Small Mammal Survey

in the Northwest Territories

Report 1998

Suzanne Carrière

Wildlife and Fisheries
Department of Resources, Wildlife and Economic Development
Government of the Northwest Territories
Yellowknife NT
X1A 3S8

1999

Manuscript Report No. 115

ABSTRACT

Small mammals play a keystone role in both arctic and boreal ecosystems; they are a major prey species for many northern carnivores. Cyclic fluctuation in the abundance of small mammals is reflected in similar fluctuations in the abundance of their predators. The NWT Small Mammal Survey is designed to monitor changes in voles (*Clethrionomys rutilus*, *C. gapperi*, *Microtus oeconomus*, *M. pennsylvanicus*, *M. xanthognathus*, *Phenacomys interdius*), mice (*Peromyscus maniculatus, Zapus hudsomius*), lemmings (*Synaptompys borealis, Lemmus sibiricus, Dicrostonyx groenlandicus*), and shrews (*Sorex* sp.) abundance in 15 sites across five ecozones in the Northwest Territories and Nunavut (April 1999). The survey is done using AMuseum Special≅ snap traps placed on two transects in typical habitat. In addition, two special projects were initiated to (1) collect specimen of deer mice to be tested for hantavirus and (2) re-examine specimens for species identification. This report adds to the information given in Shank (1996). It includes summaries of all trapping activities up to 1998 and provides update reports on the two special projects.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

Small mammals play a keystone role in both arctic and boreal ecosystems (Krebs 1996). Small mammals are a major prey species for foxes, marten (*Martes americana*), raptors, and other carnivores. Cyclic fluctuation in the abundance of small mammals is reflected in similar fluctuations in the abundance of their predators (Finerty 1980, Krebs 1996, Boonstra et al. 1998). For example, abundance cycles in small mammal populations have been associated with changes in marten harvest (Tungilik and Shank 1994).

The NWT Small Mammal Survey is designed to monitor changes in vole, mouse, lemming, and shrew abundance across five ecozones in the Northwest Territories and Nunavut (April 1999).

Trapping project

Major objectives are:

1- to develop "the capacity to predict small mammal abundance at particular locations" (Shank 1997),
2- to "describe the geographic scale of population synchrony" (Shank 1997), and
3- to develop a tool for predicting seasons of good harvest potential for some predators on small mammals, e.g., marten, lynx (*Lynx canadensis*), and arctic fox (*Alopex lagopus*).

Hantavirus project

An additional objective of the NWT Small Mammal Survey to collect specimen of deer mice (*Peromyscus maniculatus)* to be tested for hantavirus. The infection is transmissible from mice to human by simple inhalation of dried excrement and can cause death. There is yet no evidence that Hantavirus is present in NWT since testing was initiated in 1994. In 1998 cases were reported as far north as near Fort McMurray, Alberta (M. Bradley, Biologist, Fort Smith, RWED, pers. comm.).

Identification project

A special project within the Small Mammal Survey was initiated in 1997 and continued in 1998. With current identification keys, small mammals are notoriously difficult to identify to species in the field and errors may occur even in the laboratory. Errors were noted in 1997 in the identification of some specimen collected in 1995, 1996 and 1997. Our understanding of the natural variations in small mammal abundance and of their effects on fur-bearer abundance depend to some extent on a correct species identification.

Furthermore, the northern distribution of northern red-backed voles (*Clethrionomys rutilus*) and southern red-backed voles (*C. gapperi*) is still unknown. There is evidence that their distribution, as reported in mammalogy textbooks and field guides, are based on misidentified specimens.

The 1998-99 objectives of the identification project were to:
- verify the species identification of the 1998 specimens,
- build a reference collection and report for the identification of small mammals in the field and the laboratory, and
- determine the spatial distribution of the two species of voles in the Northwest Territories.

This interim report updates the information given in Shank (1997) by adding summary capture data for 1997 and 1998. Additional information is also provided for 1998: trap line location, trappers' name and weather. As in previous years, government biologists, Renewable Resources Officers, casual government employees, academic researchers, and environmental consultants performed data collection in 1997-98. At some sites, students assisted in data collection within research camps or school field courses. A successful NWT Small Mammal Survey is possible because of their efforts.

METHODS

Trapping Project

The trapping methods are unchanged since 1990. Each cooperator has the flexibility to alter methods to suit local circumstances, but the recommended procedures are as follows (Shank 1997):

1) Trapping is to be done solely with AMuseum Special≅ snap traps.
2) Traplines are to be two parallel lines ca. 100 m apart running 250 m through typical habitat. Traplines should be as close to the investigators' work stations 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 10 am. 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, and 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.

Data are reported as capture indices, defined by number of trapped specimens per 100 trap-nights. Capture indices during this survey are used as an indicator of abundance in a specific area, i.e., density. Trap-nights are defined as the number of traps set multiplied by the number of nights deployed, minus number of misfires and non-target species. Misfires are traps sprung without a capture. Target species are listed in Appendix 1.

Weather during trapping was recorded at each site, as strong wind and rain are known to increase frequency of misfires. Other causes of misfires and any systematic problems when trapping were also recorded.

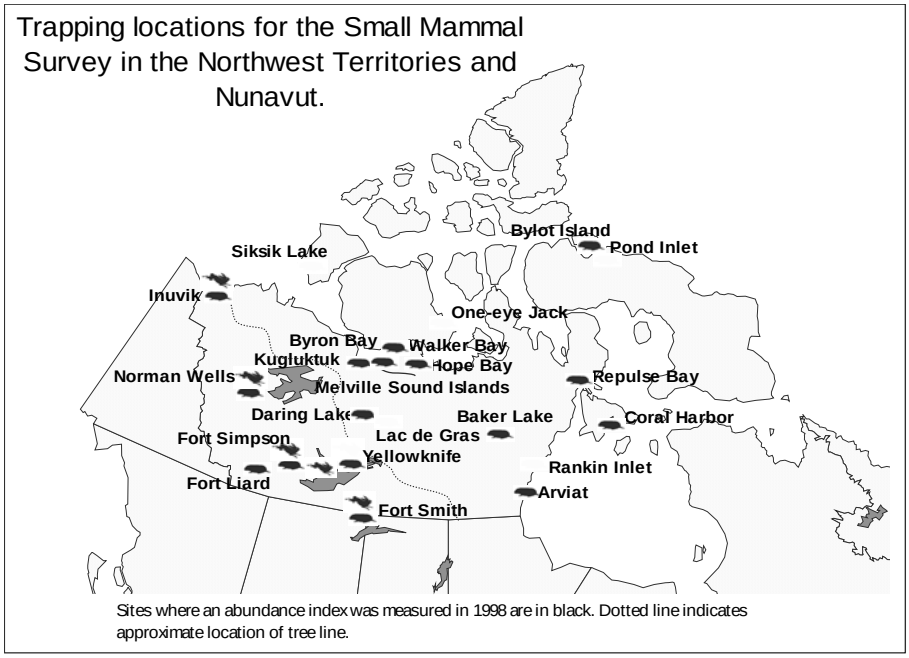


Figure 1. Trapping locations for the Small Mammal Survey in the Northwest Territories and Nunavut.

Hantavirus Project

Whenever possible all deer mice trapped in Yellowknife, Fort Smith and Fort Liard are sent for hantavirus testing. In addition, voles (red-backed and chestnut-cheeked voles) and lemmings are sent for testing. In 1998, all speciment were sent to:
Harvey Artsob
Chief, Zoonotic Diseases

Laboratory Center for Disease Control
Federal Laboratories
1015 Arlington Street
Winnipeg, Manitoba
R3E 1S1
tel.: (204) 789-2134
fax: (204) 789-2082
e-mail: Harvey_Artsob@hc-sc.gc.caHealth and Welfare Canada for testing.

Identification Project

Specimens for species identification were frozen for transportation and sent to Yellowknife RWED Laboratory for species identification using external characteristics and dental patterns (Banfield 1981). Additional measurements were obtained to differentiate between southern and norhtern red-backed voles: molar eruption, wear, and tarnish indices, presence of double molar roots, body weight, tail length and colour, ear length and molt index. Teeth patterns of lower and upper jaws were photographed at 50x magnification.

The 1998 collection from Norman Wells was sent (Export Permit: 037327) to Arianna Zimmer for her 4th year project under the supervision of Dr. Warren Fitch at University of Calgary. She will study the frequency of occurrence of internal parasites in small mammals.

RESULTS AND DISCUSSION

Summary results from 1990-1998 are provided in Appendix 2. Graphical representations of capture indices on sites in forested regions (NWT) are provided in Figure 2, on sites above treeline (mostly in Nunavut in April 1999) in Figure 3. Posters were created to help biologists and wildlife officers in their consultation with trappers and community members throughout NWT. The posters are reproduced in Appendix 4.

Site reports for 1998 (see below) and graphs (see Figures 2 and 3) were grouped so that sites that are apparently synchronized are shown together. Sites were grouped as follows: NWT, Taiga Plains, Taiga Shield, and Boreal Plains; Nunavut: High Arctic, Melville Sound, Southern Arctic Coast, Southern Arctic Interior, Hudson Bay. No additional analyses to detect synchrony were performed beyond those reported in Shank (1997). Analyses of synchronism among sites for each major species will be possible in later years with continuous verification of species identification.

Sites on the Taiga Plains were characterized by peak captures (species grouped) in 1994-95 and in 1998, and by lows in 1991-92 and 1996 (Figure 2). The Boreal

Plains site (Fort Smith) and Taiga Shield site appears not to be synchronized (Figure 3).

Small mammal abundance indices in the Western Northwest Territories, 1990-98

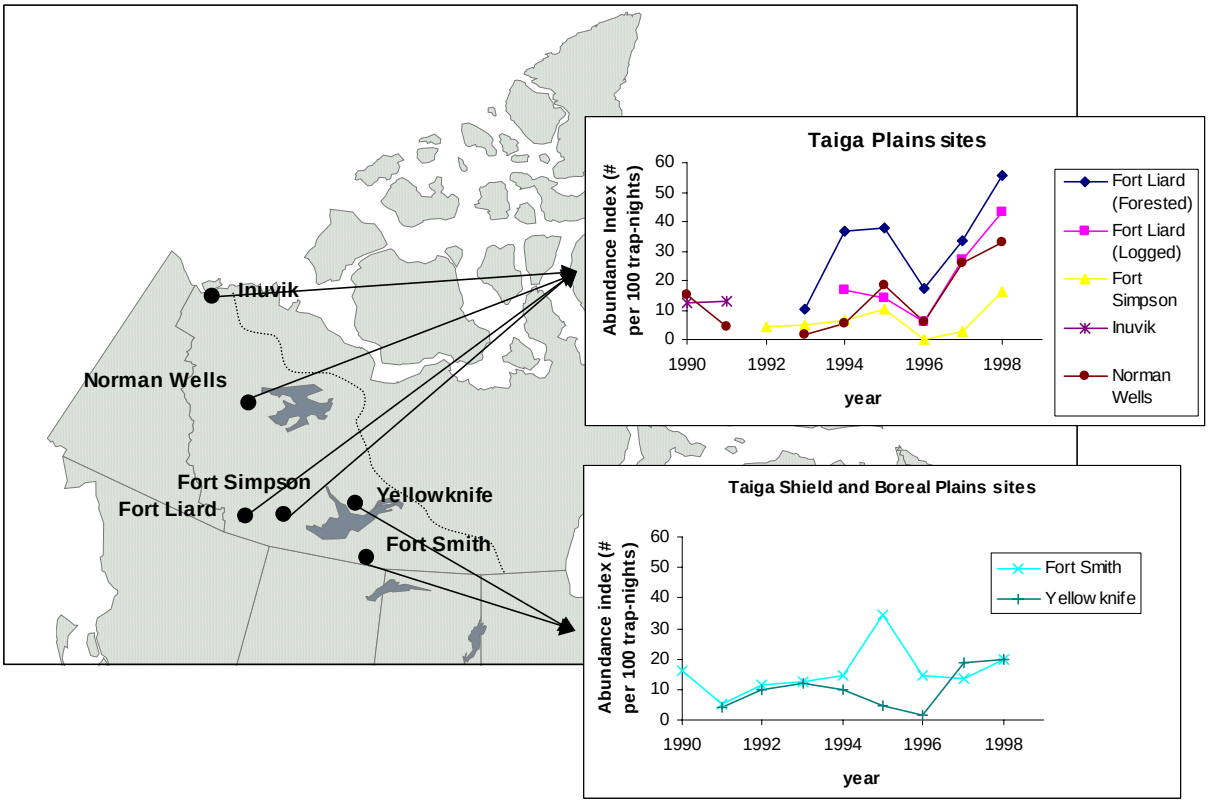


Figure 2. Abundance indices (total captured per 100 trap-nights) near six communities below the tree line.

Captures indices in the High Arctic, Melville Sound (exception of Jameson I.), and Southern Arctic Coast peaked in 1996 (Figure 3). Where data exist, there is also evidence that a peak occurred in 1992-93 in other High Arctic sites (Walker Bay: Figure 3; One-eye Jack; not shown). Captures indices at Hudson Bay sites peaked in 1994 and 1997 (Figure 3). Southern Arctic sites on the continental interior (Daring Lake and Baker Lake) may have peaked in 1994, but did not peak in 1996 as other Arctic sites (Figure 3).

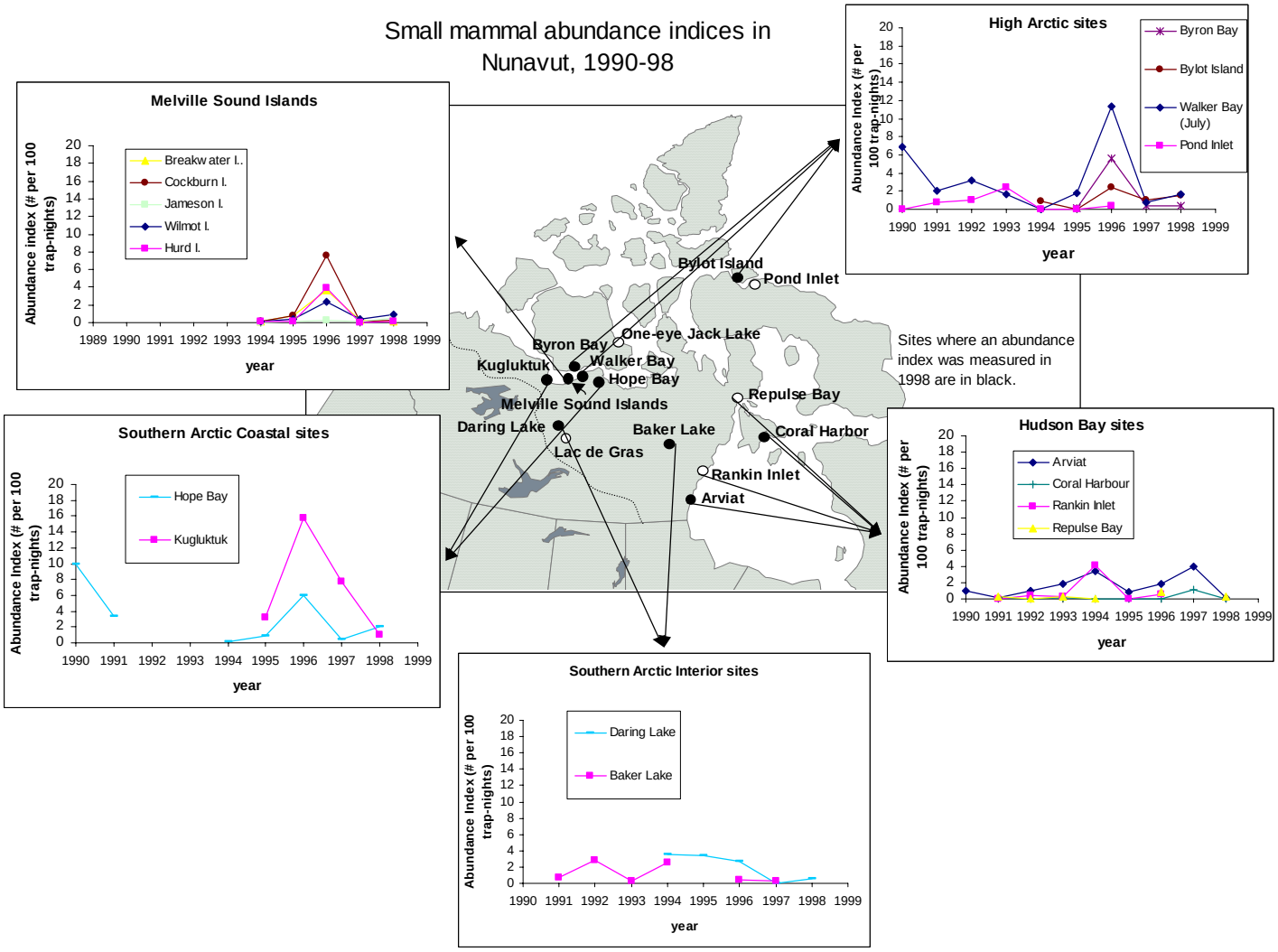


Figure 3. Abundance indices (total captured per 100 trap-nights) on 17 locations near communities and research stations in above the tree line. The survey was not performed in 1998 on locations marked by an open circle

Site reports for 1998

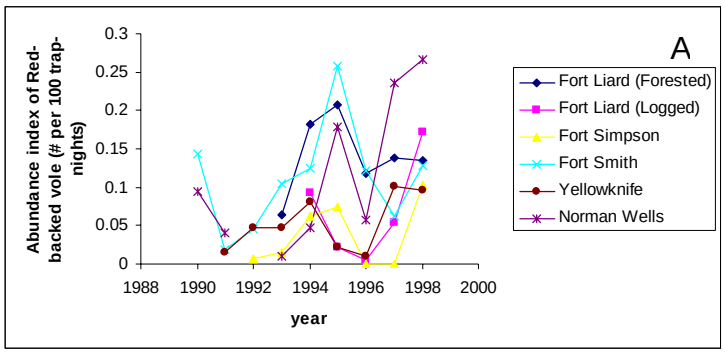
In 1998, trapping was performed at 6 sites in NWT and 11 sites in Nunavut (Figure 1).

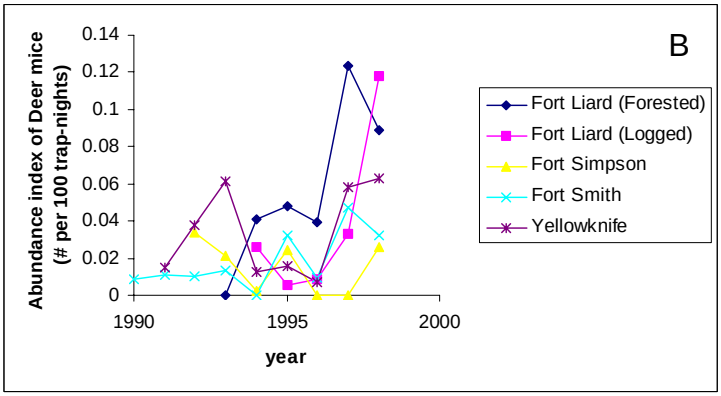
Boreal Plains - Fort Smith

Lines are located near the airport, the same location since 1994. Habitat is white spruce (*Picea glauca*) with some willow (*Salix* spp.) and aspen (*Populus tremuloides*). William Mandeville performed trapping on 02 - 06 September 1998. Weather ranged from overcast to sunny, with light winds.

Capture indices for all species are relatively constant since 1996 after a peak in 1995 (Figure 2). Red-backed vole (*Clethrionomys* sp.) was the most common species (Figure 4a) Deer mice captures increased to an all time high in 1997 and stayed relatively high in 1998 (Figure 4b).

Figure 4. Abundance index of Red-backed voles (A) and Deer mice (B) in western Northwest Territories.





Taiga Shield - Yellowknife

Lines are located near Kam Lake Tower, the same location since 1991. Habitat is peat bog with some willow and black spruce (*Picea mariana*) and Jack pine

(*Pinus banksiana*) on rock. Suzanne Carrière and Adrian D'Hont trapped on 18 - 23 August 1998. Weather was cool (10-13 C) with some strong winds and rain. Capture indices for all species were at an all time high in 1998 (Figure 2), with increases in both red-backed vole and deer mice captures (Figures 4 and 5).

Taiga Plains - Fort Simpson

Lines are located on the road to Wrigley, the same location since 1992. Habitat is mixed black and white spruce with patches of aspen, poplar (*Populus balsamifera*), willow, and tamarack (*Larix laricina*). George Tsetso and Joseph McDonald trapped on 13 -17 August 1998. Weather was cloudy with light showers on 13 August and sunny on other nights. Capture indices were at an all time high in 1998 (Figure 2), with increased in red-backed vole and deer mice captures (Figures 4 and 5).

Taiga Plains - Fort Liard

The survey performed near Fort Liard differs from most other sites. It designed and initiated by Mark Bradley in 1993 to monitor the effects of logging on small mammal abundance. Trap lines are located between the Fort Liard road and the Liard River, with 2 sets of transects in cut sites and 2 sets of transects in uncut sites of white spruce forest. White spruce with some poplar, alder (Alnus spp.), and birch (Betula spp.) dominate habitat in uncut sites. Habitat in cut sites (since winter 1993) is woody debris, exposed mineral soil, and spruce seedlings. Mark Bradley and Albert Bourque trapped in August 1998 (dates unknown). Capture indices were at an all-time high in 1998 (Figure 2), mainly due increased a three-fold increase in capture of deer mice and red-backed voles in logged sites, and a 10-fold increase in capture of meadow voles (Microtus pensylvanicus) in forested sites compared to 1997.

Taiga Plains - Norman Wells

Trap lines are near the start of the Norman Wells to Zana, AB oil pipeline. Alasdair Veitch and Arianna Zimmer trapping on 6 -10 August 1998. Habitat is black spruce, with moss, Labrador tea (*Ledum groenlandicum*) and other shrubs. Capture indices increased in compared to 1996 and 1997 (Figure 2), mostly due to increases in red-backed voles and meadow voles.

Hudson Bay - Arviat

Trap lines are near town on the same location since 1990. Habitat is flat hummocks with moist-dry mosses, lichens, graminoids, sedges and birch. Dave

Abernethy trapped in 1998 (dates unknown). Weather was overcast, with intermittent rain during two nights, winds up to 30 km/h. Capture index in 1998 was lowest recorded since 1991 (Figure 3) after a relative peak in 1997.

Hudson Bay - Coral Harbor

Trap lines are on the same location since 1991. Habitat is tundra dominated by grasses, mosses and lichens, with rock outcrops and small ponds. Clifford Netser trapped on 27 - 31 July 1998. Weather was mostly sunny. Capture index in 1998 was zero (Figure 3). A survey in late July seems inappropriate for Coral Harbor, as higher densities of lemmings were observed in early spring. This was suggested as early as in 1992. The 1998 survey was done earlier (late July) in 1998 than in most years (mid-August). Much may be learned by doing a second survey each year, in early spring.

Hudson Bay - Repulse Bay

Trap lines are on the same general area as in 1991-1996, but the exact location may differ. Habitat is fine gravel, bedrock, and low grassy tundra with moisture from wet to moist. Joani Kringayark trapped on 26 - 31 August 1998. Weather was overcast (first 2 days) to sunny (last 3 days) with temperature 3-6 ^{o}C. Northern winds up to 30 km/h occurred on 28 August. Capture index in 1998 was low. Indices are low since the start of the Survey in 1991 (Figure 3). A survey in late August may be inappropriate for Repulse Bay as for Coral Harbor.

Southern Arctic Interior - Baker Lake

Trap lines are presumably on the same location since 1991 (no changes were notified). Habitat varies from tussock tundra to wet grass-sedge meadows. Elijah Amarook trapped in 1998 (dates and weather unknown). Capture index in 1998 is not yet available.

Southern Arctic Interior - Daring Lake

Trap lines are on the same location since 1994, near the Arctic Ecosystem Research Camp, Daring Lake. Habitat varies from shrub tundra on esker to grass-sedge meadows near a lake. Trapping was performed on 28 July - 3 August 1998 during a science camp under the supervision of Steve Matthews. Weather was generally sunny with light winds. Capture index in 1998 was a slight increase from the low in 1997 (Figure 3).

Southern Arctic Coast - Hope Bay

Trap lines are on the same location as in 1997, near mouth of Koignuk River. Habitat varies from wet to dry tussock tundra. Alice Kenney and Dr. Charles Krebs (UBC: University of British Columbia) performed trapping on 29 June - 2 July 1998. There was little wind and no precipitation. Capture index in 1998 was a slight increase from the low in 1997 (Figure 3).

Southern Arctic Coast - Kugluktuk

Trap lines are on the same location since 1995, about 2 km southwest from a land fill. Habitat is unknown. Trapping was performed on 17 - 21 July 1998 during a school outing under the supervision of Damina Panayi, Brent Patterson, and Monica Kapakatoak. Weather was rainy for first 3 days, sunny for last day of trapping. Capture index in 1998 was the lowest recorded (Figure 3).

Melville Sound Islands - Breakwater, Cockburn, Jameson, Wilmot, Hurd Ills

Trap lines are on the same location since 1994. Habitat varies from wet to dry tussock tundra. Alice Kenney and Dr. Charles Krebs (UBC) trapped in June 1998. Weather per island was: Breakwater: light to no rain; Cockburn: no rain; Jameson: heavy rain on third day; Wilmot: no rain; Hurd: some rain. Capture index in 1998 was similar to 1997, a low year (Figure 3).

High Arctic - Byron Bay

Trap lines are on the same location as in 1997, near a Dew Line site. Habitat is unknown. Trapping was performed on 2-5 July 1998 by Alice Kenney and Dr. Charles Krebs (University of British Columbia). Weather was mild and without precipitation. Capture index in 1998 was similar to 1997, a low year (Figure 3).

High Arctic - Walker Bay

Trap lines are on the same location since 1994, near the Walker Bay Research Station, Kent Peninsula. Habitat varies from dry shrub tundra, hummocks, and wet grass-sedge meadows. Trapping in 1998 was performed in mid-June (dates unknown) by George Hakongak, Monica Kapakatoak, and Richard Cook, and on 17 - 22 July 1998 by students during a science camp under the supervision of Dr. Robert G. Bromley. Weather was mild and without precipitation. Capture index in 1998 slightly increased from the low in 1997 (Figure 3).

High Arctic - Bylot Island

Lines are on the same location since 1996. Habitat varies from dry shrub tundra to wet polygon meadows with moss and graminoids. Joël Bety trapped on 17 - 21 July 1998. Weather is unknown. Capture index in 1998 slightly increased from the low in 1997 (Figure 3).

Hantavirus Project

Results from the additional 186 specimens collected in 1998 were not available when this report was written.

Table 1. Specimen collected for hantavirus testing since 1994.

	Deer Mouse			Voles[a]	Collared lemming
Year	Yellowknife	Fort Smith	Fort Liard		Daring Lake/Kugluktuk
1994		62[b]		40	
1995		80[b]		170	
1996	1	3	21		
1997	22	21	142		
1998	27	13	146		3

a: Voles: Red-backed voles (subspecies unknown) and chestnut-cheeked voles.
b: Origin unknown.

Identification Project

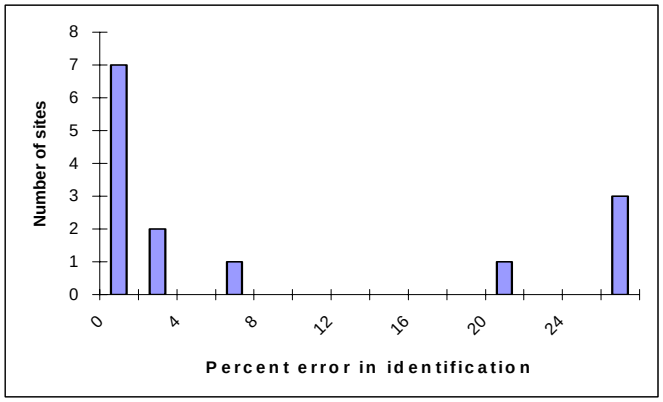


Figure 5. No. of sites with different percent error in identification of specimen. Data for 1996-98.

About 90% of specimens re-examined in 1996-1998 had been correctly identified in the field. In a few sites, however, large proportions of the re-examined specimen were mis-identified (Figure 5). In these sites, few specimens were collected in most years and the species collected are notoriously difficult to identify in the field. Tundra voles (*Microtus oeconomus*) were often confounded with other species (red-backed voles, brown lemmings, and collared lemmings). Meadow voles were also be mistaken for red-backed voles. Collared lemmings were also confounded with brown lemmings and red-backed voles. Lemmings were sometimes not identified to species. A help booklet for the most difficult species will be produced in 1999 and a manuscript on identification and distribution of Northern and Gapper's Red-backed voles is being prepared.

LITERATURE CITED

Banfield, A. W. F. 1981. The mammals of Canada. Univ. of Toronto Press. Toronto, ON. 438 pp.

Boonstra, R., Krebs, C.J., and Stenseth, N.C. 1998. Populations cycles in small mammals: the problem of explaining the low phase. Ecology 79:1479-1488.

Finerty, J. P. 1980. The population ecology of cycles in small mammals. Yale University Press, New Haven, CT. 234 pp.

Krebs, C. J. 1996. Population cycles revisited. J. Mamm. 77: 8-24.

Shank, C.C. 1997. The Northwest Territories small Mammal Survey: 1990-1996. Manuscript report 96. Gov. of the NWT, Department of Resources, Wildlife and Economic Development, Yellowknife, NT. 25 pp.

Tungilik, J. and Shank, C.C. 1994. The Northwest Territories small mammal survey, Interim report for 1994. Gov. of the NWT, Department of Renewable Resources, Yellowknife, NT. 10 pp.

Appendix 1. Annoted list of species captured at least once since 1990 in each site above the treeline (table 1.a, b) and below the treeline (table 1.c).

Table 1.a. Hudson Bay

		Hudson Bay sites			
Common name	Latin name	Arviat	Coral Harbour	Rankin Inlet	Repulse Bay
Red-backed vole	*Clethrionomys rutilus* or *C. gapperi*	x		x	
Tundra vole	*Microtus oeconomus*				
Meadow vole	*Microtus pennsylvanicus*	x			
Shew	*Sorex* sp.				
Brown lemming	*Lemmus sibiricus*	x	x	x	x
Collared lemming	*Dicrostonyx groenlandicus*	x	x	x	x
Total number of species		4	2	3	2

Table 1.b. Arctic

		Arctic Continental sites			Arctic Coastal sites						Arctic Small Islands
Common name	Latin name	Daring Lake	Baker Lake	Lac de Gras	Hope Bay	Kuglukt uk	Byron Bay	Walker Bay (July)	Bylot Island	Pond Inlet	Colville sound islands
Red-backed vole	*Clethrionomys rutilus* or *C. gapperi*	x	x	x	x	x					
Tundra vole	*Microtus oeconomus*				x	x					
Meadow vole	*Microtus pennsylvanicus*	x	x	x	x						
Shew	*Sorex* sp.	x			x	x		x			
Brown lemming	*Lemmus sibiricus*	x	x	x	x	x	x	x	x	x	x
Collared lemming	*Dicrostonyx groenlandicus*	x	x	x	x	x	x	x	x	x	x
Total number of species		5	4	4	6	4	2	3	2	2	2

Appendix 1. Con't

Table 1.c. Below the tree line

		Taiga Plains				Boreal Plains	Taiga Sheild
Common name	Latin name	Fort Liard (Forested)	Fort Liard (Logged)	Fort Simpson	Norman Wells	Fort Smith	Yellowknife
Red-backed vole	*Clethrionomys rutilus* or *C. gapperi*	x	x	x	x	x	x
Meadow vole	*Microtus pennsylvanicus*	x	x		x	x	x
Heather vole	*Phenacomys interdius*			x		x	
Chestnut-cheeked vole	*Microtus xanthognathus*	x	x		x		
Deer mouse	*Peromyscus maniculatus*	x	x	x		x	x
Jumping mouse	*Zapus hudsonius*	x	x				
Shew	*Sorex* sp.	x	x	x	x	x	x
Northern Bog lemming	*Synaptompys boeralis*	x					
Total number of species		7	6	4	5	5	4

Appendix 2. Summary of trap-nights, number of each species caught, misfires, and abundance indices for each study site below (a) and above the treeline (b).

a. Sites below the treeline.

Ecozone	Location	Year	trap-nights	Red-backed vole	Meadow vole	Heather vole	Chestnut-cheeked vole	Deer mouse	Jumping moose	Bog lemming	Shew	Other small mammals	non-target sp./birds	Trap misfires	Effective trapnights	Total captures	Capture index
Boreal Plains	Fort Smith	1990	500	48	1	0	0	3	0	0	2	0	1	165	334	54	16.17
		1991	500	7	0	0	0	4	0	0	5	3	1	137	362	19	5.25
		1992	500	13	4	0	0	3	0	0	11	1	1	216	283	32	11.31
		1993	500	46	0	0	0	6	0	0	4	0	0	60	440	56	12.73
		1994	491	23	0	0	0	1	0	0	3	1	4	309	178	28	15.73
		1995	500	80	2	0	0	10	0	0	15	0	3	187	310	107	34.52
		1996	248	25	0	0	0	2	0	0	3	0	0	42	206	30	14.56
		1997	500	25	0	0	0	19	0	0	9	1	2	95	403	54	13.40
		1998	500	51	0	2	0	13	0	0	14	0	1	100	399	80	20.05
Taiga Plains	Fort Liard (Forested)	1993	1900	107	19	0	16	0	0	1	31	0	0	247	1653	174	10.53
		1994	1000	148	0	0	79	33	0	1	37	0	0	186	814	298	36.61
		1995	1000	137	2	0	13	32	1	1	64	0	9	328	663	250	37.71
		1996	500	48	0	0	0	16	0	0	5	0	0	96	404	69	17.08
		1997	1000	100	9	0	2	90	1	0	42	0	4	271	725	244	33.66
		1998	800	142	33	0	0	73	5	0	55	0	0	190	610	308	50.49
	Fort Liard (Logged)	1994	1000	85	5	0	5	24	0	0	37	0	40	40	920	156	16.96
		1995	1000	21	63	0	1	5	0	0	42	0	1	56	943	132	14.00
		1996	500	2	17	0	0	4	0	0	4	0	1	41	458	27	5.90
		1997	1000	45	83	0	3	28	0	0	67	0	17	140	843	226	26.81
		1998	800	96	201	0	13	73	12	0	41	0	0	161	639	436	68.23
	Fort Simpson	1992	500	3	0	0	0	16	0	0	1	0	0	24	476	20	4.20
		1993	500	7	0	0	0	10	0	0	6	0	3	23	474	23	4.85
		1994	500	27	0	0	0	1	0	0	0	0	0	68	432	28	6.48
		1995	512	24	0	0	0	8	0	0	1	0	4	185	323	33	10.22
		1996	500	0	0	0	0	0	0	0	0	0	1	61	438	0	0.00
		1997	500	0	0	0	0	0	0	0	11	0	0	95	405	11	2.72
		1998	500	51	0	2	0	13	0	0	14	0			500	80	16.00

a. Sites below the treeline (con't).

Ecozone	Location	Year	trap-nights	Red-backed vole	Meadow vole	Heather vole	Chestnut-cheeked vole	Deer mouse	Jumping moose	Bog lemming	Shew	Other small mammals	non-target sp./birds	Trap misfires	Effective trap-nights	Total captures	Capture index
Taiga Plains	Inuvik	1990	200	17	5	0	0	0	0	1	0	0	2	13	185	23	12.43
		1991	375	42	1	0	0	0	0	2	0	0	1	31	343	45	13.12
	Norman Wells	1990	500	43	4	0	11	0	0	0	10	0	7	41	452	68	15.04
		1991	500	20	0	0	1	0	0	0	0	0	1	14	485	21	4.33
		1993	500	5	1	0	0	0	0	0	1	0	4	22	474	7	1.48
		1994	500	22	3	0	0	0	0	0	0	0	3	26	471	25	5.31
		1995	347	46	0	0	0	0	0	0	1	0	7	83	257	47	18.29
		1996	495	25	0	0	0	0	0	0	0	0	8	57	430	25	5.81
		1997	446	85	8	0	0	0	0	0	1	0	13	74	359	94	26.18
		1998	400	89	19	0	2	0	0	0	0	0	*6*	*60*	334	110	32.93
	Yellowknife	1991	600	7	2	0	0	7	0	0	4	0	6	119	475	20	4.21
		1992	488	21	4	0	0	17	0	0	3	0	2	36	450	45	10.00
		1993	524	21	1	0	0	27	0	0	3	0	2	82	440	52	11.82
		1994	500	32	2	0	0	5	0	0	0	0	3	98	399	39	9.77
		1995	500	10	4	0	0	7	0	0	0	0	2	55	443	21	4.74
		1996	494	4	0	0	0	3	0	0	0	0	6	86	402	7	1.74
		1997	500	42	0	0	0	24	0	0	10	2	7	81	412	78	18.93
		1998	500	41	7	0	0	27	0	0	10	0	2	71	427	85	19.91

b. Sites above the treeline.

Ecozone	Location	Year	trap-nights	Red-backed vole	Tundra vole	Meadow vole	Bog lemming	Brown lemming	Collared lemming	Shew	Other small mammals	non-target sp./birds	Trap misfires	Effective trapnights	Total captures	Capture index
Arctic Cordillera	Pond Inlet	1990	440	0	0	0	0	0	0	0	0	0	3	437	0	0.00
		1991	506	0	0	0	0	0	2	0	2	0	3	503	4	0.80
		1992	505	0	0	0	0	2	3	0	0	1	11	493	5	1.01
		1993	520	0	0	0	0	2	10	0	0	1	10	509	12	2.36
		1994	510	0	0	0	0	0	0	0	0	2	8	500	0	0.00
		1995	520	0	0	0	0	0	0	0	0	5	12	503	0	0.00
		1996	520	0	0	0	0	1	1	0	0	5	42	473	2	0.42
Northern Arctic	Baker Lake	1991	500	0	0	0	0	2	1	0	0	1	102	397	3	0.76
		1992	500	0	0	13	0	0	0	0	0	10	29	461	13	2.82
		1993	495	0	0	0	0	0	0	0	1	2	45	448	1	0.22
		1994	500	8	0	0	0	0	4	0	0	2	21	477	12	2.52
		1996	500	0	0	0	0	2	0	0	0	4	*40*	456	2	0.44
		1997	497	0	0	0	0	0	1	0	0	5	40	452	1	0.22
	Bylot Island	1994	548	0	0	0	0	4	0	0	0	15	73	460	4	0.87
		1995	1000	0	0	0	0	0	0	0	0	33	29	938	0	0.00
		1996	1050	0	0	0	0	19	4	0	0	21	87	942	23	2.44
		1997	1050	0	0	0	0	9	0	0	0	19	92	939	9	0.96
		1998	1050	0	0	0	0	11	4	0	0	14	69	967	15	1.55
	Byron Bay	1995	1179	0	0	0	0	0	1	0	0	0	21	1158	1	0.09
		1996	1170	0	0	0	0	20	40	0	0	0	104	1066	60	5.63
		1997	1170	0	0	0	0	3	2	0	0	3	44	1123	5	0.45
		1998	1170	0	0	0	0	0	5	0	0	0	23	1147	5	0.44
	KingWilliams I.	1997	500	0	0	0	0	0	1	0	0	0	9	491	1	0.20
		1997	500	0	0	0	0	0	0	0	0	1	10	489	0	0.00
	One Eyed Jack	1991	497	0	0	0	0	0	7	0	0	1	13	483	7	1.45
		1992	488	0	0	0	0	0	9	0	0	2	23	463	9	1.94
		1993	943	0	0	0	0	16	52	0	2	12	148	783	70	8.94
		1994	1023	0	0	0	0	0	2	0	0	6	19	998	2	0.20
		1998												0	n	
	Repulse Bay	1991	500	0	0	0	0	0	1	0	0	1	56	443	1	0.23
		1992	500	0	0	0	0	0	0	0	0	0	13	487	0	0.00
		1993	485	0	0	0	0	1	0	0	0	0	160	325	1	0.31
		1994	600	0	0	0	0	0	0	0	0	1	73	526	0	0.00
		1996	497	0	0	0	0	0	4	0	0	2	38	457	4	0.88
		1998	491	0	0	0	0	0	1	0	0	1	49	441	1	0.23

Ecozone	Location	Year	trap-nights	Red-backed vole	Tundra vole	Meadow vole	Bog lemming	Brown lemming	Collared lemming	Shew	Other small mammals	non-target sp./birds	Trap misfires	Effective trapnights	Total captures	Capture index
	Siksik Lake	1993	479	0	0	0	0	0	84	0	0	2	55	422	84	19.91
		1994	602	0	0	0	0	0	2	0	0	5	0	597	2	0.34
	Walker Bay (July)	1990	450	0	0	0	0	2	27	0	0	2	24	424	29	6.84
		1991	926	0	0	0	0	7	8	3	0	8	20	898	18	2.00
		1992	979	0	0	0	0	5	22	1	0	4	108	867	28	3.23
		1993	579	0	0	0	0	6	2	0	0	5	89	485	8	1.65
		1994	486	0	0	0	0	0	0	0	0	1	14	471	0	0.00
		1995	499	0	0	0	0	4	4	0	0	10	35	454	8	1.76
		1996	619	0	0	0	0	24	28	1	0	19	135	465	53	11.40
		1997	586	0	0	0	0	0	4	0	0	11	39	536	4	0.75
		1998	588	0	0	0	0	7	2	0	0	9	23	556	9	1.62
	Walker Bay (June)	1993	545	0	0	0	0	1	13	0	0	1	86	458	14	3.06
		1996	490	0	0	0	0	10	27	0	0	3	111	376	37	9.84
		1997	588	0	0	0	0	0	12	0	0	5	30	553	12	2.17
		1998	*600*	0	0	0	0	0	9	0	0	2	*20*	578	9	1.56
Southern Arctic	Arviat	1990	1100	2	0	0	0	0	8	0	0	15	51	1034	10	0.97
		1991	600	0	0	0	0	1	0	0	0	6	1	593	1	0.17
		1992	597	0	0	2	0	0	4	0	0	9	23	565	6	1.06
		1993	500	0	0	0	0	1	8	0	0	4	25	471	9	1.91
		1994	600	0	0	0	0	2	13	0	0	7	156	437	15	3.43
		1995	500	0	0	2	0	0	2	0	0	13	26	461	4	0.87
		1996	500	9	0	0	0	0	0	0	0	6	23	471	9	1.91
		1997	500	18	0	0	0	0	1	0	0	5	12	483	19	3.93
		1998	500	0	0	1	0	0	0	0	0	6	18	476	1	0.21
	Breakwater I..	1994	1170	0	0	0	0	0	1	0	0	0	2	1168	1	0.09
		1995	1020	0	0	0	0	0	8	0	0	0	10	1010	8	0.79
		1996	1170	0	0	0	0	0	40	0	0	0	77	1093	40	3.66
		1997	1170	0	0	0	0	0	3	0	0	4	6	1160	3	0.26
		1998	1170	0	0	0	0	0	1	0	0	0	15	1155	1	0.09
	Cockburn I.	1994	1170	0	0	0	0	0	1	0	0	0	2	1168	1	0.09
		1995	1170	0	0	0	0	5	4	0	0	0	8	1162	9	0.77
		1996	1170	0	0	0	0	41	32	0	0	0	208	962	73	7.59
		1997	1170	0	0	0	0	0	2	0	0	2	11	1157	2	0.17
		1998	1170	0	0	0	0	0	3	0	0	1	4	1165	3	0.26

Ecozone	Location	Year	trap-nights	Red-backed vole	Tundra vole	Meadow vole	Bog lemming	Brown lemming	Collared lemming	Shew	Other small mammals	non-target sp./birds	Trap misfires	Effective trapnights	Total captures	Capture index
Southern Arctic	Coral Harbour	1991	500	0	0	0	0	0	1	0	0	0	11	489	1	0.20
		1992	485	0	0	0	0	0	0	0	0	0	13	472	0	0.00
		1993	490	0	0	0	0	1	0	0	0	0	3	487	1	0.21
		1994	500	0	0	0	0	0	0	0	0	1	8	491	0	0.00
		1995	500	0	0	0	0	0	0	0	0	2	26	472	0	0.00
		1996	500	0	0	0	0	0	0	0	0	7	12	481	0	0.00
		1997	500	0	0	0	0	1	4	0	0	16	21	463	5	1.08
		1998	500	0	0	0	0	0	0	0	0	1	14	485	0	0.00
	Daring Lake	1994	500	9	0	3	0	2	1	0	0	0	83	417	15	3.60
		1995	520	10	0	7	0	0	0	0	0	2	28	490	17	3.47
		1996	598	8	0	0	0	1	2	1	0	4	155	439	12	2.73
		1997	700	0	0	0	0	0	0	0	0	0	51	649	0	0.00
		1998	600	1	0	0	0	0	2	0	0	4	119	477	3	0.63
	Hope Bay	1984	180	12	0	0	0	2	0 ?		0	*0*	*0*	180	14	7.78
		1985	390	0	4	0	0	2	1 ?		0	*0*	*0*	390	7	1.79
		1986	600	0	0	0	0	0	0 ?		0	*0*	*0*	600	0	0.00
		1987	600	14	16	0	0	3	0 ?		0	*0*	*0*	600	33	5.50
		1988	600	5	0	0	0	0	0 ?		0	*0*	*0*	600	5	0.83
		1989	600	6	0	0	0	0	0 ?		0	*0*	*0*	600	6	1.00
		1990	600	42	0	0	0	8	0	0	0	0	93	507	50	9.86
		1991	500	6	1	0	0	3	3	2	0	0	45	455	15	3.30
		1994	1170	1	0	0	0	0	0	0	0	0	43	1127	1	0.09
		1995	1173	0	0	0	0	1	9	0	0	0	29	1144	10	0.87
		1996	1165	6	0	23	0	16	18	0	0	0	101	1064	63	5.92
		1997	1170	0	0	3	0	0	1	0	0	6	121	1043	4	0.38
		1998	1170	0	18	0	0	0	5	0	0	7	42	1121	23	2.05
	Hurd I.	1994	1170	0	0	0	0	1	1	0	0	0	2	1168	2	0.17
		1995	1170	0	0	0	0	0	1	0	0	0	9	1161	1	0.09
		1996	1168	0	0	0	0	8	34	0	0	0	97	1071	42	3.92
		1997	1170	0	0	0	0	0	0	0	0	2	14	1154	0	0.00
		1998	1170	0	0	0	0	0	1	0	0	1	82	1087	1	0.09
	Jameson I.	1994	1140	0	0	0	0	0	0	0	0	0	7	1133	0	0.00
		1995	1170	0	0	0	0	0	1	0	0	0	2	1168	1	0.09
		1996	1170	0	0	0	0	0	3	0	0	0	10	1160	3	0.26
		1997	1170	0	0	0	0	0	1	0	0	0	5	1165	1	0.09
		1998	1170	0	0	0	0	0	5	0	0	1	119	1050	5	0.48
	Kugluktuk	1995	491	4	0	0	0	2	0	0	0	0	300	191	6	3.14
		1996	500	11	12	0	0	1	0	1	3	0	322	178	28	15.73
		1997	589	21	1	0	0	0	0	1	0	1	290	298	23	7.72
		1998	346	0	1	0	0	0	1	0	0	6	133	207	2	0.97

Ecozone	Location	Year	trap-nights	Red-backed vole	Tundra vole	Meadow vole	Bog lemming	Brown lemming	Collared lemming	Shew	Other small mammals	non-target sp./birds	Trap misfires	Effective trapnights	Total captures	Capture index
Southern Arctic	Rankin Inlet	1991	600	0	0	0	0	0	0	0	0	0	65	535	0	0.00
		1992	500	0	0	0	0	0	2	0	0	0	39	461	2	0.43
		1993	500	0	0	0	0	1	0	0	0	0	75	425	1	0.24
		1994	500	0	0	0	0	0	6	0	10	0	106	394	16	4.06
		1995	200	0	0	0	0	0	0	0	0	0	26	174	0	0.00
		1996	500	1	0	0	0	0	0	0	1	1	101	398	2	0.50
		1997	255	4	0	0	0	0	2	0	0	0 *			6	
	Wilmot I.	1994	1170	0	0	0	0	0	1	0	0	0	7	1163	1	0.09
		1995	1170	0	0	0	0	0	5	0	0	0	19	1151	5	0.43
		1996	1170	0	0	0	0	0	26	0	0	0	63	1107	26	2.35
		1997	1170	0	0	0	0	0	4	0	0	1	14	1155	4	0.35
		1998	1170	0	0	0	0	0	11	0	0	2	26	1142	11	0.96

Species names follow US-Man and the Biosphere, Fauna list (1998).

Appendix 3. List of locations, latitude and longitude in degrees, name and agency of the main cooperator for each year of the Small Mammal Survey, Northwest Territories.

Territory (in April 1999)	Ecozone	Location	Latitude in degrees	Longitude in degrees	Year	Main cooperator	Agency/Org.
Nunavut	Arctic Cordilliera	Pond Inlet	72.42	78.00	1990-91	Mike Ferguson	RWED
					1992-96	Line Gauthier	RWED
Nunavut	Northern Arctic	Baker Lake	64.19	96.02	1991-93	Joe Tigullaraq	RWED
					1994	Elijiah Amarook	RWED
					1996-97	Elijiah Amarook	RWED
Nunavut	Northern Arctic	Bylot Island	73.09	79.58	1994-97	Gilles Gauthier	UL
					1998	Joel Bety	UL
Nunavut	Northern Arctic	Byron Bay	68.45	109.04	1995-98	Charles Krebs	UBC
Nunavut	Northern Arctic	KingWilliams I.	68.38	95.51	1997	David R. White	Private
Nunavut	Northern Arctic	One Eyed Jack	69.43	103.39	1991-92	Chris O'Brien	RWED
					1993	Dean Robertson	RWED
					1994	Chris O'Brien	RWED
Nunavut	Northern Arctic	Repulse Bay	66.31	86.14	1991-92	Joe Larose	RWED
					1993-94	Leroy Bloomstrand	
					1996	Mike Gravel	
					1998	not active	
Nunavut	Northern Arctic	Siksik Lake	72.23	125.08	1993-94	Richard Cotter	
Nunavut	Northern Arctic	Walker Bay (July)	68.21	108.10	1990-98	Bob Bromley	RWED
Nunavut	Southern Arctic	Arviat	61.06	94.05	1990-92	Mark Bradley	RWED
					1993-98	Dave Abernethy	RWED
Nunavut	Southern Arctic	Breakwater I..	67.55	108.30	1994-98	Charles Krebs	UBC
Nunavut	Southern Arctic	Cockburn I.	68.05	108.18	1994-98	Charles Krebs	UBC
Nunavut	Southern Arctic	Coral Harbour	64.08	83.10	1991-93	Tim Devine	RWED
					1994-96	Dave Abernethy	RWED
					1997	Elijiah Amarook	RWED
					1998	Clifford Netser	RWED
Nunavut	Southern Arctic	Daring Lake	64.52	111.35	1994-98	Steve Mattews	RWED
Nunavut	Southern Arctic	Hope Bay	68.06	106.43	1984-86	Kim Poole	RWED
					1987-89	Richard Cotter	RWED
					1990-91	Leslie Wakelyn	RWED
					1994-98	Charles Krebs	UBC

Territory	Ecozone	Location	Latitude in degrees	Longitude in degrees	Year	Main cooperator	Agency/Org.
Nunavut	Southern Arctic	Hurd I.	68.13	107.20	1994-98	Charles Krebs	UBC
Nunavut	Southern Arctic	Jameson I.	68.10	109.44	1994-98	Charles Krebs	UBC
Nunavut	Southern Arctic	Kugluktuk	67.48	115.11	1995-96	Anne Gunn	RWED
					1997	Paul Panegyuk	RWED
					1998	Damian Panayi	RWED
Nunavut	Southern Arctic	Lac de Gras			1995-96	David Penner & Ass.	Private
Nunavut	Southern Arctic	Rankin Inlet	62.49	92.05	1991-94	Robin Johnstone	RWED
					1995	Raymond Bourget	RWED
					1996	Dave Abernethy	RWED
					1997	Kelly Owlifoot	RWED
					1998	not active	RWED
Nunavut	Southern Arctic	Wilmot I.	68.12	109.05	1994-98	Charles Krebs	UBC
NWT	Boreal Plains	Fort Smith	60.01	111.54	1990-92	Ron Graf	RWED
					1993-97	Lee Keary	RWED
					1998	William Mandeville	RWED
NWT	Taiga Plains	Fort Liard (Forested)	60.39	117.29	1993	Adrian D'hont	RWED
					1994-96	Lee Keary	RWED
					1997-98	Mark Bradley	RWED
NWT	Taiga Plains	Fort Liard (Logged)	60.43	123.28	1994-96	Lee Keary	RWED
					1997-98	Mark Bradley	RWED
NWT	Taiga Plains	Fort Simpson	62.00	122.00	1992-94	Ken Davidge	RWED
					1995-96	Ken Lambert	RWED
					1997	Ken Davidge	RWED
					1998	George Tsetso	RWED
NWT	Taiga Plains	Norman Wells	65.18	127.20	1990	Kim Poole	RWED
					1991	Paul Latour	RWED
					1992	not active	
					1993-94	Norman McLean	RWED
					1995-98	Alasdair Veitch	RWED
NWT	Taiga Shield	Yellowknife	62.24	114.26	1991	Dean Robertson	RWED
					1992	Chris Shank	RWED
					1993	Leslie Wakelyn	RWED
					1994-95	Johanne Coutu	RWED
					1996	Chris Shank	RWED
					1997	Albert Bourque	RWED
					1998	Suzanne Carrière	RWED

RWED: Resources, Wildlife and Economic Development; UL: University Laval; UBC: University of British Columbia.