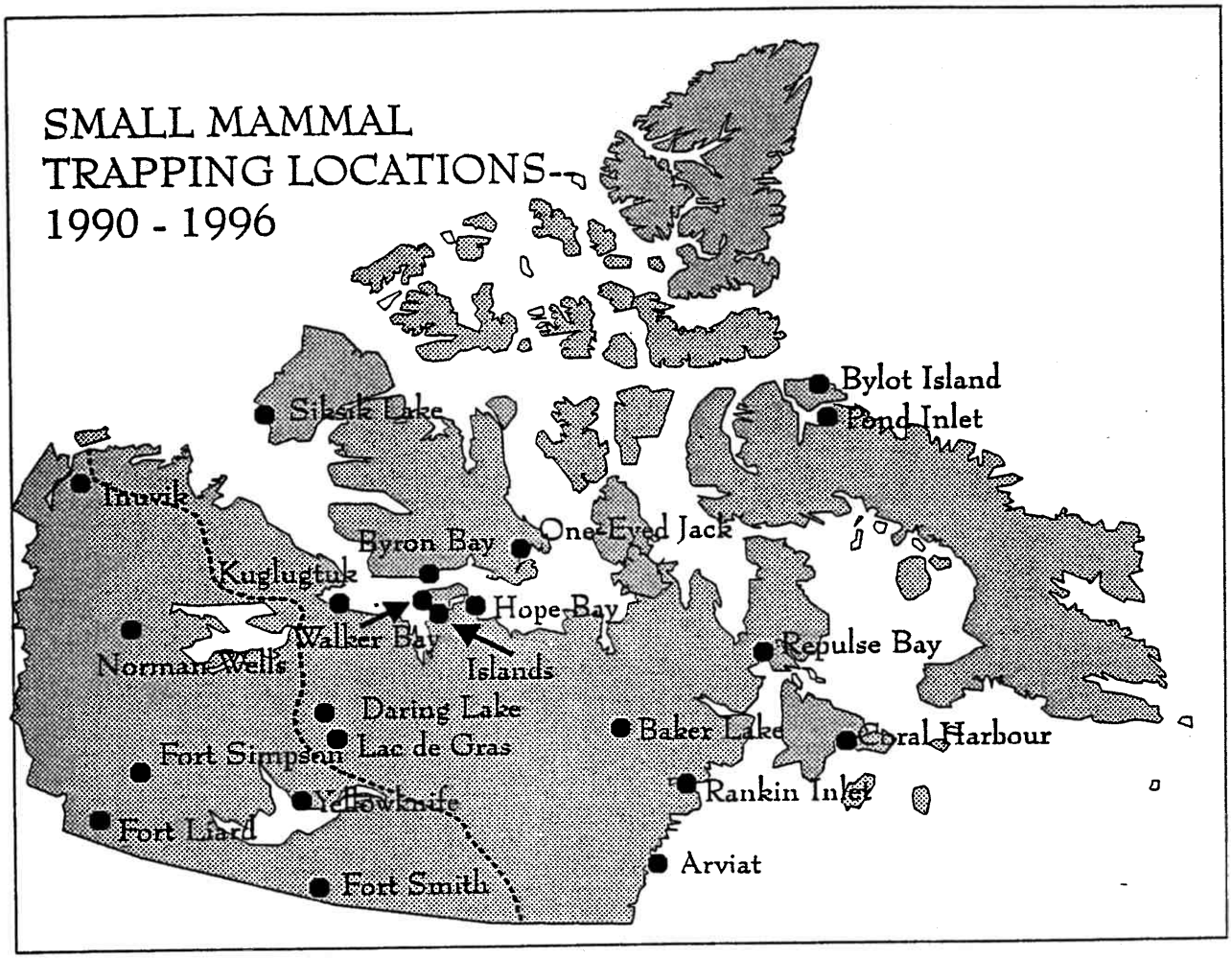


Figure 1. Locations at which small mammal trapping was undertaken; 1990 - 1996. The dotted line depicts the approximate location of treeline.

Table 1. Summary of microtine captures above treeline; 1990 - 1996

		TN	RBV	MV	TV	BL	CL	S	O	NT	MIS	ETN	TCAP	INDEX	NO-S
POND INLET															
	1990	440	0	0	0	0	0	0	0	0	3	437	0	0.0	0.0
	1991	506	0	0	0	0	2	0	2	0	3	503	4	0.8	0.8
	1992	505	0	0	0	2	3	0	0	1	11	493	5	1.0	1.0
	1993	520	0	0	0	2	10	0	0	1	10	509	12	2.4	2.4
	1994	510	0	0	0	0	0	0	0	2	8	500	0	0.0	0.0
	1995	520	0	0	0	0	0	0	0	5	12	503	0	0.0	0.0
	1996	520	0	0	0	1	1	0	0	5	42	473	2	0.4	0.4
BYLOT ISLAND															
	1994	548	0	0	0	4	0	0	0	15	73	460	4	0.9	0.9
	1995	1000	0	0	0	0	0	0	0	33	29	938	0	0.0	0.0
	1996	1050	0	0	0	19	4	0	0	21	87	942	23	2.4	2.4
REPULSE BAY															
	1991	500	0	0	0	0	1	0	0	1	56	443	1	0.2	0.2
	1992	500	0	0	0	0	0	0	0	0	13	487	0	0.0	0.0
	1993	485	0	0	0	1	0	0	0	0	160	325	1	0.3	0.3
	1994	600	0	0	0	0	0	0	0	1	73	526	0	0.0	0.0
	1995														
	1996	497	0	0	0	0	4	0	0	2	38	457	4	0.9	0.9
CORAL HARBOUR															
	1991	500	0	0	0	0	1	0	0	0	11	489	1	0.2	0.2
	1992	485	0	0	0	0	0	0	0	0	13	472	0	0.0	0.0
	1993	490	0	0	0	1	0	0	0	0	3	487	1	0.2	0.2
	1994	500	0	0	0	0	0	0	0	1	8	491	0	0.0	0.0
	1995	500	0	0	0	0	0	0	0	2	26	472	0	0.0	0.0
	1996	500	0	0	0	0	0	0	0	7	12	481	0	0.0	0.0
BAKER LAKE															
	1991	500	0	0	0	2	1	0	0	1	102	397	3	0.8	0.8
	1992	500	0	13	0	0	0	0	0	10	29	461	13	2.8	2.8
	1993	495	0	0	0	0	0	0	1	2	45	448	1	0.2	0.2
	1994	500	8	0	0	0	4	0	0	2	21	477	12	2.5	2.5
	1995											0			
	1996	500	0	0	0	2	0	0	0	4	0?	496		0.0	0.0
RANKIN INLET															
	1991	600	0	0	0	0	0	0	0	0	65	535	0	0.0	0.0
	1992	500	0	0	0	0	2	0	0	0	39	461	2	0.4	0.4
	1993	500	0	0	0	1	0	0	0	0	75	425	1	0.2	0.2
	1994	500	0	0	0	0	6	0	10	0	106	394	16	4.1	4.1
	1995	200	0	0	0	0	0	0	0	0	26	174	0	0.0	0.0
	1996	500	1	0	0	0	0	0	1	1	101	398	2	0.5	0.5
ARVIAT															
	1990	1100	2	0	0	0	8	0	0	15	51	1034	10	1.0	1.0
	1991	600	0	0	0	1	0	0	0	6	1	593	1		0.2
	1992	597	0	2	0	0	4	0	0	9	23	565	6	1.1	1.1
	1993	500	0	0	0	1	8	0	0	4	25	471	9	1.9	1.9
	1994	600	0	0	0	2	13	0	0	7	156	437	15	3.4	3.4
	1995	500	0	0	2	0	2	0	0	13	26	461	4	0.9	0.9
	1996	500	9	0	0	0	0	0	0	6	23	471	9	1.9	1.9

		TN	RBV	MV	TV	BL	CL	S	O	NT	MIS	ETN	TCAP	INDEX	NO-S
DARING LAKE															
	1994	500	9	3	0	2	1	0	0	0	83	417	15	3.6	3.6
	1995	520	10	7	0	0	0	0	0	2	28	490	17	3.5	3.5
	1996	598	8	0	0	1	2	1	0	4	155	439	12	2.7	2.5
LAC DE GRAS															
	1995	2337	49	2	0	2	0	0	0	0	0	2337	53	2.3	2.3
	1996	4446	200	40	0	31	4	0	0	0	0	4446	275	6.2	6.2
WALKER BAY(JUNE)															
	1993	545	0	0	0	1	13	0	0	1	86	458	14	3.1	3.1
	1996	490	0	0	0	10	27	0	0	3	111	376	37	9.8	9.8
WALKER BAY(JULY)															
	1990	450	0	0	0	2	27	0	0	2	24	424	29	6.8	6.8
	1991	926	0	0	0	7	8	3	0	8	20	898	18	2.0	1.7
	1992	979	0	0	0	5	22	1	0	4	108	867	28	3.2	3.1
	1993	579	0	0	0	6	2	0	0	5	89	485	8	1.6	1.6
	1994	486	0	0	0	0	0	0	0	1	14	471	0	0.0	0.0
	1995	499	0	0	0	4	4	0	0	10	35	454	8	1.8	1.8
	1996	619	0	0	0	24	28	1	0	19	135	465	53	11.4	11.2
BREAKWATER I.															
	1994	1170	0	0	0	0	1	0	0	0	2	1168	1	0.1	0.1
	1995	1020	0	0	0	0	8	0	0	0	10	1010	8	0.8	0.8
	1996	1170	0	0	0	0	40	0	0	0	77	1093	40	3.7	3.7
COCKBURN I.															
	1994	1170	0	0	0	0	1	0	0	0	2	1168	1	0.1	0.1
	1995	1170	0	0	0	5	4	0	0	0	8	1162	9	0.8	0.8
	1996	1170	0	0	0	41	32	0	0	0	208	962	73	7.6	7.6
HURD I.															
	1994	1170	0	0	0	1	1	0	0	0	2	1168	2	0.2	0.2
	1995	1170	0	0	0	0	1	0	0	0	9	1161	1	0.1	0.1
	1996	1168	0	0	0	8	34	0	0	0	97	1071	42	3.9	3.9
JAMESON I.															
	1994	1140	0	0	0	0	0	0	0	0	7	1133	0	0.0	0.0
	1995	1170	0	0	0	0	1	0	0	0	2	1168	1	0.1	0.1
	1996	1170	0	0	0	0	3	0	0	0	10	1160	3	0.3	0.3
WILMOT I.															
	1994	1170	0	0	0	0	1	0	0	0	7	1163	1	0.1	0.1
	1995	1170	0	0	0	0	5	0	0	0	19	1151	5	0.4	0.4
	1996	1170	0	0	0	0	26	0	0	0	63	1107	26	2.3	2.3
HOPE BAY															
	1984	180	12	0	0	2	0?		0?	?		180	14	7.8	7.8
	1985	390	0	0	4	2	1?		0?	?		390	7	1.8	1.8
	1986	600	0	0	0	0	0?		0?	?		600	0	0.0	0.0
	1987	600	14	0	16	3	0?		0?	?		600	33	5.5	5.5
	1988	600	5	0	0	0	0?		0?	?		600	5	0.8	0.8
	1989	600	6	0	0	0	0?		0?	?		600	6	1.0	1.0
	1990	600	42	0	0	8	0	0	0	0	93	507	50	9.9	9.9
	1991	500	6	0	1	3	3	2	0	0	45	455	15	3.3	2.9
	1992														
	1993														
	1994	1170	1	0	0	0	0	0	0	0	43	1127	1	0.1	0.1

		TN	RBV	MV	TV	BL	CL	S	O	NT	MIS	ETN	TCAP	INDEX	NO-S
	1995	1173	0	0	0	1	9	0	0	0	29	1144	10	0.9	0.9
	1996	1165	6	23	0	16	18	0	0	0	101	1064	63	5.9	5.9
ONE EYED JACK															
	1991	497	0	0	0	0	7	0	0	1	13	483	7	1.4	1.4
	1992	488	0	0	0	0	9	0	0	2	23	463	9	1.9	1.9
	1993	943	0	0	0	16	52	0	2	12	148	783	70	8.9	8.9
	1994	1023	0	0	0	0	2	0	0	6	19	998	2	0.2	0.2
BYRON BAY															
	1995	1179	0	0	0	0	1	0	0	0	21	1158	1	0.1	0.1
	1996	1170	0	0	0	20	40	0	0	0	104	1066	60	5.6	5.6
KUGLUGTUK															
	1995	491	4	0	0	2	0	0	0	0	300	191	6	3.1	3.1
	1996	500	16	0	0	16	1	0	2	0	322	178	35	19.7	19.7
SIKSIK LAKE															
	1993	479	0	0	0	0	84	0	0	2	55	422	84	19.9	19.9
	1994	602	0	0	0	0	2	0	0	5	0	597	2	0.3	0.3

LEGEND

TN = Trapnights
RBV = Red-backed vole (Clethrionomys sp.)
MV = Meadow Vole (Microtus pennsylvanicus)
TV = Tundra vole (Microtus oeconomus)
BL = Brown lemming (Lemmus sibiricus)
CL = Collared lemming (Dicrostonyx groenlandicus)
S = Shew (Sorex sp.)
O = Other small mammals
NT = Non-target sp. / birds
MIS = Trap misfires
ETN = Total trapnights (TN-MIS-NT)
TCAP = Total captures
INDEX = (TCAP/ETN) x 100
NO-S = Index without shrews [(TCAP - S) /ETN] x 100

Relationship of Brown and Collared Lemming Numbers

Numbers of brown lemmings (*Lemmus sibiricus*) and collared lemmings (*Dicrostonyx groenlandicus*) are positively correlated within sites and between years for most eastern arctic and central mainland sites (Table 2). In these areas, a change in density of one species is generally associated with a change in a similar direction by the other species. No between-area correlations for brown lemmings is attempted for the Keewatin because only 11 brown lemming captures were made in 13,838 effective trap nights (capture index = 0.8) at Keewatin locations (Repulse Bay, Coral Harbour, Baker Lake, Rankin Inlet, Arviat).

Table 2. Correlation between index of capture for brown lemmings and collared lemmings. (r = Pearson's product moment correlation, p = level of significance, n = sample size)

	r	p	n
POND INLET	0.75	0.05	7
BYLOT ISLAND	0.90	0.28	3
DARING LAKE	0.50	0.67	3
WALKER BAY	0.54	0.21	7
HOPE BAY	0.31	0.62	5
ONE EYED JACK	0.97	0.03	4

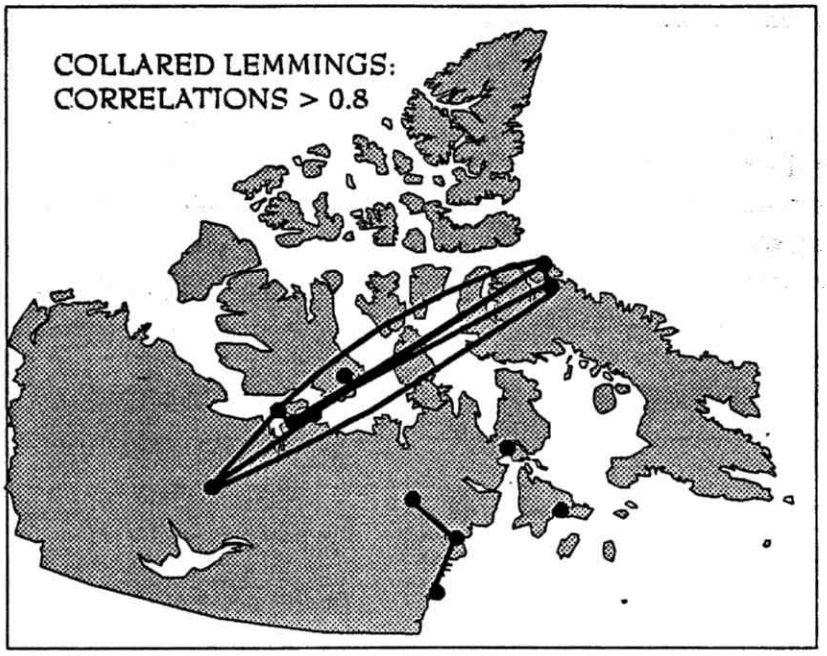
Population Synchrony Above Treeline

Figure 2 illustrates between-site population synchrony for collared and brown lemmings. On both maps, dark lines connect locations at which the correlation coefficient between brown or collared trapping indices are 0.80 or greater.

Collared lemmings exhibit correlated trends in the central and eastern arctic (Daring Lake, Walker Bay, Elu Inlet, Hope Bay, Bylot Island, and Pond Inlet) (Figure 2). Keewatin locations are not in synchrony with the central and eastern arctic and only Baker Lake, Arviat, and Rankin Inlet are in synchrony with each other. Repulse Bay and Coral Harbour are anomalous.

Brown lemmings show similar close correlation for the central and eastern arctic (Figure 2). The sample sizes of brown lemmings in the Keewatin are very small so the illustrated correlations should be ignored.

Figure 3 depicts annual population indices for collared and brown lemmings expressed as a proportion of maximal index observed. This presentation serves to correct for between-area density differences and makes relationships more obvious visually.



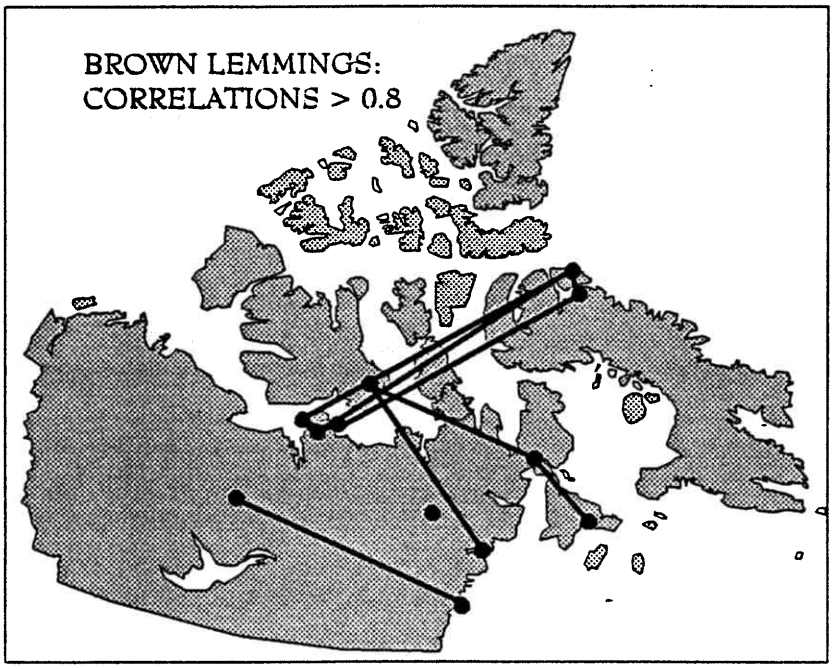


Figure 2. Pairs of trapping areas exhibiting correlation coefficients greater than 0.80 for collared lemmings and brown lemmings.

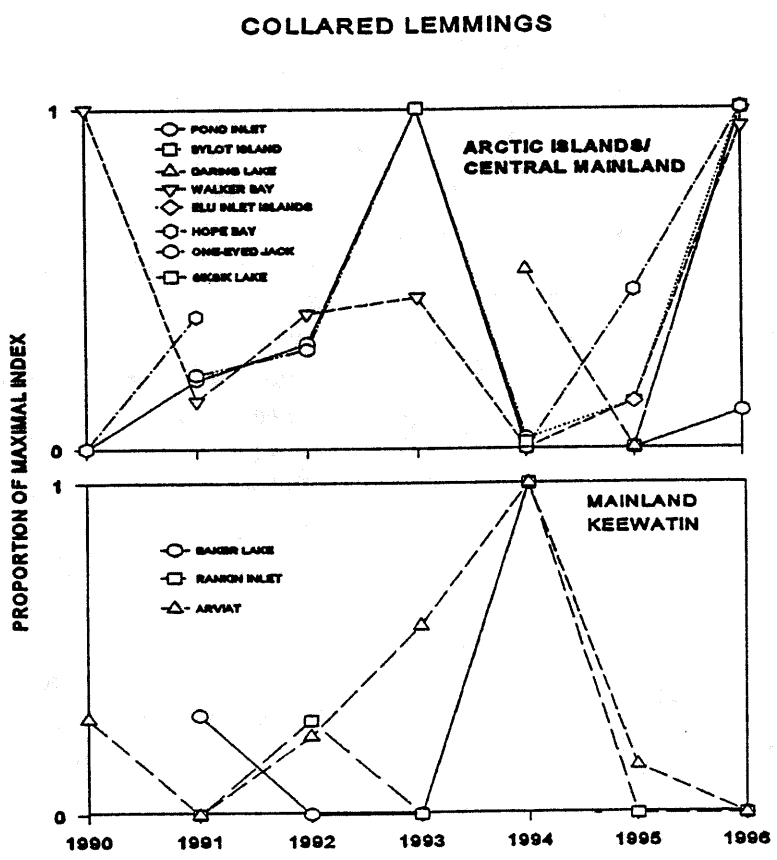


Figure 3. Population trend in collared lemmings at eastern and central arctic locations and at mainland Keewatin locations. Symbols represent proportion of maximal capture index observed.

Figure 3 shows that collared lemmings of the arctic islands and central mainland exhibited peaks in 1993 and 1996. The 1993 value presented for Walker Bay is taken from the June trapping period; it appears as if lemming numbers were undergoing a collapse at this time so the value is lower than might be expected.

The possibility of a widespread peak in 1990 is equivocal. Data suggest a large number of collared lemmings at Walker Bay but none at Pond Inlet. Very few collared lemmings are caught at Hope Bay so the zero value for 1990 there is not particularly instructive.

Collared lemmings at mainland Keewatin locations (Baker Lake, Rankin Inlet, Arviat) peaked in 1994 (Figure 3); one year after the central and eastern arctic. No trend was apparent for Repulse Bay or Coral Harbour. For all Keewatin areas except Arviat, number of collared lemming captures is very small so this result is not particularly robust. No analysis is provided for brown lemmings in Keewatin because of the small number of captures.

Figure 5 presents annual population indices for brown lemming expressed as the proportion of the maximal capture index observed. Brown lemmings of the arctic islands and mainland coast peaked in 1996 (Figure 5). The high values for Pond Inlet in 1992 and 1993 are based on only 2 captures each year and may therefore be an artifact of the small number of brown lemmings caught there.

Relationship of Microtine Populations to Rough-legged Hawk Numbers

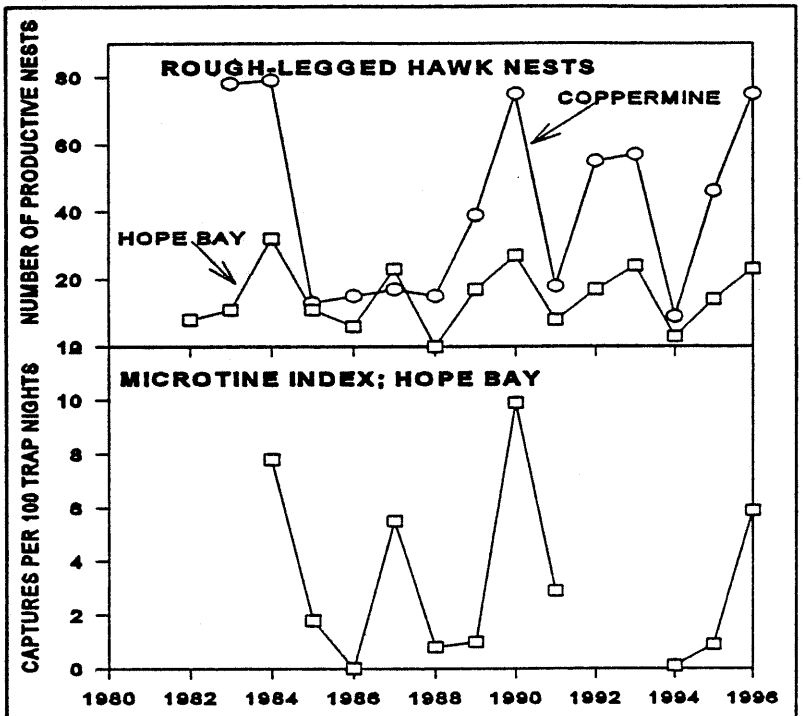


Figure 4. Relationship between number of productive Rough-legged Hawk nests seen at Kuglugtuk (Coppermine) and Hope Bay (1981 - 1996) with the microtine capture indexed for Hope Bay (1984 - 1996).

Figure 4 shows the microtine index at Hope Bay since 1984 and the number of Rough-legged Hawk nests containing either young or eggs. Rough-legged Hawk numbers are greater and more variable at Kuglugtuk than at Hope Bay but the correspondence in trend is evident. The only significant departure from correspondence is for 1987 when fewer than expected productive nests were seen at Kuglugtuk. This was also the only survey not undertaken by experienced personnel from the Department of Renewable Resources.

The microtine index at Hope Bay shows peaks every fourth year. Four peaks were observed with a fifth expected to have occurred in 1993 when trapping was not undertaken at Hope Bay. The correlation coefficient for Hope Bay microtines and productive rough-legged hawks at Hope Bay is 0.86 ($p = 0.0006$, $n = 11$). The correlation between Hope Bay microtines and Kuglugtuk Rough-legged Hawks is 0.76 ($p = 0.0061$, $N = 11$).

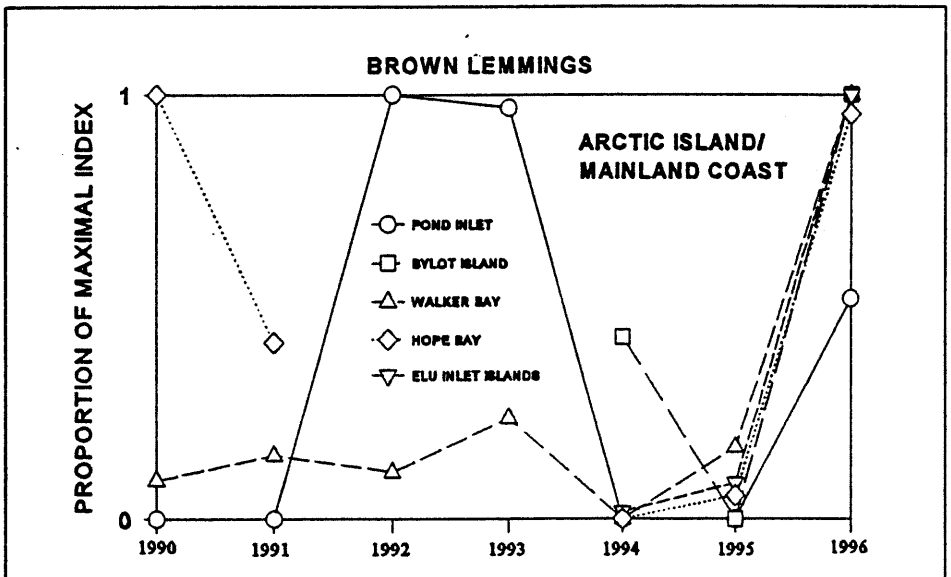


Figure 5. Population trend in brown lemmings at eastern/central arctic locations. Analysis is not provided for Keewatin locations because of small sample sizes. Figures are proportion of maximal capture index observed.

Below Treeline

Relationship between White-footed Deer Mice and Red-backed Voles

Table 3 summarizes 1990-1996 data on trapping effort, number of each species captured, and summary indices for forested locations in the NWT. *Clethrionomys* is represented by two species, *C. gapperi* south of Great Slave Lake and *C. rutilus* north of Great Slave Lake. In practice, these species have not been differentiated within this study and are treated as a single unit, the "red-backed vole". Below treeline, the two most common species are *Clethrionomys* sp., the red-backed vole, and *Peromyscus maniculatus*, the white-footed deer mouse.

Table 4 shows that the index of abundance for *Clethrionomys* and *Peromyscus* is positive in 4 of the 5 areas in which they co-occur. There is a tendency for density of the two species to vary in tandem although none of the correlations is statistically significant.

Table 4. Correlations between capture indices for red-backed voles and deer mice below treeline. (r = Pearson's product moment correlation, p = level of significance, n = sample size).

	r	p	n
YELLOWKNIFE	0.300	0.563	6
FORT SMITH	0.638	0.131	7
FORT LIARD (FORESTED)	0.884	0.116	4
FORT LIARD (LOGGED)	0.940	0.226	3
FORT SIMPSON	-0.037	0.953	5

Table 3. Summary of microtine captures below treeline; 1990 - 1996.

		TN	RBV	TV	MV	CCV	DM	BOL	S	O	NT	MIS	ETN	TCAP	IDX	NO-S
YELLOWKNIFE																
	1991	600	7	0	2	0	7	0	4	0	6	119	475	20	4.2	3.4
	1992	488	21	0	4	0	17	0	3	0	2	36	450	45	10.0	9.3
	1993	524	21	0	1	0	27	0	3	0	2	82	440	52	11.8	11.1
	1994	500	32	0	2	0	5	0	0	0	3	98	399	39	9.8	9.8
	1995	500	10	0	4	0	7	0	0	0	2	55	443	21	4.7	4.7
	1996	494	4	0	0	0	3	0	0	0	6	86	402	7	1.7	1.7
FORT SMITH																
	1990	500	48	0	1	0	3	0	2	0	1	165	334	54	16.2	15.6
	1991	500	7	0	0	0	4	0	5	3	1	137	362	19	5.2	3.9
	1992	500	13	0	4	0	3	0	11	1	1	216	283	32	11.3	7.4
	1993	500	46	0	0	0	6	0	4	0	0	60	440	56	12.7	11.8
	1994	300	22	0	0	0	0	0	3	1	4	120	176	26	14.8	13.1
	1995	500	80	0	2	0	10	0	15	0	3	186	311	107	34.4	29.6
	1996	248	25	0	0	0	2	0	3	0	0	42	206	30	14.6	13.1
FORT LIARD																
Forested																
	1993	1900	107	0	19	16	0	1	31	0	0	247	1653	174	10.5	8.7
	1994	1001	148	0	0	79	33	1	37	0	5	186	810	298	36.8	32.2
	1995	1000	137	0	2	13	32	1	64	1	9	328	663	250	37.7	28.1
	1996	500	48	0	0	0	16	0	5	0	0	95	405	69	17.0	15.8
Logged																
	1994	1000	85	0	5	5	24	0	37	0	40	40	920	156	17.0	12.9
	1995	1000	21	0	63	1	5	0	42	0	1	56	943	132	14.0	9.5
	1996	500	2	0	17	0	4	0	4	0	1	41	458	27	5.9	5.0
FORT SIMPSON																
	1992	500	3	0	0	0	16	0	1	0	0	24	476	20	4.2	4.0
	1993	500	7	0	0	0	10	0	6	0	3	23	474	23	4.9	3.6
	1994	500	27	0	0	0	1	0	0	0	0	68	432	28	6.5	6.5
	1995	512	24	0	0	0	8	0	1	0	4	185	323	33	10.2	9.9
	1996	500	0	0	0	0	0	0	0	0	1	61	438	0	0.0	0.0
NORMAN WELLS																
	1990	500	43	0	4	11	0	0	10	0	7	41	452	68	15.0	12.8
	1991	500	20	0	0	1	0	0	0	0	1	14	485	21	4.3	4.3
	1992															
	1993	500	5	0	1	0	0	0	1	0	4	22	474	7	1.5	1.3
	1994	500	22	0	3	0	0	0	0	0	3	26	471	25	5.3	5.3
	1995	347	46	0	0	0	0	0	1	0	7	83	257	47	18.3	17.9
	1996	495	25	0	0	0	0	0	0	0	8	57	430	25	5.8	5.8
INUVIK																
	1990	200	17	0	5	0	0	1	0	0	2	13	185	23	12.4	12.4
	1991	375	42	0	1	0	0	2	0	0	1	31	343	45	13.1	13.1

RBV = Red-backed vole (Clethrionomys sp.)
MV = Meadow Vole (Microtus pennsylvanicus)
TV = Tundra vole (Microtus oeconomus)
CCV = Chestnut-cheeked vole (Microtus xanthognathus)
DM = Deer mouse (Peromyscus maniculatus)
BOL = Bog lemming (Synaptomys borealis)
S = Shrew (Sorex sp.)

TN = Trapnights
O = Other small mammals
NT = Non-target sp. / birds
MIS = Trap misfires
ETN = Total trapnights (TN-MIS-NT)
TCAP = Total captures
INDEX = (TCAP/ETN) x 100
NO-S = Index without shrews [(TCAP - S) /ETN] x 100

Patterns of Population Synchrony

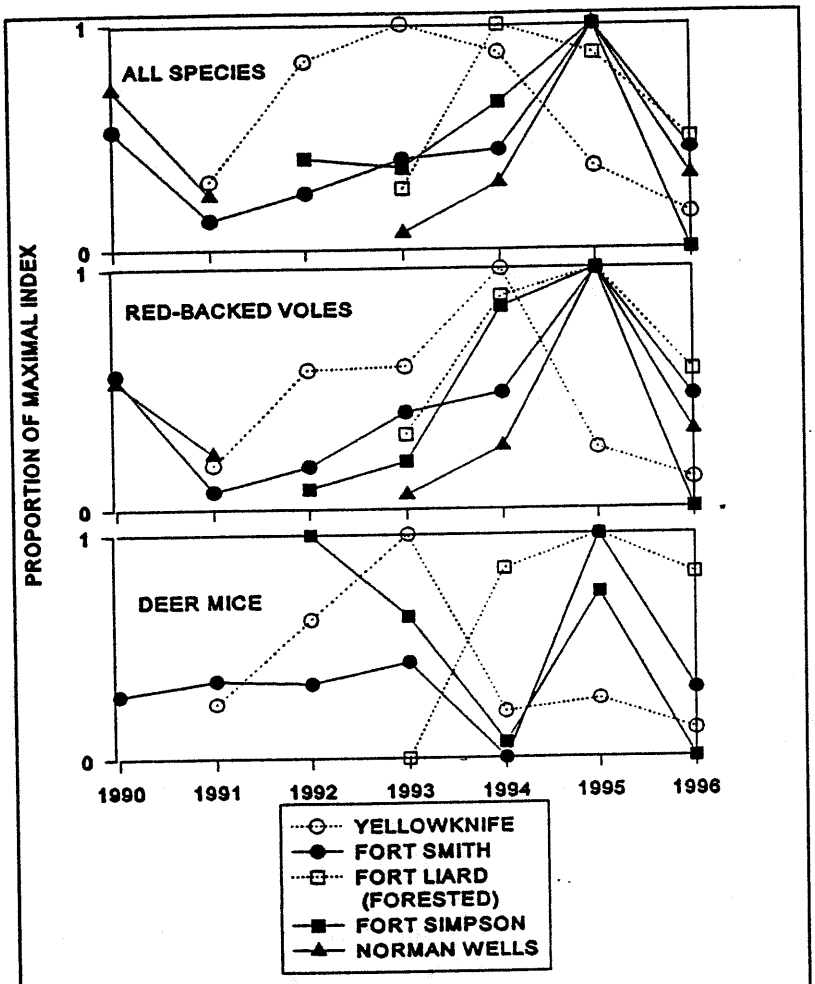


Figure 6. Population trend in species below treeline. Points indicate proportion of the maximal capture index observed.

Figure 6 shows annual population indices for all microtine species combined, for red-backed voles, and for white-footed deer mice. The data are expressed as proportions of maximal capture index observed. This serves to correct for between-area density differences and make patterns more evident.

The populations of all microtine species combined were in rough synchrony at all below treeline locations except Yellowknife. Numbers increased from 1991 to reach a peak in 1995 and then declined in 1996. Fort Liard microtines appeared to peak in 1994 but this is apparently an artifact of encountering a colony of chestnut-cheeked voles (*Microtus xanthognathus*) which inflated the capture index. Limited evidence suggests that there may have been a minor peak in microtine populations below treeline in 1990. The only clearly anomolous site was Yellowknife which built to a peak from 1991 - 1993 then declined to a low in 1996.

Red-backed voles were the most common type caught. Figure 6 shows that all sites except Yellowknife reached a peak in red-backed vole numbers in 1995 and subsequently declined in 1996. At Yellowknife, the peak in red-backed vole numbers was reached a year earlier in 1994.

The second most common species is the white-footed deer mouse. Figure 6 shows that there is no clear geographical or temporal pattern in number of deer mice captured.

DISCUSSION

Between-Species Population Synchrony

In the central and eastern arctic, brown and collared lemmings were in rough numerical synchrony (Table 2). However, correlations relating abundance of the two species are statistically significant only at Pond Inlet, where only 5 brown and 16 collared lemmings were caught in 7 years, and at One-eyed Jack Lake on Victoria Island where there are data only for 3 years and where brown lemmings were caught in only one year (Table 1). It appears as if abundance of collared and brown lemmings is related but not strongly.

Not enough animals were caught at Keewatin locations to determine the numerical relationships between brown and collared lemmings.

In the forested areas of the NWT, a very weak relationship exists between numbers of white-footed deer mice and the two *Clethrionomys* species. At four of the five locations, the correlations are positive in direction but none are statistically significant.

Between-Area Population Synchrony

For both collared and brown lemmings, the eastern and central arctic locations appear to exhibit similar trends whereas Keewatin show different dynamics.

It appears as if collared lemming numbers peaked in the central and eastern arctic in 1993 and 1996 with evidence for a possible localized peaks in 1990 (Figure 3). Supplementary evidence extends the geographic and temporal ranges of this generalization. Banks Island (Siksik Lake) showed a clear peak in collared lemming abundance in 1993 (Table 1) suggesting that the geographic extent of the synchrony may extend to the western arctic islands. In 1996, students and staff from the Royal Military College caught 36 collared lemmings at Cambridge Bay using 20 traps over the period 8 - 20 July (350 TN; index ca. 10.3) (Unpubl. rpt. on file with Dept. Resources, Wildlife, and Economic Development). In 1996, Olivier Gilg (pers. comm., 1997) counted collared lemming nests, calculated "dropping indices", and determined reproductive rates at Cambridge Bay, Arctic Bay, Pond Inlet, and Bylot Island. He characterized 1996 population levels as "high" in all locations. His 1993 nest count for Bylot Island was higher than the 1996 count corroborating Gilles Gauthier's observation (pers. comm. 1996) that the lemming peak of 1993 was at a higher numerical level than that of 1996.

Few collared lemmings were caught in Keewatin locations but it appears clear that there was a peak in 1994, one year after the central/eastern arctic peak. This suggests a major discontinuity in geographical synchrony.

Brown lemming numbers in the eastern and central arctic peaked in 1996. Evidence is equivocal for a 1993 high because very few locations were trapped that year. So few brown lemmings

were caught in Keewatin that no conclusions can be drawn.

In the forested areas of the NWT, redbacked voles were at a peak in 1995 at all forested locations except Yellowknife which peaked in 1994(Figure 6). At Fort Simpson and Fort Liard, red-backed vole numbers were at similarly high levels in 1994-95. This suggests rough synchrony of red-backed voles in forested areas of the NWT with peaks sometimes extending for more than a year and varying between locations by a year. Differences in population dynamics do not seem to correlate with presumed inter-specific differences (i.e., north and south of Great Slave Lake). As a broad generalization, population levels were comparable in 1996 and 1990 suggesting a possible population high in 1989. This would suggest a population peak every 6 - 7 years. The pattern is obviously more complex than in tundra locations.

There was no apparent pattern in population fluctuations of white-footed deer mice (Figure 6).

Rough-legged Hawks Indicators of Small Mammal Abundance

Rough-legged Hawks are obligate small mammal predators. They arrive on the breeding grounds in late May and, in some manner assess small mammal abundance. If microtine numbers are low, most individuals either go elsewhere to breed or remain in the area but forego breeding for that year. If small mammals are abundant, many pairs remain to breed.

The number of Rough-legged Hawks counted at Kuglugtuk and Hope Bay is highly correlated with small mammal abundance. The experience of 1993 might suggest that rough-legged abundance could provide an insight not provided by mid- or late-summer trapping. Small mammal trapping at Walker Bay was undertaken in June and July 1993. Numbers declined from a June index of 3.1 to a July index of 1.8. The predicted microtine index from the regression of hawk numbers on the microtine index is 5.9. This suggests that small mammal numbers had begun to decline prior to the June 14 - 20 trapping period.

Number of Rough-legged Hawk breeding pairs appears to be capped at a fairly constant peak (Figure 4) presumably as a result of territorial behaviour. It is unlikely that a predictive equation could be developed to quantify small mammal numbers from Rough-legged Hawk abundance. Accordingly, number of Rough-legged Hawk breeding pairs would only allow characterization of small mammal abundance as low, intermediate, or high. As well, Rough-legged Hawk numbers would integrate all small mammal species into a single estimate.

Establishing trend in numbers of Rough-legged Hawks can provide vital information supplementary to small mammal trapping and, depending upon data needs, may be a more reliable and cost-effective means of establishing general trends in small mammal abundance.

Timing of Trapping

The recommended methods call for trapping to be done in August. The justification for this time period is that it provides the opportunity for summer breeding to occur. In Keewatin locations particularly, this reasoning may not apply. Almost all persons involved in trapping in the Keewatin have commented that lemmings were more common earlier in the year and that they had declined by August; in some years dramatically. The small number of captures in Keewatin locations and the 1993 experience in the central arctic support this conclusion.

It is recommended that small mammal trapping be undertaken in mid- to late-June at Keewatin locations. If possible, August trapping should continue to establish whether numbers are truly declining throughout the summer. Supplementary June trapping at other tundra locations should be undertaken if it is convenient.

ACKNOWLEDGMENTS

Well over 70 persons have been involved in the trapping efforts which have produced the data contained in this paper. A list of trapping personnel is provided in the appendices. The cooperation of all these people is appreciated.

I would also like to acknowledge those principle researchers who have recognized the significance of broad synthesis and have accordingly allowed their data to be incorporated.

APPENDIX I. Summary of methods used in small mammal trapping sessions above treeline; 1990 - 1996.

STUDY AREA	LOCATION DESCRIPTION	DATES	OBSERVATIONS/PROBLEMS	PERSONNEL
POND INLET				
1990	72°42'N, 78°00'W; just west of DRR office. Line 1 at base of north-facing slope. Line 2 above on poorly-vegetated hilltop.	3 -8 September	Kids stole many traps. Site too accessible.	Mike Ferguson, Terry Audla
1991	New area set up 2 km south of town on water lake road; 72°42'N, 77°58'W. Two lines on gentle south facing slope. Vegetation variable from wet to xeric.	23 August - 1 September	New location seems to have solved trap theft problem.	Mike Ferguson, Line Gauthier
1992	Same as 1991.	19 August - 1 September	High winds and rain on 22nd.	Line Gauthier, Mike Ferguson
1993	Same as 1991.	17 - 27 August	Snowy owls nesting at density of 1/km². High lemming denisty.	Line Gauthier, Angela Legge, Mike Ferguson
1994	Same as 1991.	22 - 27 August	No captures	Line Gauthier
1995	Same as 1991.	14 - 24 August	No captures	Line Gauthier, Joe Tigullaraq, Anita Ootoowak
1996	Same as 1991.	14 - 24 August	25 traps stolen; 12 returned. Raining for first 5 days; everything very wet.	Erik Coleman, Mike Ferguson, Joe Tigullaraq, Jamie Enook
BYLOT ISLAND				
1994	73°09'N,79°58'W; dry tundra, low -centered, moderately wet polygon tundra, and stream bank habitat.	19- 30 July	Large decline in number of lemming predators from '93.	Gilles Gauthier
1995	Same as 1994.	19 - 29 July	No captures.	Gilles Gauthier
1996	New sites established because of large number of birds caught. Site 2 is a dry upland area with Salix, Cassiope, lichens mosses, ans sparse graminoids. Site 3 is a wet lowland dominated by moss and grasses except for polygon rims which support hummocky vegetation.	20 - 31 July	Lemming numbers high but indications not as high as '93	Gilles Gauthier
REPULSE BAY				
1991	66°31'56"N,86°14'10"W. Near a small lake. One line follows a rocky outcrop.	13 - 22 August	LaRose thinks there were more lemmings earlier in the summer.	Joe LaRose
1992	Same as 1991.	14 - 19 August	Traps soften in moist conditions and fall apart.	Joe LaRose

STUDY AREA	LOCATION DESCRIPTION	DATES	OBSERVATIONS/PROBLEMS	PERSONNEL
1993	Same as 1991.	23 - 28 August	Traps in poor condition leading to many misfires. Higher densities of lemmings earlier in year.	Leroy Bloomstrand
1994	Same as 1991.	26 - 30 August	Lemmings more common earlier in year.	Leroy Bloomstrand
1995	No trapping	-	-	-
1996	Same as 1991.	24 - 28 August	Many misfires from high winds and heavy rain.	Mike Gravel
CORAL HARBOUR				
1991	64°08'N,83°10'W. Flat tundra with rocky outcrops and tundra ponds. A wide range of communities including tussocks, lichen uplands, and boggy areas.	12-22 August	Devine thinks there are more lemmings earlier in the year.	Tim Devine
1992	As 1991. Habitat assessment in '92 file.	18 - 20 August		Tim Devine
1993	Same as 1991.	15 - 20 August		Tim Devine
1994	Same as 1991.	12 - 16 August	Trapping considered to be too late.	Dave Abernethy
1995	Same as 1991	25 - 31 August	No captures.	Jamie Chalmers
1996	Same as 1991	21 - 25 August		Ian Ellesworth
BAKER LAKE				
1991	64°19'N,96°02'W. One line through tussock tundra and other in a wetter area.	22 - 31 August	Weather wet and windy.	Joe Tigullaraq
1992	As in 1991. Habitat assessment in '92 file.	26 - 30 August	At least 4 captured lemmings were eaten by something.	Joe Tigullaraq
1993	Same as 1991	14 - 19 August		Joe Tigullaraq, Elijah Amarook
1994	Same as 1991	22- 29 August		Elijah Amarook
1995	Same as 1991	??	Number of trap nights not recorded.	Elijah Amarook
1996	Same as 1991	22 - 28 August		Elijah Amarook
RANKIN INLET				
1991	62°49'N,92°05'W. Habitats include tussock tundra, bog, and a small (3m) lichen-covered esker.	13 - 18 August	Siksiks caused some setoffs.	Robin Johnstone, Mark Bradley

STUDY AREA	LOCATION DESCRIPTION	DATES	OBSERVATIONS/PROBLEMS	PERSONNEL
1992	Same as 1991	13 -17 August		Robin Johnstone, Mark Bradley, Damian Panayi
1993	Same as 1991	12 - 17 August	Lemming numbers higher earlier in year.	Robin Johnstone, Mark Bradley, Damian Panayi
1994	Same as 1991	18 - 25 August	Lemming numbers higher earlier in year.	Robin Johnstone, Damian Panayi
1995	Same as 1991	29 August - 1 September	No captures.	Raymond Bourget
1996	Same as 1991	9 - 13 August		Dave Abernethy, Dave Stepniske
ARVIAT				
1990	61°06'N,94°05'W. Tundra hummocks, wet bog, and lichen upland.	15 - 25 August	Caught lots of passerines.	Mark Bradley, Paul Mikiyurgiok
1991	As 1990. Habitat assessment in '92 file.	13 -18 August		Mark Bradley
1992	As in 1990.	22 - 27 August	Nine passerines captured.	Mark Bradley, Johanne Tungilik
1993	As in 1990.	23 - 28 August	Snowy owls and foxes seen near trapline.	Dave Abernethy
1994	As in 1990.	25 - 30 August		Dave Abernethy
1995	As in 1990.	23 - 27 August		Dave Abernethy
1996	As in 1990.	27 - 31 August	Rain on 26 - 27 left some of trap area flooded.	Dave Abernethy
DARING LAKE				
1994	Perpendicular to esker. Habitat varies from heath community (*Ledum, Empetrum, Betula*, lichen) to grasses to sedges/mosses further from esker.	20 - 24 July		Adrian D'hont and Robert Gau
1995	Same location as '94.	4 - 8 July		Johanne Coutu
1996				
LAC DE GRAS				

STUDY AREA	LOCATION DESCRIPTION	DATES	OBSERVATIONS/PROBLEMS	PERSONNEL
1995	Diavik mine site. Exact location not know n. Trapping is a variety of habitat types.	??	Boulder fields were most productive sites.	David Penner and Associates
1996	As 1995.	??	As above.	David Penner and Associates
WALKER BAY				
1990	68°21'N,108°1-0'W at DRR waterfowl research station. Mesic, low willows with sedge hummocks. About 10% of traps in wet, grassy terrain.	13 - 21 July	Timing dictated by other research.	Bruno Croft
1991	As 1990?	11 - 20 July		Bruno Croft, Dean Robertson
1992	Another line positioned south of camp ridge in similar habitat.	July 9 - 18	Something (raven?) Took at least 2 lemmings from traps. Trapping also done 16 - 21 June but not included in report.	Bruno Croft, Dean Robertson
1993	As in 1992.	July 11 - 16 June 14 - 20	June trapping done as well. Showed dramatic drop in lemming density in July.	Bruno Croft, Bob Bromley, Karen Timms, Christophe Ferry
1994	Two new lines set up west of camp ridge in similar habitat to previous years. A third line starts on top of the camp ridge and runs east into wetter terrain than the other two lines.	July 12 - 16	Nothing captured.	Deb Wilson, Gwylin Blackburn
1995	As in 1994.	12 - 16 July		Deb Wilson, Bob Bromley
1996	As in 1994.	11 - 16 July 13 - 17 June		Rod Brook
MELVILLE SOUND (5 islands) Breakwater Island(67°55'N,108°30'N), Cockburn Island (68°05'N,108°18'W), Hurd Island (68°13'N,107°20'W), Jameson Island (68°10'N,109°44'W), and Wilmot Island (68°12'N,109°05'W),				
1994	No habitat description.		Slightly different protocol. 320 - 390 traps per night for 3 nights. Bait = peanut butter and raisins	Charles Krebs' crew
1995	No data.	7 June-10 July (Exact dates not known)	Same protocol as above.	Charles Krebs' crew
1996	No data.	7 June - July 8(Exact dates not known)	Same protocol as above.	Charles Krebs' crew
HOPE BAY				
1984	North end of Windy Lake	??	20 Victor traps. Lines moved every 5 days.	Kim Poole

STUDY AREA	LOCATION DESCRIPTION	DATES	OBSERVATIONS/PROBLEMS	PERSONNEL
1985	North end of Windy Lake	??	20 Victor traps. Lines moved every 5 days.	Kim Poole
1986	"122 Bay"	??	20 Victor traps. Lines moved every 5 days.	Kim Poole
1987	South end of Windy Lake	??	Six plots established each with two lines of 10 Victor traps. Two plots were trapped for 5 days, then moved to the next two plots.	Richard Cotter.
1988	South end of Windy Lake	??	Same as 1987	Richard Cotter.
1989	South end of Windy Lake	??	Same as 1987 and 1988	Richard Cotter.
1990	68°07'N,106°40'W. Lines 1, 2 and 5 near mouth of Koignuk River. On a gradual slope in wet to mesic tussock tundra. Lines 3 and 4 at north end of Windy Lake. Line 3 in mesic tussock tundra. Line 4 in drier area with sparse willow/graminoid cover. Photos in 1990 file.	4 - 9 August	About 35% of traps on Lines 3 and 4 were set off by ground squirrels.	Leslie Wakelyn, Richard Cotter, Kathy Martin
1991	Lines 1,2 and 5 the same. Lines 3 and 4 abandoned.	25 - 29 July	Heavy rain on 27th caused many set offs.	Leslie Wakelyn, Mika Sutherland
1992	No trapping.			
1993	No trapping.			
1994	Slightly down slope from lines 1, 2 and 5.	?	Some setoffs by siksiks.	Charles Krebs' crew
1995	Same as 1994?	?		Charles Krebs' crew
1996	Same as 1994?	7 June - July 8(Exact dates not known)		
VICTORIA ISLAND				
1991	One-eyed Jack Lake, (69°43'N,103°39'W). Lines perpendicular across a low, dry ridge. Mostly graminoid tussocks interspersed with sparse moss and lichen. Transect ends in wet areas. Rock cairns mark ends.	12 - 21 July	Staples on 2 traps pulled.	Chris O'Brien, Wayne Brode
1992	Same as 1991.	16 - 20 July		Chris O'Brien, Brenda McNair
1993	One-eyed Jack was trapped in June. In July, trapping was east of the mouth of Freshwater Creek (69°08'N,105°00'W) not far from Cambridge Bay.	17 - 23 June, 25 - 31 July	Muskoxen would not allow traps to be checked 30 July	Dean Robertson, Doug Stern

STUDY AREA	LOCATION DESCRIPTION	DATES	OBSERVATIONS/PROBLEMS	PERSONNEL
1994	Same as 1991.	21-25 June, 11 - 16 July		Chris O'Brien, Brenda McNair
BYRON BAY (Victoria Island)				
1995	68°46'N,109°08'W.	7 June 10 July (Exact dates not known)	Slightly different protocol. 390 traps per night for 3 nights. Bait = peanut butter and raisins	Charles Krebs' crew
1996	Same as 1995?	7 Jun - 8 July (Exact dates not known)	Same as above.	Charles Krebs' crew
KUGLUGTUK				
1990	67°48'50"N,115°08'00"W, 500 m north of airport terminal. Low shrub tundra heath with patches of grass/sedge.	29 August - 3 September	Large number of misfires caused by ravens, siksiks, Canada geese, and passerines. Data are not representative.	Anne Gunn
1995	Different than 1990 but not known.	16 - 20 August	Siksiks triggered 95/99 traps on 17 August.	Paul Panegyuk
1996	Two km southwest of land fill.	19 - 24 August	Siksiks sprung as many as 78% of the traps and ate lemmings out of the traps.	Paul Panegyuk
SIKSIK LAKE (Banks Island)				
1993	Siksik Lake at 72°23'N,125°08'W. Dry hummock tundra. Cover = 15% willow, 35% grass, 20% moss, 30% bare ground	28 July 1 August		Richard Cotter
1994	Same location	17 -23 July		Richard Cotter

APPENDIX II. Summary of trapping sessions undertaken below treeline, 1990 - 1996.

STUDY AREA	LOCATION DESCRIPTION	DATES	PROBLEMS/OBSERVATIONS	PERSONNEL
YELLOWKNIFE				
1991	Kam Lake Tower; 62°24'N, 114°26'W Line 1 largely in peat bog with scattered willows and spruce. Line 2 has rock and jack pine at both ends and Labrador Tea/Spruce bog in middle.	13-18 August	Heavy rain night of 14th. Otherwise sunny.	Dean Robertson
1992	As above	11-15 August		Chris Shank
1993	As above	11-16 August		Leslie Wakelyn, Judy Dragon
1994	Line 1 bulldozed so moved 10 m east. Habitat similar to original but at edge of bulldozed peat bog.	16 - 19 August; 23 August	Grey Jays and a red fox set off traps.	Johanne Coutu
1995	As 1994	15-19 August		Johanne Coutu, Judy Dragon
1996	As 1994.	07 - 11 August		Chris Shank
FORT SMITH				
1990	60°01'N, 111°54'W; near airport White spruce with some willow openings and aspen.	20-24 August	Heavy rains	Ron Graf, Tom Duncan
1991	As 1990	2 - 6 August	Heavy rain night of 2nd; otherwise hot. Most setoffs by red squirrels.	Ron Graf, Tom Duncan
1992	As 1990	21 - 25 August		Ron Graf, Leroy Bloomstrand
1993	As 1990	30 August - 3 September		Lee Keary, Troy Ellesworth
1994	Previous area logged. New location 300 m north of original. Similar in habitat but less debris on forest floor.	17 - 21 August	On the last two days, a bear triggered lots of traps and ate the yellow triggers. Only 3 days of data are used in the report. Cloudy weather.	Lee Keary
1995	As 1994	20-24 August	Many red-backed voles.	Lee Keary
1996	50 kill traps and 25 live traps used. Only live trap data reported.	26 - 30 August		Lee Keary
FORT SIMPSON				

STUDY AREA	LOCATION DESCRIPTION	DATES	PROBLEMS/OBSERVATIONS	PERSONNEL
1992	At student winter camp 34 km from Simpson towards Wrigley (62°00"N, 122°00'W) Mixed woodland of black and white spruce with patches of aspen, poplar, willow and tamarack.	11 - 15 August		Ken Davidge, Ron Graf, Leroy Bloomstrand,, George Tsetso
1993	Same as 1992.	??		Ken Davidge
1994	Same as 1992.	23 - 27 August		Ken Davidge
1995	Same as 1992.	8 - 12 August		Ken Lambert, George Tsetso
1996	As 1995	20 - 24 August		Ken Lambert, George Tsetso
FORT LIARD (FORESTED)				
1993	Control #1 at 60°39'27"N, 117°29'12"W. Flett West 60°43'20"N, 111°26'59"W. Flett Control 60°43'10"N, 111°25'50"W. Flett East 60°43'02"N, 111°25'01"W. Flett East and Flett West will be logged in winter 1993-94. Control #1 and Flett Control will not be logged. All areas are similar mature to "overmature" white spruce with some balsam poplar, alder, birch, rose, high bush cranberry, and labrador tea. Ground cover of moss, horsetail.	Control #1; 5 - 9 August. Flett West; 2 - 6 September. Flett Control; 3 - 7 September. Fleatt East; 4 - 7 September		Control #1; Adrian D'hont, Ron Graf, Larry Bertrand. Flett West; Adrian D'hont, Gregory Lomen.
1994	Two new areas all very close to 1993 Flett locations. One of controls unapproachable because of stream crossing. Flett 5 in white spruce forest similar to 1993 trapping areas. Flett 6 is similar but with more mesic conditions and hence more ferns and sedge.	Flett 5; 3 - 7 August, Flett 6; 4 - 8 August		Lee Keary
1995	As in 1994	9 - 13 August		Lee Keary, Mark Bradley
1996	50 kill traps and 25 live traps used Flett 5 and 6. Only kill trap results reported.	9 - 13 August	Not much success with live traps	Lee Keary, Mark Bradley, Louis Bethale, Gerry Bethale
FORT LIARD (LOGGED)				
1994	Two new areas near 1993 Flett lines. Logged areas did not overlap 1993 Flett East and Flett West. Two lines were not accessible. Flett 1 was logged winter 93-94 and has windrowed slash separated by 3-4 m of mineral soil. Spruce seedlings planted earlier in summer. Traps set at edge of windrows. Flett 2 was logged and the slash left as it fell. More vegetation remains than in Flett 1.	Flett 1 and 2; 2 - 6 August		Lee Keary

STUDY AREA	LOCATION DESCRIPTION	DATES	PROBLEMS/OBSERVATIONS	PERSONNEL
1995	Old Lines 1 and 2 plowed up. New Line 1 (= Flett #2) 60°43'30.0"N, 123°25'39.1"W. Line 2 (= Flett #4) at 60°43'52.7"N, 123°28'11.9"W Line 1 moved from Cutblock 1 to 2. Lines run perpendicular to slash windrows. The area was unbladed in '94 and bladed in '95. Line 2 moved 1.5 km from Cutblock 2 to 4 where no site prep occurred.	9 - 13 August		Lee Keary, Mark Bradley
1996	One line at each location was live-trapped and the other kill-trapped as in previous years. Only the kill data are reported.	9 - 13 August	Not much success with live traps.	Lee Keary, Mark Bradley, Louis Bethale, Gerry Bethale
NORMAN WELLS				
1990	Marten study area 30 km west of Norman Wells (65°18'N,127°20'W). Line A in mature black spruce with understory of moss, labrador tea, and blueberry. Line B in 10-yr old burn with small spruce and willow and a discontinuous understory.	9 - 13 September	Seven grey jays caught so traps placed under logs, etc. to minimize problems.	Kim Poole, Paul Latour, Norman McLean
1991	Same as 1990.	1 - 4 October	Much later than ideal.	Paul Latour, Norman McLean
1992	No trapping.	--	--	--
1993	New area nearer town at 65°17'N,126°50'W Black spruce forest with no secondary layer and ground cover of spaghnum moss and Labrador tea.	21 - 25 August		Norman McLean
1994	Same as 1993	27 - 31 August		Norman McLean
1995	Same as 1994.	23 - 27 August	Red-backed voles increased to 1990 levels.	Alasdair Veitch, Richard Popko
1996	Same as 1995.	22 - 26 August		Alasdair Veitch