SMALL MAMMALS

OF

VERMILION PASS BURN: ANNUAL CHECK, 1976

Final Report

by

Robert Guy

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287

ABSTRACT

This paper presents the results of a check on the densities of small mammals in the area of the Vermilion Pass, conducted during the summer of 1976. Densities within the various habitats (Burn, pristine forest, successional forest, and burn edge) are all still following similar patterns of change. In general, densities remained the same or dropped slightly this year as compared with 1975. In a successful attempt to estimate more realistic densities of *Peromyscus maniculatus* within the Burn, a series of variously sized grids were used. The data obtained, when plotted, gave a curve described by the relation:

$$y = \frac{2.0199}{x} + 4.78,$$

where y = observed density, x = grid area in hectares, 2.0199 = a constant related to actual experimental conditions, and b = the 'true' resident density (4.78).

INTRODUCTION

This paper is based on the final results of the fifth season of fieldwork on the small mammal communities of the Vermilion Pass Burn and adjacent areas. The preliminary study (Shank, 1971) was not begun until three years after the fire of 1968. This was followed by two consecutive years of fieldwork (Ried, 1972 and Fitzmartyn, 1973). 1974 saw no research but the study was again undertaken the following year (Guy, 1975). Due to certain striking patterns of change in the population densities brought out by last year's work, it was deemed desirable that a density determination be carried out annually. These patterns included similar changes within different populations of different species under different habitat conditions and a possible correlation of cold winters with a large loss in numbers. The small mammal study hopefully will again be carried out in 1977.

The Burn itself covers 2,493 hectares (6160 acres) and spans an altitude range of some 915 metres (3,000 feet). A wide array of habitat types were included in the burned over area. Not far from the Burn, one can find climax spruce-fir forest, near-climax forest (c. 250 years B.P.), and lodgepole pine forest (c. 46 years B.P.). Thus the present condition of the Vermilion Pass is quite conducive to a study of this sort.

DESIGN OF DATA COLLECTION

The procedure for collecting data involved a capture, tag, release and recapture method, as in previous years. Most traps used were regular Sherman traps. On line A-2, however, penetentiary-built traps were used in order to get some idea of their value. Also, in August on line Y-3, a few

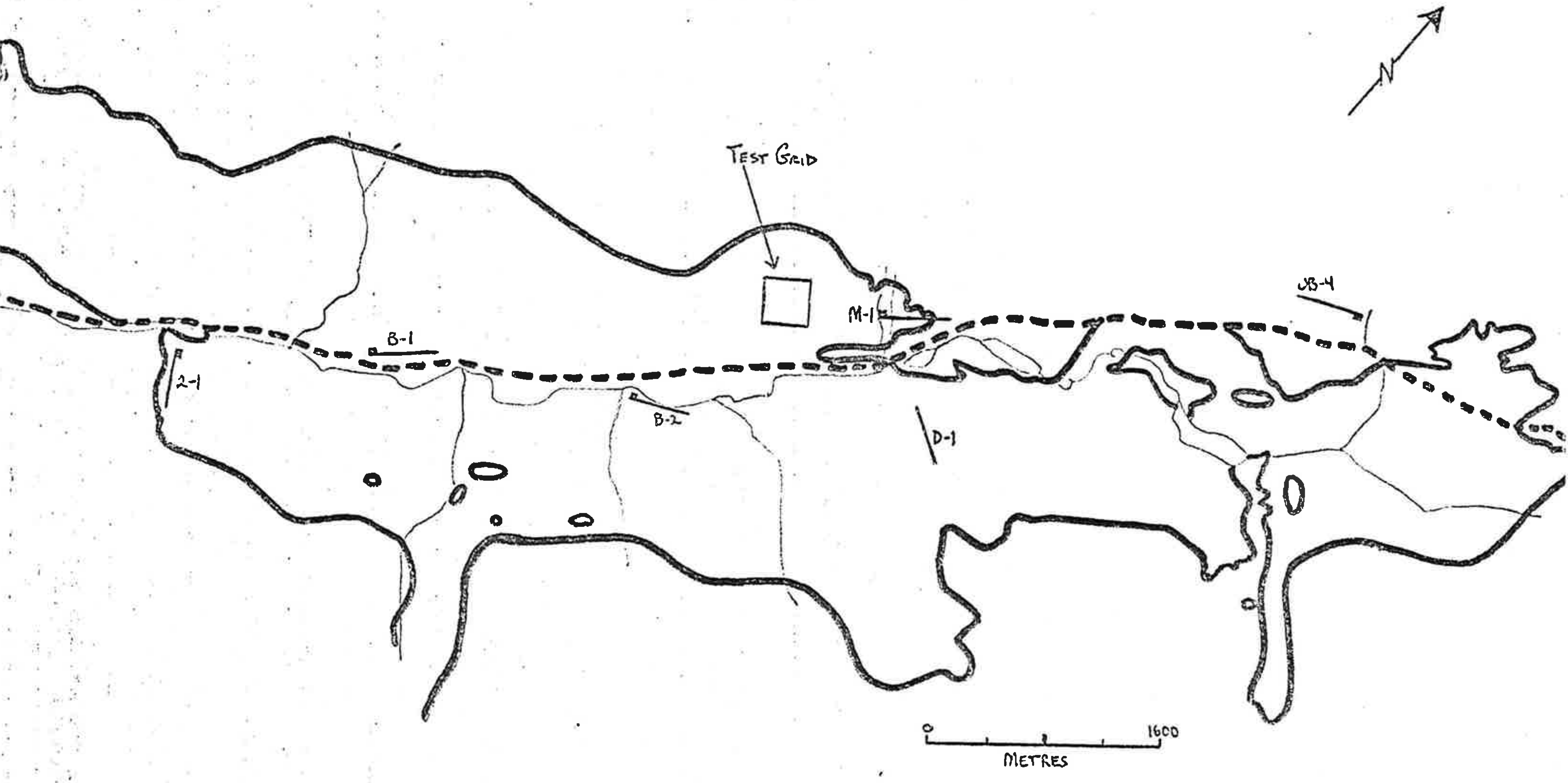


Figure 1. Locations of some of the Traplines for Small Mammals, 1976

small sized Sherman traps were tested. Collectively, the traps were placed in 758 locations in 10 acres (8 of which were used in 1975; 7 in 1973). Every effort was made to make sure traps were placed just as they were in 1975. Four major habitat types were sampled this year; successional forest, pristine forest, middle burn, and burn edge. Both grids and transects have been maintained again this year in order that we may eventually develop an index by which values obtained from the two methods can be compared in a satisfactory manner.

Locations of some of the traplines are shown in Figure 1. Except for A-2, the lines are the same as in previous years. The transects were composed of two roughly parallel lines of 30 traps placed about 10-15 metres apart. A grid was attached to one end of most transects by the addition of two more parallel lines of four traps each. This yielded a 4 x 4 grid joined to a 2 x 30 transect (total = 68 traps).

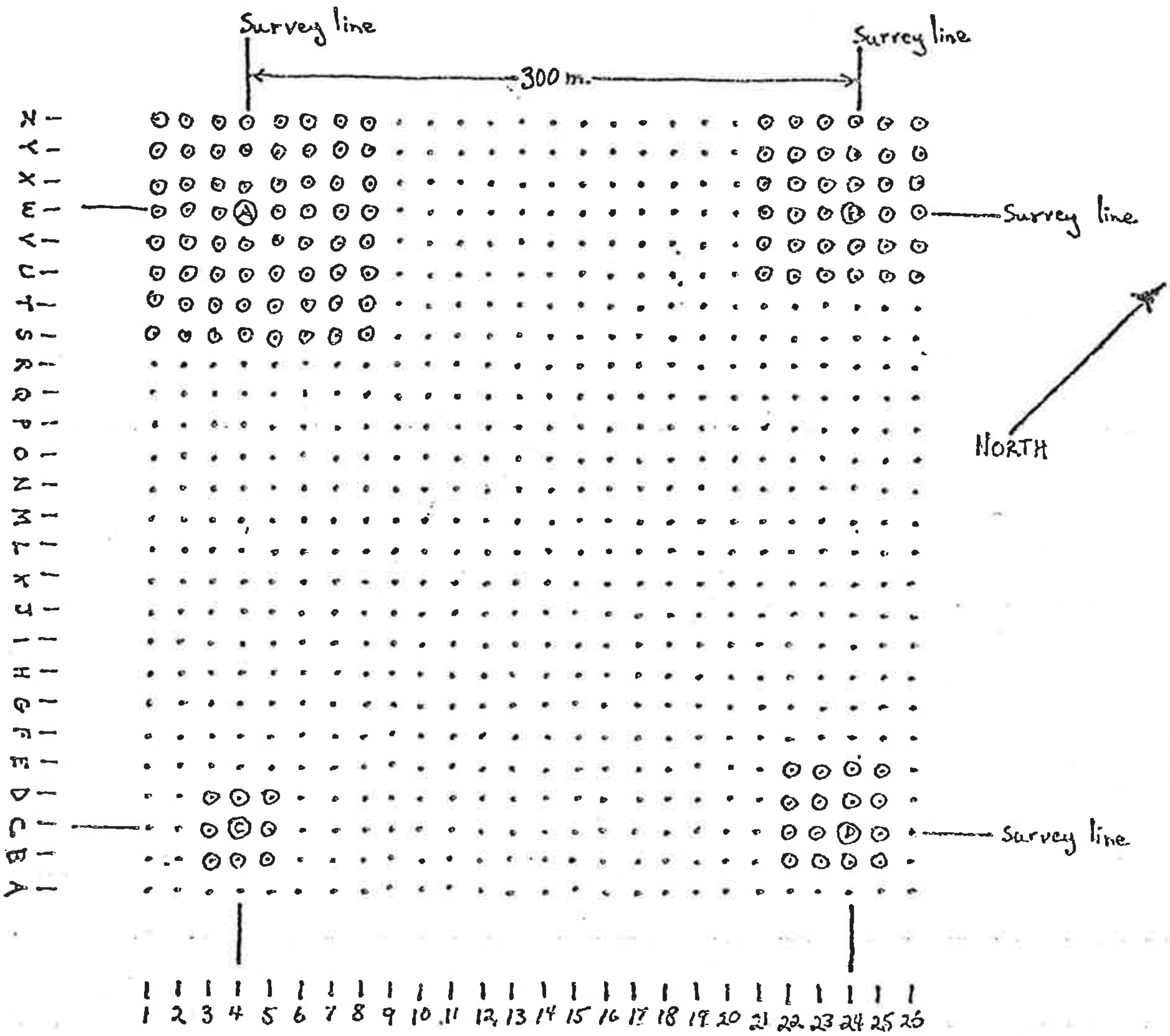
The bait was a mixture of peanut butter, rolled oats, and bacon fat sandwiched between paper towelling. All traps were provided with ample bedding (mattress stuffing) which was replaced whenever it became too wet or dirty. Wherever possible, traps were placed on the dry side of trees or under logs or preferably under rocks. If no natural shelter was available, a makeshift one was constructed out of the materials at hand. If done carefully, this can substantially reduce trap deaths. Traps were opened in the evening and left open all night to be checked as early as possible in the morning. Late in the summer, this occasionally necessitated the use of a flashlight. The traps were then left closed until the afternoon when they were reopened (in most cases), to be checked again in the evening.

Traps were not left open all day to avoid the loss of animals to overheating. On particularly cold and rainy nights, the traps were simply left closed. Generally speaking, each area was studied for a four to five-day period once a month. This time period seems to be sufficient for capturing most of the resident small mammals without resulting in excessive "trap happiness".

When an individual was captured, it was first ear-marked with a numbered fish tag. Weight, body length (from the tip of the nose to the base of the tail), sex, and reproductive condition were recorded. In some cases (particularly with *Microtus* individuals), tail length and hind foot length were taken as well. Full data was recorded whenever a dead specimen was obtained. Study skins from 1975's trap deaths have been prepared. Tags were usually placed on the left ear to help keep this year's captures separate from animals that may have been caught in 1975 (when they were usually tagged on the right ear). As the animals often lost their tags, individual peculiarities were also noted as an aid in identification. Any observations concerning behaviour (e.g. feeding habits) were noted as well.

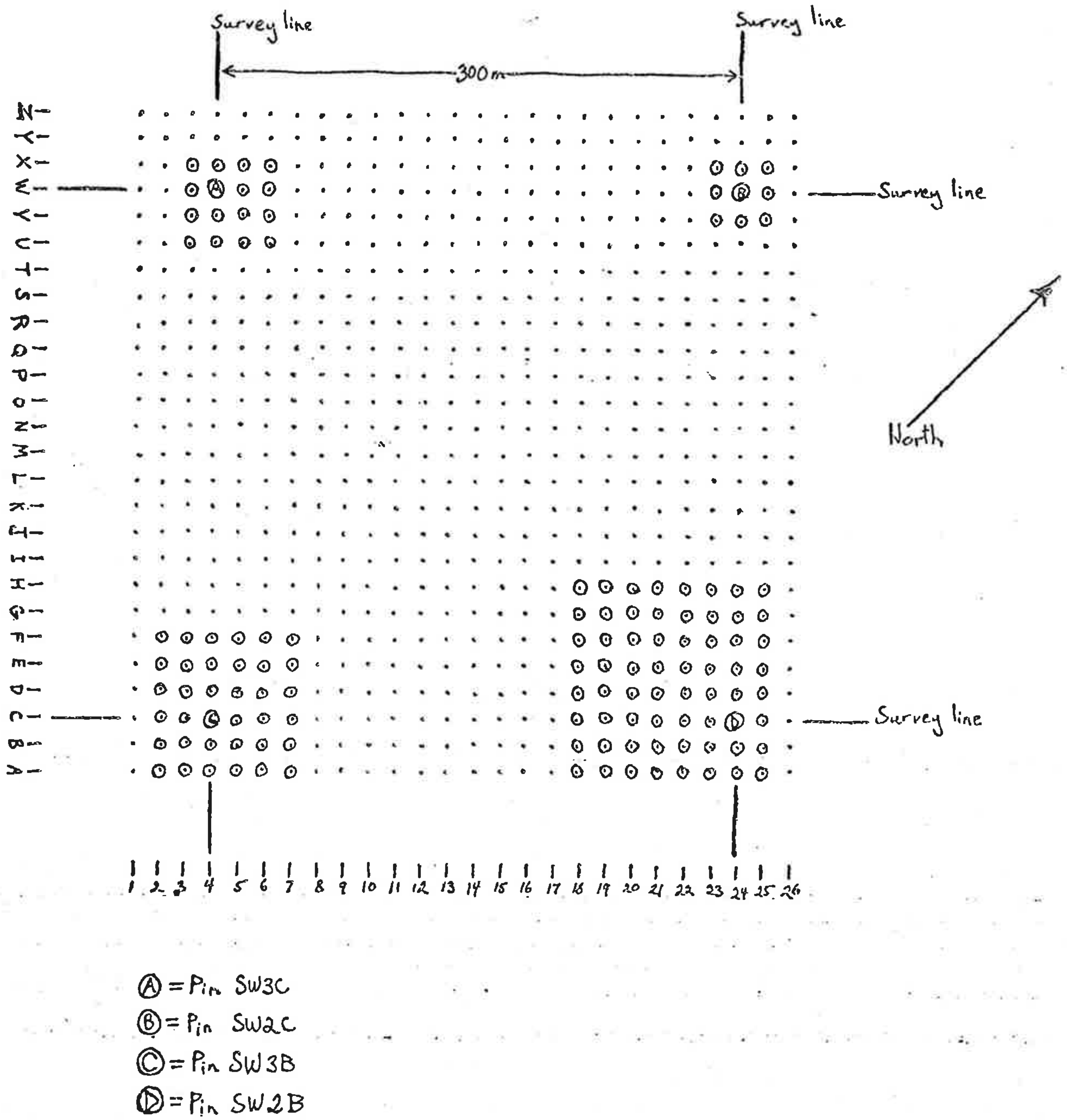
In addition to the density check, an experiment was carried out this year designed to give some indication of the true density of mice in the Burn. In other words, its purpose was to try and estimate by how much our present methods exaggerate the actual resident density. This is related primarily to trap-line size and shape. It is a function of edge per trap (a quantity which cannot be accurately measured), and is affected by the species (i.e., size of home range, degree of aggressive behaviour, etc.), physiognomy (the gross community form; e.g., forest, parkland, talus, etc.),

Figure 2. Test Grids arrangement for the last week of July - first week of August. Circled dots represent trap locations. Circled letters are survey pins (with traps). Numbers along the bottom and letters along the side define the trap locations (e.g. trap C-4 is at pin SW3B).



Ⓐ = Pin SW3C
Ⓑ = Pin SW2C
Ⓒ = Pin SW3B
Ⓓ = Pin SW2B

Figure 3. Test Grid Arrangement for the Second Period (August 31-September 3) of Trapping. Circled dots represent trap locations. Circled letters are survey pins (with traps).



and the distances between adjacent traps. Four different sized grids were set up within the Burn and run simultaneously for two trapping periods three weeks apart. Grids were used rather than transects because the shape could be kept constant. The grids were rotated the second time around in order to avoid bias caused by localized population pockets. It was because of this rotation that the trapping periods were separated by three weeks. This was to ensure that no subsequent bias, stemming from an uneven distribution of animals that were more familiar with the traps, would result. During the "second period", traps were not opened during the day as it was impossible to cope with the large number of mantled ground-squirrels (*Spermophilus lateralis*) being captured. This is of no consequence as I was only using the mice, which were exclusively *Peromyscus maniculatus* (deer mice), a strictly nocturnal species (at least in the Burn). Traps were positioned as shown in Figures 2 and 3. The entire grid, which served as the framework for the smaller grids, will be referred to as the "test grid". Further information on the experimental design is presented under the area description.

AREA DESCRIPTIONS

The measured dimensions and calculated areas of all grids and transects (excepting A-2) are presented in Table 1. A-2 is not tabulated because this line was not included in any subsequent density analysis due to the nature of traps[1] The "border area" used in most of the calculations was

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[1] These were penetentiary-built traps, found to be totally unsuitable for a study of this sort under the prevailing climatic conditions. The most important of many drawbacks the traps had are: (1) they do not fold up; (2) it is not possible to put sufficient bedding in them.

Table 1. Dimensions and areas of trap lines All data (excepting that for the Test Grid) from Guy, 1975. A-2 was not measured. Border area for Test Grid = 7.5 m wide; all other traplines, border area = 6.4 m wide.

	DIMENSIONS, WITHOUT BORDER AREA, OF:		AREA CALCULATED WITH BORDER AREA:	
	GRID	TRANSECT Length & Width	GRID	TRANSECT
2-1	35.9 m x 36.8 m	327 m x 13.6 m	2416 m^2	8979 m^2
A-1	41.9 x 34.4	350 x 20.3	2035	11986
B-1	49.7 x 50.9	425 x 17.8	3981	13400
B-2	38.7 x 43.4	344 x 14.8	2894	9834
D-1		322 x 15.0		9577
M-1	34.5 x 42.9	397 x 14.4	2635	11136
UB-4	43.0 x 42.1	377 x 14.7	3063	10725
Y-3	28.3 x 37.3	347 x 15.7	2560	10260
Test Grid:				
3x3	30.0 x 30.0		2025	
4x4	45.0 x 45.0		3600	
6x6	75.0 x 75.0		8100	
8x8	105.0 x105.0		14400	

obtained in 1975 by halving the average distance between all adjacent traps in all lines (thus border area = 6.4 metres). However, because of the somewhat separate purpose and more precise structure of the test grids, the border used in the calculation of these areas was 7.5 metres. Unless otherwise mentioned, locations of the following traplines are shown on Figure 1.

2-1 is a grid and transect combination starting about 20 metres into the Burn on the northeast side of the fireguard at the southwest end of the Burn near 17A-SE. The transect runs up the slope parallel to this fireguard. Regeneration is fair at the base of the line but improves as the elevation increases. Deadfall is heavy. Over most of the line, *Elymus innovatus* is the dominant herb, while *Menziesia glabella* and *Ledum glandulosum* are the co-dominant shrubs. *Cornus canadensis*, *Aquilegia flavescens*, *Calamagrostis canadensis*, *Linnaea borealis* var. *americana*, *Aster* spp., *Arnica cordifolia*, and others occur in patches. Elevation at the base of the line where the grid is located is approximately 1,550 metres (5,100 feet). Pins mark the line.

A-1 (not shown on the map) is within the successional lodgepole pine forest located on relatively level ground about 1.5 kilometres east of Storm Mountain Lodge. It lies just inside the forest 50 metres west of the benchmark on the southeast side of the highway. The ground cover in the forest is almost exclusively *Vaccinium scoparium*. *Shepherdia canadensis* and *Menziesia glabella* are the common large shrubs. The area is broken here and there by small clearings of primarily *Fragaria virginiana* var. *glauca*. At the beginning of the transect, where the grid is situated, is a moist area of dense shrubs with *Shepherdia canadensis*, *Salix* spp., some *Arctostaphylos rubra*, and moss. The line is marked with survey pins and the elevation is about 1,550 metres (5,100 feet).

A-2 (not shown on the map) is a transect (2 x 11) starting on the crest of the hill behind 'our' cabin at Eisenhower Junction. The line runs west through the lodgepole pine forest there. Ground cover is largely *Vaccinium scoparium*, with *V. caespitosum*, *V. vitis-idaea*, *Arnica cordifolia*, *Arctostaphylos uva-ursi*, and moss also being common. Dominant shrub is *Shepherdia canadensis*. This line was created in order to try out some penetentiary-built traps. Elevation is approximately 1,450 metres (4,760 feet).

B-1 is a grid and transect combination which begins on the escarpment above Highway 93, 35 paces above 12A-SW, and runs northeast beyond 11A-SW. Elevation is 1565 metres (5,150 feet). This is a middle burn area with heavy débris but very good regeneration. The dominant herb is *Epilobium angustifolium*, although *Arnica cordifolia*, *Elymus innovatus*, *Linnaea borealis* var. *americana*, *Fragaria virginiana* var. *glauca*, *Thalictrum occidentale*, and others are also widespread. The proximal portion of the transect is dominated by *Menziesia glabella*, while distally this dominance is shared with *Spiraea lucida*. *Ledum glandulosum*, *Viburnum edule*, *Salix glauca*, *Rosa acicularis*, *Shepherdia canadensis*, and *Lonicera involucrata* are also quite common. The transect ends are marked by pins. Some problems with bait-stealing occurred on this line this year.

B-2 is a grid and transect combination situated on reasonably flat ground parallel to the Vermilion River. Along the river is a thin belt of unburned forest, so although the line is in the centre of the Burn, it is still classified as burn edge. The transect begins 20 metres southwest of weather station #1 in the vicinity of 6A-SE and runs towards 5A-SE. The grid is almost entirely within the Burn in a hygric area thickly covered with *Salix glauca*, *S. barrattiana*, *Betula glandulosa*, *Lonicera involucrata*, and *Potentilla fruticosa*. The rest of the transect is similar in composition but not so densely populated. A mosaic of *Epilobium angustifolium*, *Elymus innovatus*, *Calamagrostis canadensis*, *Aster ciliolatus*, *Solidago multiradiata*, *Carex* spp., and numerous others make up the herb layer. Regeneration is poor. Elevation is about 1,610 metres (5,300 feet). Fewer problems with marten were encountered on this line this year than in 1975. It is marked with pins.

D-1 is a 2 x 30 transect running parallel to the B.C.-Alberta cutline 50 metres to the northeast. The line runs from 1,690 metres (5,560 feet) to 1,745 metres (5, 745 feet) in elevation. Regeneration ranges from fair to good. *Epilobium angustifolium* dominates throughout, although the lower parts are somewhat grassy. As elevation increases, shrubs become more prevalent with *Menziesia glabella*, *Ledum glandulosum*, *Sambucus melanocarpa*, *Vaccinium membranaceum*, and *V. myrtillus* present. Patches of *Arnica cordifolia*, *Linnaea borealis* var. *americana*, *Cornus canadensis*, and *Aquilegia flavescens* occur. It, too, is marked with pins. This line was not used in August due to severe bait-stealing and some predation.

M-1 is a grid and transect combination beginning in a small area between the Great Divide streams approximately 70 metres west of where OBW should be located at an elevation of 1,645 metres (5,420 feet). The grid is entirely within the area bordered by the streams. The transect continues in a northeasterly direction where at trap #8 another intermittent stream is crossed. Up to this point, the area is dominated by *Elymus innovatus*, *Salix glauca*, and *Lonicera involucrata* with very poor regeneration. Beyond trap #8 to about trap #25, the area is typical burn dominated by *Epilobium angustofolium* and a sparse shrub layer of *Menziesia glabella*, *Salix glauca*, and *Ledum glandulosum*. Also present in substantial quantity are: *Linnaea borealis* var. *americana*, *Arnica cordifolia*, *Cornus canadensis*, *Aster ciliolatus*, *Vaccinium myrtillus*, and moss. Regeneration is very good. The northeast end of this transect is located in the pristine forest. This line is subdivided into the following classes: traps #1 to #23 and #38 to #68 are middle burn; traps #24 to #27 and #34 to #37 are burn edge, while traps #28 to #33 are pristine forest. The line is marked with pins.

UB-4 is a grid and transect combination situated in the spruce-fir forest near Boom Creek. Parts of the forest have somewhat open canopies. The transect begins in a boggy meadow 30 metres southwest of the old Boom Lake trail, 150 metres from the parking lot, and continues southwest. Elevation is about 1,730 metres (5,700 feet). Ground cover is principally moss (notably *Hylocomium splendens*) and some *Vaccinium scoparium*. Dominant shrubs are *Menziesia glabella*, *Salix vestita*, and *Ledum groenlandicum*; *Juniperus communis* and *Arctostaphylos rubra* occur frequently. The transect is marked by pins.

Y-3 (not shown on the map) is a grid and transect combination in the near climax spruce-fir forest behind the Marble Canyon Warden Station.

Although not quite fully mature, the area has not been burned for 250 years and is therefore more properly classified as pristine forest. It starts in the forest just east of the barn and runs alongside the stream. Boggy areas provide small open spaces, while the shifting stream has created some interesting habitat patterns. Near the stream are grasses with *Shepherdia canadensis*, *Salix* spp., *Betula glandulosa*, *Potentilla fruticosa*, and *Lonicera involucrata*. Further from the banks the forest is thick with *Menziesia glabella* and moss. Deadfall is heavy. Elevation is 1,460 metres (4,800 feet) and the transect is marked with pins.

TEST GRID is a set of four trapping grids (3 x 3, 4 x 4, 6 x 6, and 8 x 8) created as part of an experiment to determine by how much we are over-estimating the density of mice in the Burn. The grids were set up around pins SW2B, SW2C, SW3B, and SW3C as shown in Figures 2 and 3. Circled dots represent the trap locations. All traps were measured 15 metres apart. The different sized grids were rotated as shown for the second period of trapping (August 31 - September 3) in a successful attempt at minimizing the effects of localized population pockets. The test grid is in an area of reasonable homogeneity. Regeneration ranges from good to excellent. Although not flat, the slope is comparatively gentle, undulating, and rocky. Pins SW2B and SW2C are in an area dominated by *Epilobium angustifolium*, while pins SW3B and SW3C are within an association in which *Epilobium angustifolium*, *Linnaea borealis* var. *americana*, *Vaccinium myrtillus*, and *Carex* spp. are the most important members. These two areas or types intergrade considerably so that the distinction between them is not obvious. The entire area is dominated by *Menziesia glabella* in the shrub stratum, with some *Shepherdia canadensis* and *Salix glauca* present as well. Deadfall ranges from light to moderate; elevation from 1660 m to 1730 m. No streams or seepage areas were present. For the most part, the slope faces southeast.

RESULTS

This year, a total of 8636 trap ½ days were accumulated. 669 retained captures (682 captures minus 13 escapes) of 320 individuals gave an average of 2.09 captures per individual. Trap success reached its highest level yet with 7.90 captures per 100 trap ½ days. Further general qualitative data are presented in Table 2.

Trap deaths were down this year with 3.23 deaths per 100 captures. Most of these deaths were in August. The main cause of death was the weather which seemed reasonably normal for the duration of the summer. Table 3 gives all pertinent information regarding trap mortality. Percentage death is shown for each species. Only one death was attributable to predation by marten (*Martes americana*) as it was our practice to abandon the use of lines biased in this manner. With this in mind, results are comparable to 1975 except that two *Microtus longicaudus* (long-tailed mountain vole) deaths were recorded this year. *Peromyscus maniculatus* (deer mouse) had the lowest trap mortality of the mice, while *Microtus pennsylvanicus* (meadow vole) had a very high percentage death. No shrew deaths are reported this year (there was only a single capture). Species captured this year include the following:

umber of individuals, captures, escapes, and
re given for each trapline by month and the

ed S	Total	Captures/ Individual J	J	A	S	Total	# of escapes J	J	A	S	Total	All Captures J	J	A	S	Total	Captures/100 Trap ½ days J	J	A	S	Total
	3		0.67			0.67		0			0		3			3		0.55			0.55
	24		1.85			1.85		0			0		24			24		3.92			3.92
	5			2.5		2.5			0		0			5		5			2.84		2.84
	36		2.10	1.36		1.89		2	0		2		23	15		38		4.23	2.45		3.29
	50		1.61	1.30		1.52		1	0		1		38	13		51		6.9[illegible]	2.12		4.41
	11		1.10			1.10		0			0		11			11		2.29			2.29
	36	2.25	1.80			2.40	0	1			1	18	19			37	20.45	3.49			5.85
	181		1.81	1.81		2.21		0	1		1		67	115		182		12.32	21.14		16.73
	141		1.56	1.65		1.81		0	3		3		42	102		144		6.86	15.00		11.15
0	182		1.00	1.88	2.35	2.76		0	5	0	5		6	101	80	187		4.80	10.10	21.33	12.47
30	669	2.25	1.66	1.74	2.35	2.09	0	4	9	0	13	18	233	351	80	682	20.45	5.12	9.69	21.33	7.90

Table 3. Trap mortality by species, month, and trapline

	Peromyscus	*Clethrionomys*	*Microtus pennsylvanicus*	*Microtus longicaudus*	ALL DEATHS	Deaths/100 captures June	July	August	September	Total
2-1					0	-	0.00			0.00
A-1					0	-	0.00	-	-	0.00
A-2					0	-	-	0.00	-	0.00
B-1					0	-	0.00	0.00	-	0.00
B-2				1	1	-	2.63	0.00	-	1.96
D-1	1				1	-	9.09	-	-	9.09
M-1		1			1	0.00	5.26	-	-	2.70
UB-4		7		1	8	-	0.00	6.96	-	4.40
Y-3		5	5		10	-	4.76	7.84	-	6.94
GRID	1				1	—	0.00	0.00	1.25	0.53
TOTALS:	2	13	5	2	22	0.00	2.15	4.56	1.25	3.23
%CAPTURES:	0.80	4.68	16.67	18.18						

(1) *Sorex cinereus* - cinereous shrew (a, b, c, e)[1]

(2) *Spermophilus lateralis* - golden mantled ground squirrel (b, c open area)

(3) *Eutamias amoenus* - northwestern chipmunk (a, b, e)

(4) *Peromyscus maniculatus* - white footed or deer mouse (a, b, c, d, e)

(5) *Clethrionomys gapperi* - boreal redback vole (a, b, c, e)

(6) *Microtus pennsylvanicus* - meadow vole (a, b, c, e)

(7) *Microtus longicaudus* - long-tailed mountain vole (b, c, e)

(8) *Zapus princeps* - western jumping mouse (b, c, e)

Other species trapped sometime during the previous four field seasons include:

(9) *Microsorex hoyi* - pigmy shrew (c)

(10) *Eutamias minimus* - least chipmunk (uncertain identification) (b)

(11) *Tamiasciuris hudsonicus* - red squirrel (a, c, e)

(12) *Neotoma cinerea* - grey bushy tailed wood rat (tail portions only) (b)

(13) *Synaptomys borealis* - northern bog-lemming (e)

Incidentally captured by Fitzmartyn, 1973, was:

(14) *Glaucomys sabrinus* - northern flying squirrel (a)

Also observed within the Burn this year were:

(15) *Spermophilus columbianus* - columbian ground squirrel (b)

(16) *Ochotona princeps* - pika (rocky areas, possibly exposed by erosion as a direct result of the fire, and unburned talus slopes). (b, d).

The possibility that *Phenacomys intermedius* may occur in the study area, but

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1 Letters following the species names indicate the habitats where they have been captured or observed over the years of this study (a = successional, b = Burn, c = climax, d = alpine, e = burn edge).

has not been recognized as such, was not cleared up. Table 4 gives the breakdown on the species found in each trapping area this year. In the absence of water, the diversity of nocturnal small mammals in the Burn is similar to that of the pristine (or climax) forest (Guy, 1975), the only difference being that while *Peromyscus maniculatus* is present to almost complete exclusion of other species in the Burn, *Clethrionomys gapperi* excludes most other species in the climax forest. A more real difference between the two habitats is that the Burn supports a very different diurnal population whereas within the pristine forest, there is merely less activity with no change in species composition (Shank, 1971). Over the years, it would appear that, generally speaking, the climax forest supports higher densities (by perhaps as much as two times) than the Burn. However, the Burn, at any one time, probably contains twice the small mammal biomass per unit area. Turnover, though, would appear to be much greater in the climax forest. All things considered, it is not possible for me to make a statement concerning the relative small mammal productivities of the two habitats. An attempt should be made in future years to come to some conclusions in this regard as it is important to an understanding of the ecology of the respective predator-prey relationships involved.

Table 5 presents calculated resident and transient densities (numbers per hectare) in each trapping area for 1976. Densities obtained from the test grid are presented separately in Table 6. The method of density analysis employed was as outlined in Guy, 1975. The method utilizes a system which places individuals into seven type categories as follows:

Table 4. Numbers of individuals captured per species in each trapping area, organized by habitat type. Monospecific inhabitation index is given.

	Spermophilus lateralis	*Eutamias amoenus*	*Peromyscus maniculatus*	*Clethrionomys gapperi*	*Microtus pennsylvanicus*	*Microtus longicaudus*	*Zapus princeps*	*Sorex cinereus*	Monospecific Inhabitation Index;	For the most abundant species:
PRISTINE FOREST:										
Y-3	1		21	38	13	3	2		48.72	*Clethrionomys*
UB-4			1	75	4	2			91.46	*Clethrionomys*
M-1									-	
Totals	1	0	22	113	17	5	2	0	70.63	*Clethrionomys*
SUCCESSIONAL FOREST:										
A-1		9	2	1				1	69.23	*Eutamias*
A-2		1		1					50.00	-
Totals	0	10	2	2	0	0	0	1	66.67	*Eutamias*
EDGE OF BURN:										
B-2		5	3	11	8	1	5		33.33	*Clethrionomys*
2-1		1	1						50.00	-
M-1				1					100.00	*Clethrionomys*
Totals	0	6	4	12	8	1	5	0	33.33	*Clethrionomys*
MIDDLE OF BURN:										
B-1	5	4	9		1				47.37	*Peromyscus*
B-1	4		5		1				50.00	*Peromyscus*
M-1			7			2	5		50.00	*Peromyscus*
Test Grid[1]	24	3	39						59.09	*Peromyscus*
Totals	33	7	60	0	2	2	5	0	55.05	*Peromyscus*
Overall Totals:	34	23	88	127	27	8	12	1		

1 Data somewhat biased because traps were not set during the afternoons for the duration of the second trapping period.

Table 5. Density of small mammals (squirrels excluded) by trapline and month for 1976. The upper figure is resident density, while the lower parenthetical figure is transient density. Where different, both high and low estimates are given. Test Grid data is presented separately in Table 6. Values are numbers per hectare.

	JUNE	JULY	AUGUST
MIDDLE BURN: B-1			
Grid		0.00	0.00
		(0.00)	(0.00)
Transect		2.99 - 4.63	0.75 - 2.69
		(0.75 - 1.34)	(1.49 - 2.54)
D-1			
Transect		0.00 - 3.08	
		(2.09 - 3.18)	
BURN EDGE: B-2			
Grid		3.46 - 8.11	0.00 - 3.11
		(10.37 - 15.38)	(0.00 - 0.35)
Transect		4.07 - 11.24	1.02 - 6.56
		(4.07 - 7.07)	(1.02 - 3.61)
2-1			
Grid		0.00	
		(0.00)	
Transect		1.11	
		(1.11)	
SUCCESSIONAL: A-1			
Grid		24.57	
		(14.74 - 19.66)	
Transect		4.17 - 6.09	
		(2.50 - 3.92)	
PRISTINE FOREST:			
Y-3			
Grid		7.81 - 18.16	15.63 - 41.21
		(7.81 - 9.18)	(23.44 - 33.01)
Transect		4.87 - 17.15	11.70 - 32.60
		(2.92 - 5.26)	(6.82 - 15.16)
UB-4			
Grid		3.26 - 22.36	16.32 - 40.97
		(3.26 - 7.02)	(9.79 - 17.79)
Transect		9.32 - 19.95	14.92 - 35.52
		(2.80 - 8.02)	(5.59 - 12.03)
OTHER: M-1			
Grid	11.39 - 21.44	11.39 - 21.06	
	(0.00 - 1.33)	(3.80 - 5.50)	
Transect		1.80 - 4.76	
		(0.90 - 1.53)	

Table 6. Density (in numbers per hectare) of small mammals (squirrels excluded) for the Test Grid. First Period = July 31 - August 8; Second Period = August 31 - September 3. During the Second Period, the traps were not opened in the afternoons. The upper figure is resident density, while the lower parenthetical figure is transient density. Where different, both high and low estimates are given.

	FIRST PERIOD	SECOND PERIOD
3 x 3	9.88 - 29.96 (9.88 - 11.60)	9.88 (0.00 - 9.88)
4 x 4	11.11 (11.11)	5.56 - 13.61 (0.00 - 0.28)
6 x 6	2.47 - 4.69 (0.00 - 0.25)	8.64 - 11.48 (1.23 - 2.10)
8 x 8	2.78 - 3.23 (0.69 - 1.63)	9.03 - 9.93 (0.00 - 0.49)

1. Type One: An animal captured two or more times with a time span of two or more days between first and last capture. These are considered to be definitely residents.

2. Type Two: An animal captured only once with two or more days of chance at recapture. These are considered to be definitely transients.

3. Type Three: More than one capture within a time span of two days with two or more days of chance at recapture thereafter. These are considered to be probably transient.

4. Type Four: Classified as a resident in the past or future but presently would be classed as any other type. These are probably residents.

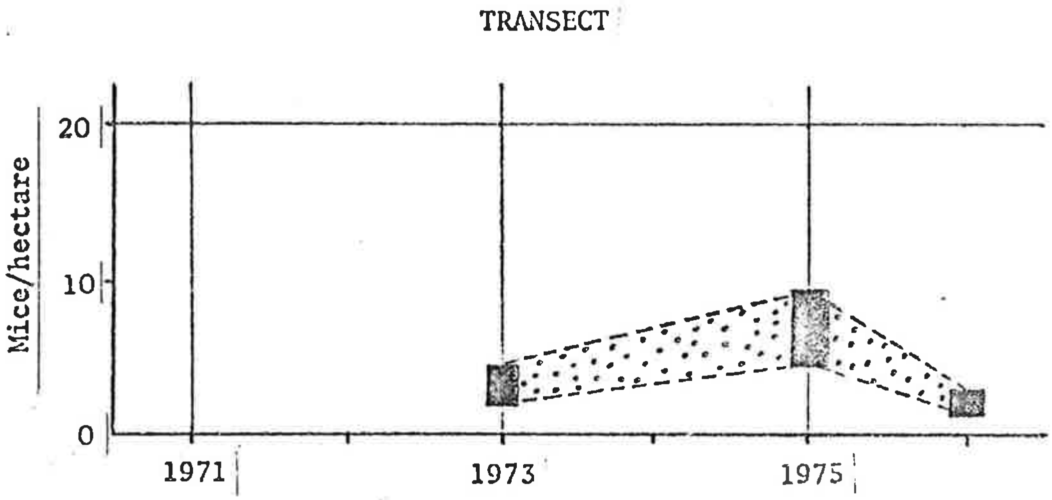
5. Type Five: An animal captured once with less than two days of chance at recapture thereafter. This includes dead animals which have not previously been caught. These could be considered to be either Type One or Type Two in reality.

6. Type Six: An animal captured in the past or future and classified as any type but Type One and presently not classed as Type One. These individuals are probably residents.

7. Type Seven: An animal caught twice within two days without two or more days of chance at recapture thereafter (either because of death or because of termination of the trapping period). These could be either Type One or Type Three in reality.

What constitutes a "time span of two days" or "two days chance at recapture" is in many cases open to a certain amount of discretion. Low and high density estimates were calculated from the above types as follows:
Low number of residents = #1

Figure 4. Changes in resident small mammal densities (excluding squirrels and chipmunks) in the Middle Burn. The upper lines represent the high estimates while the lower lines show the lower estimates.



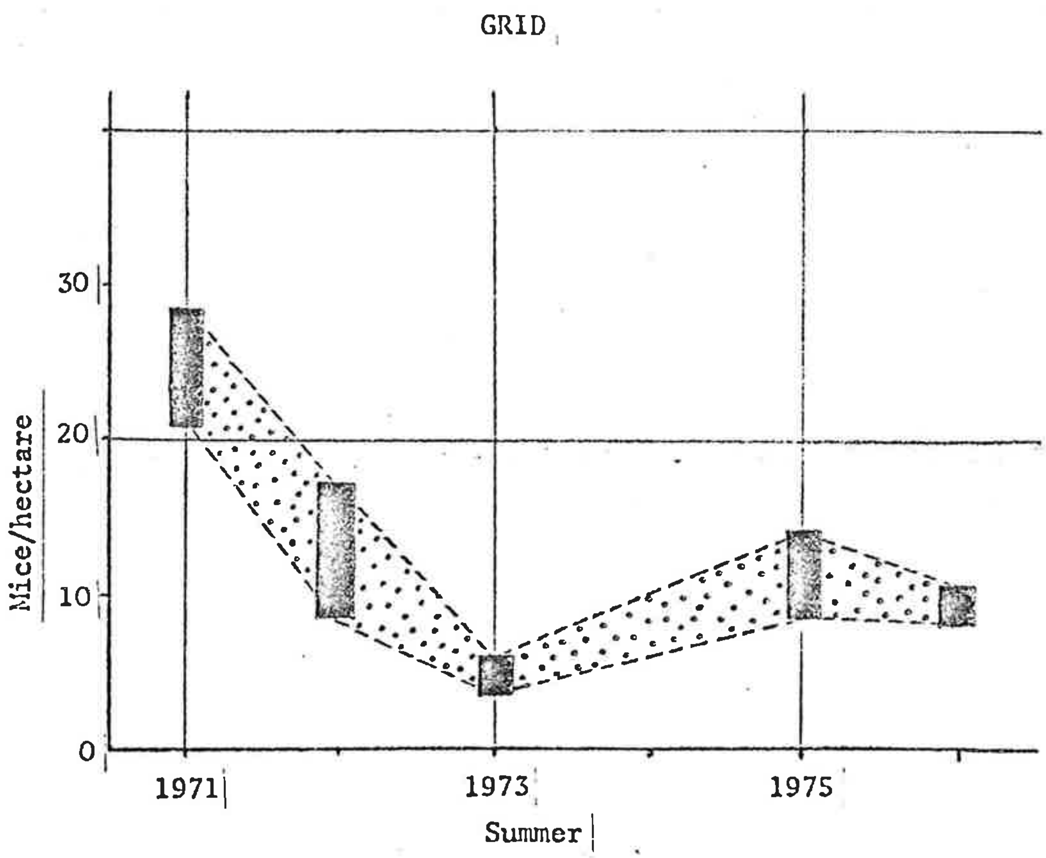


Figure 5. Changes in resident small mammal densities (excluding squirrels and chipmunks) The upper lines represent the high estimates while the lower lines show the low estimates.

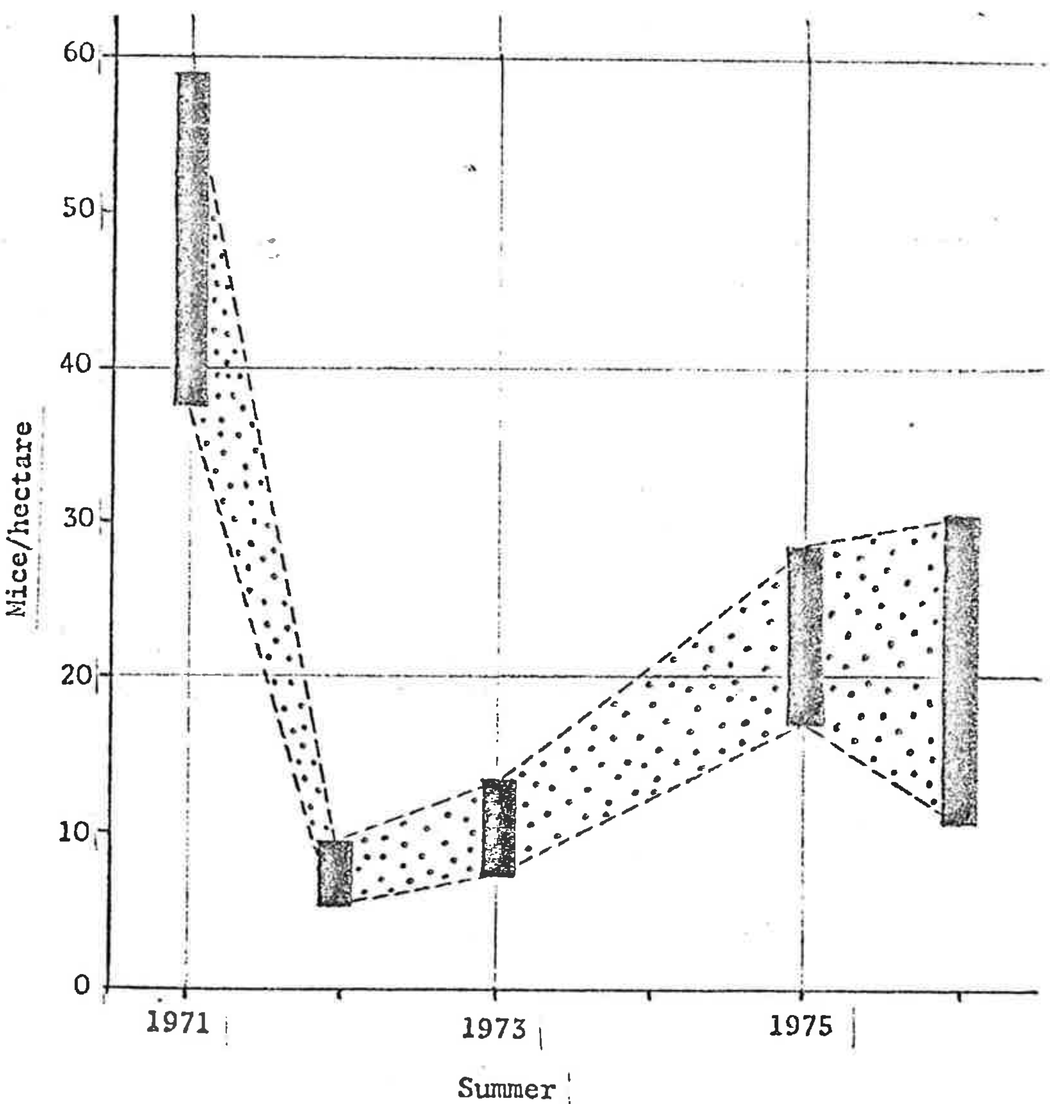


Figure 6. Changes in resident small mammal densities (excluding squirrels and chipmunks) in the pristine forest, according to transect data. The upper lines represent the high estimates while the lower lines show the low estimates.

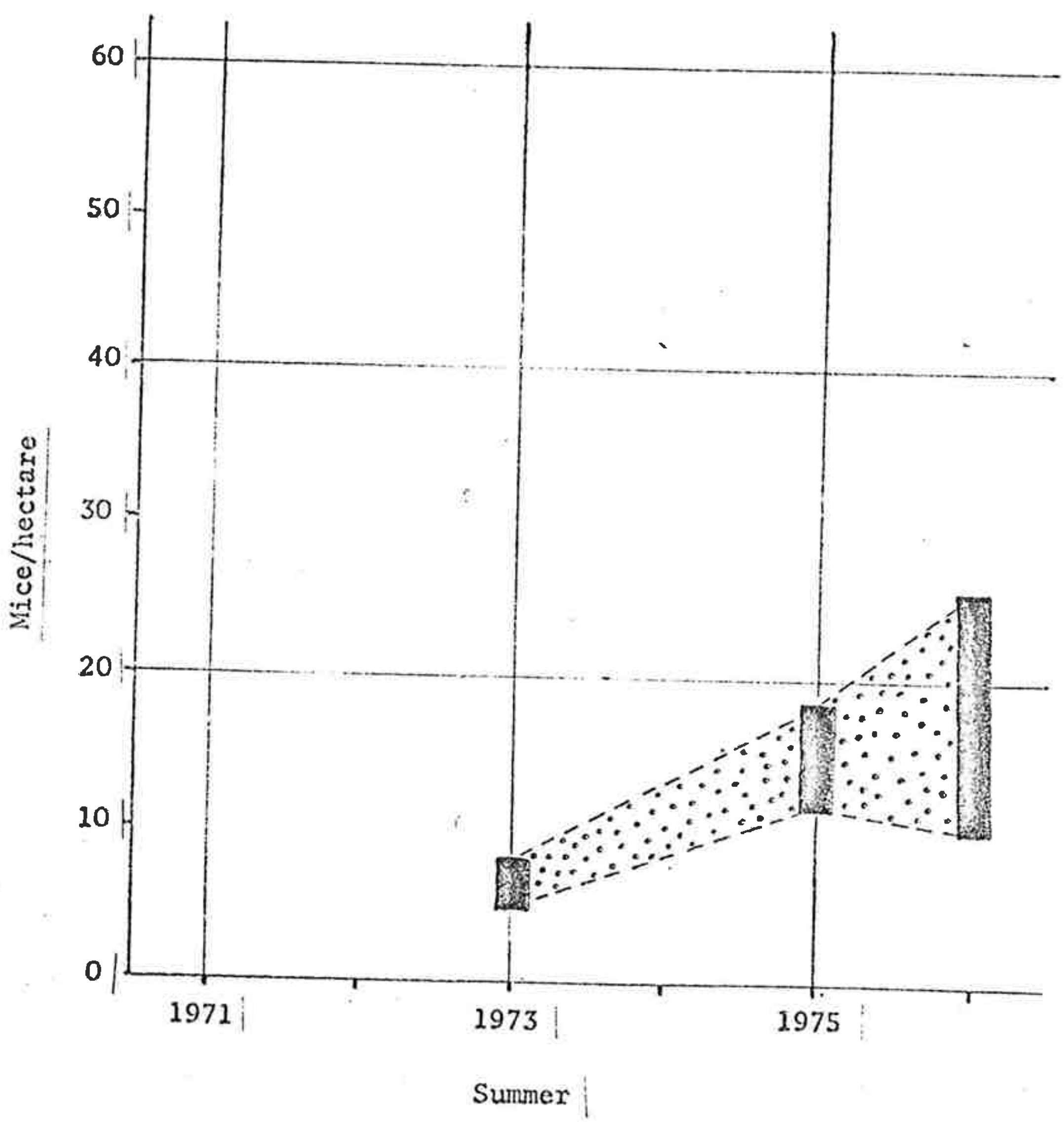
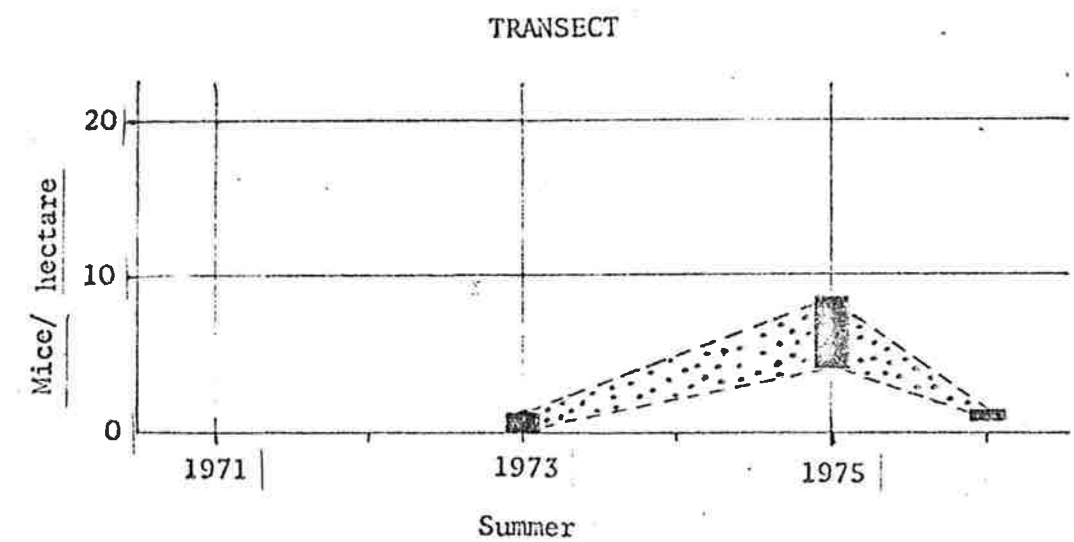


Figure 7. Changes in resident small mammal densities (excluding squirrels and chipmunks) in the successional forest. The upper lines represent the high estimates while the lower lines show the low estimates.



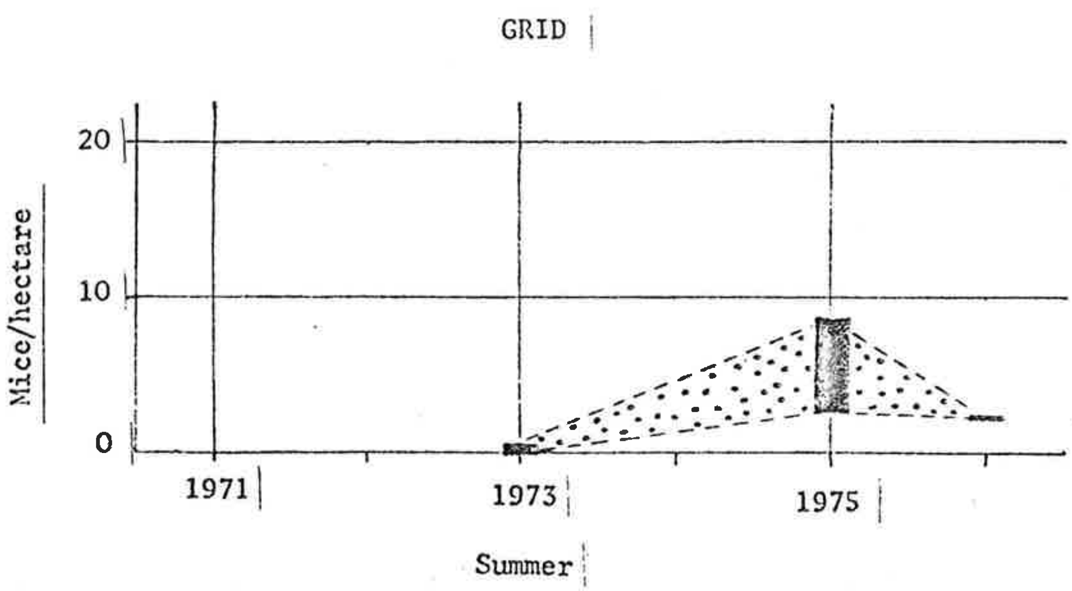
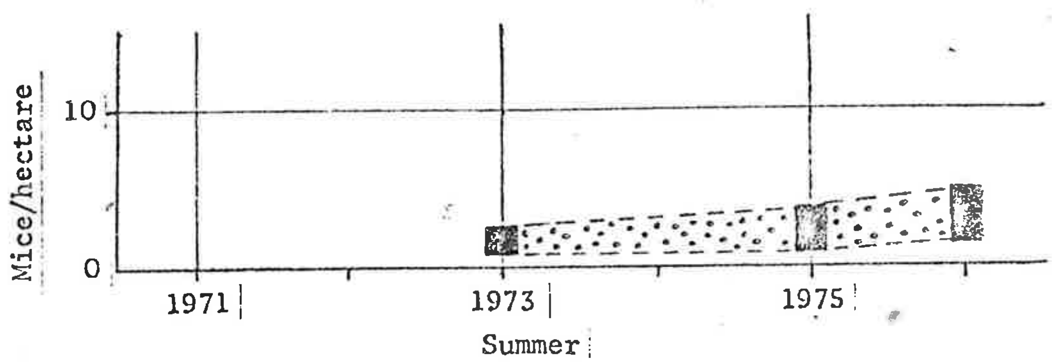
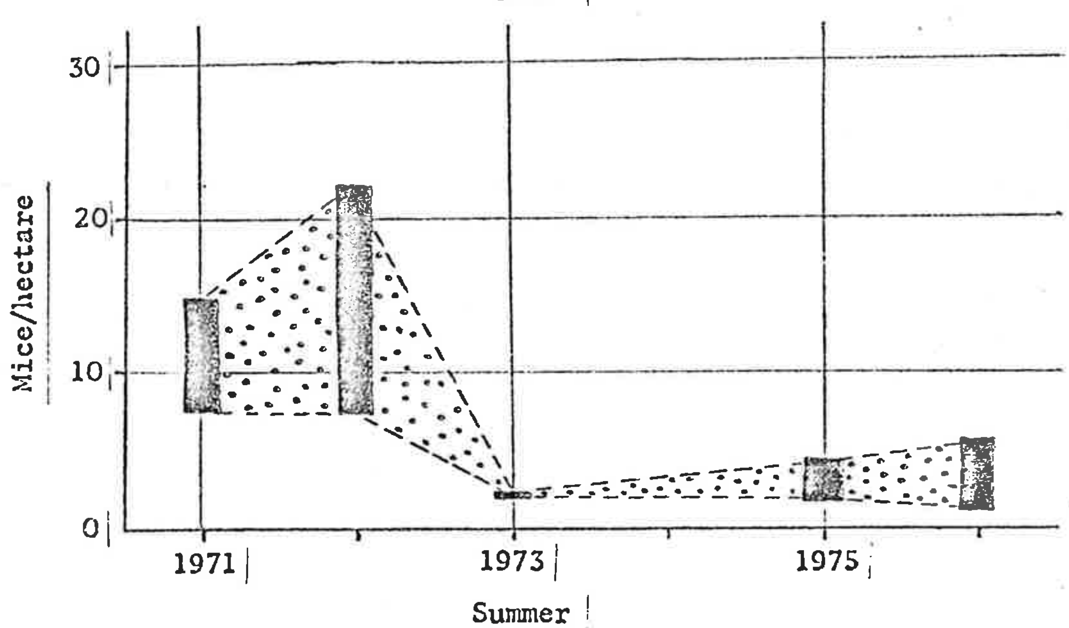


Figure 8. Changes in resident small mammal densities (excluding squirrels and chipmunks) at the Burn Edge. The upper lines represent the high estimates while the lower lines show the low estimates.

TRANSECT



GRID



High number of residents = $\#1 + \#4 + \#6 + \#5\left(\frac{\#1}{\#1 + \#2}\right) + \#7\left(\frac{\#1}{\#1 + \#3}\right)$

Low number of transients = $\#2$

High number of transients = $\#2 + \#3 + \#5\left(\frac{\#2}{\#1 + \#2}\right) + \#7\left(\frac{\#3}{\#1 + \#3}\right)$

Values thus obtained are divided by trap-line area in hectares. The ratios $\left(\frac{\#1}{\#1 + \#2}\right)$, $\left(\frac{\#2}{\#1 + \#2}\right)$, $\left(\frac{\#1}{\#1 + \#3}\right)$, and $\left(\frac{\#3}{\#1 + \#3}\right)$ were computed from all data collected this year and therefore did not vary from trap-line to trap-line. In the case of the test grid, however, the experiment was treated as a separate system and thus these ratios were different.[1] Squirrels were not included in the density analyses as it was believed that their size and disposition biased the data. However, trapping on the test grid for three afternoons yielded 39 captures of 24 individuals, giving an estimated resident squirrel density of 1.07-4.75 (low-high) per hectare and an estimated transient squirrel density of 1.78-3.99 per hectare. They were so numerous that it was just impossible to keep up.

This year the successional forest supported the lowest densities of mice; considerably lower than in 1975. I do not believe this represents any trend but rather it is the result of a limited sample size. We have only one successional forest trap-line which this year was only run in July. Figures 4-8 show changes in resident mice densities according to habitat over the past six years. Upper lines represent the high estimates while lower lines represent the low estimates. Again this year, as in 1975, the

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1 In Table 6 the densities are as calculated using the ratios representing all of this year's data in order that this information could properly be used in conjunction with the rest of the Burn data for presentation in the figures.

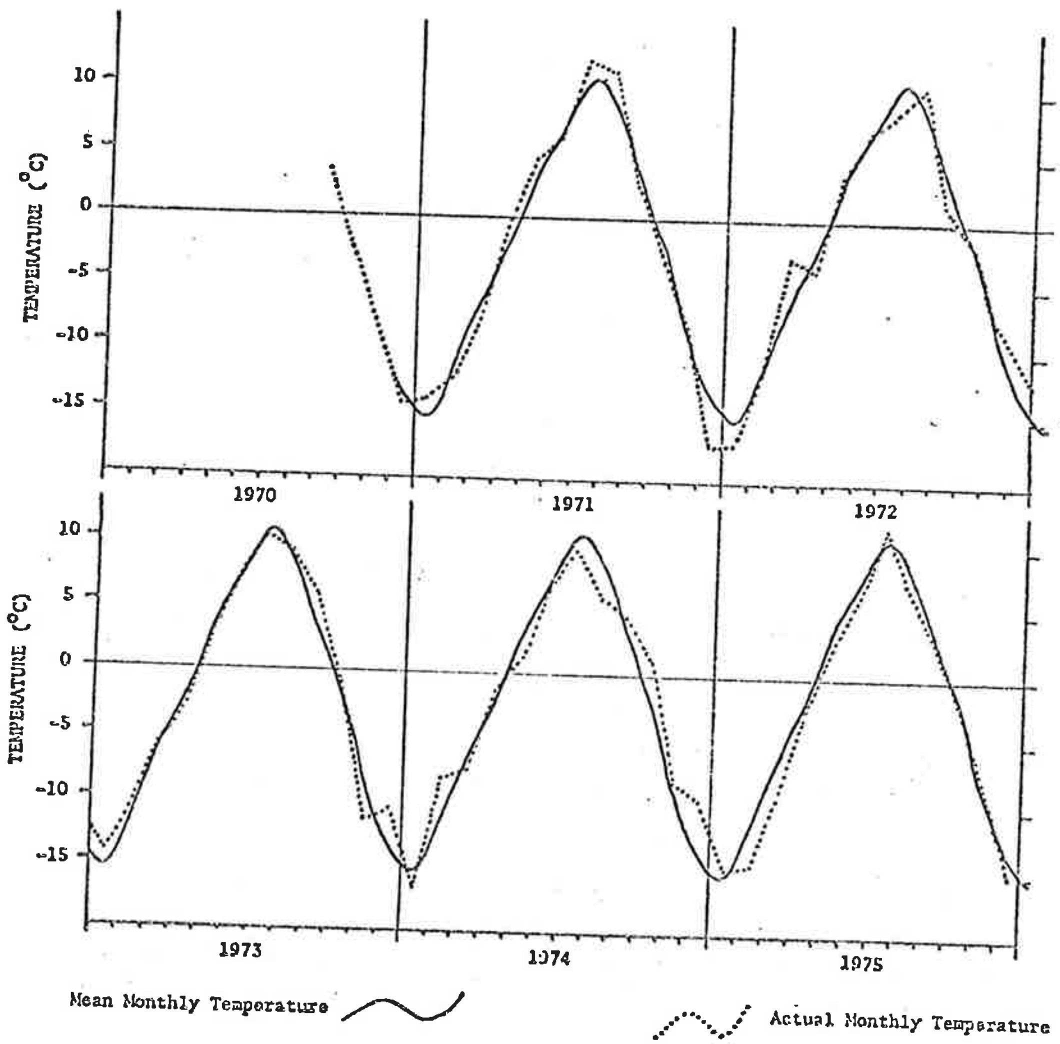

Figure 9. Temperature at Weather Station #1 (valley floor, vicinity of B-2 grid; elevation 1610 m A.S.L.) from September 1970 to December 1975.

same basic trends in population change occurred within the very different habitats of the Burn and the pristine forest. The not-so-well represented burn edge and successional habitats do not deviate from these patterns significantly. More middle burn transect data would have been helpful for the month of August of this year. It was stated (Guy, 1975) that the prime candidate for a possible cause of these similar patterns was believed to be the macroclimatic conditions; specifically, the degree of winter severity. Figure 9 presents temperature data for Weather Station #1 (middle burn, valley floor, vicinity of B-2 grid, elevation ~ 1610 m A.S.L.) over the past 5½ years.[1] Means are the averages obtained over those years. The very cold winter of 1971/1972 corresponds nicely with the dramatic drop in density experienced the following year (Guy, 1975). It is expected, in the absence of severe winters, that once population numbers have become re-established after such a crash that they will variously fluctuate up and down about the separate carrying capacities. This, however, does not as yet appear to be the case. It is important to note that, at this time, in weather, I only seek a possible explanation of major density drops. It could prove very worthwhile to keep the check on densities, such as this paper represents, going every year. Although the Canadian Wildlife Service has set up "benchmark" trap-lines for similar purposes (Archibald, 1976), within Banff Park, it must be remembered that they are dead trapping. I believe that this method is totally unsuitable for such a study as the possible biasing effects due to unnatural removal of individuals are not known.

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1 Data courtesy of Dr. S. Harris

Another intent of this year's work was to look into the existence of rather odd population phenomena exhibited by *Zapus princeps*. In past years there has been a tendency for well established (sometimes for up to a few years) local populations to suddenly disappear within a few weeks. Indications are that in some situations, groups of *Zapus princeps* have been known to suddenly appear where they were previously not present, then to move en masse to a new area where they may remain (Telfer, 1972). Although not deeply pursued this year, some trapping was carried out in June to see if any of the western jumping mice which vanished from M-1 in late June, 1975 had returned. One of the five previously present did so.

Test Grid Experiment

The purpose and experimental design of this section are outlined in the introduction and area descriptions. The theory and results are presented here. A natural assumption made when placing traps a certain distance apart (in this case 15 m) is that each trap is sampling an area 15 m x 15 m square. This is the origin of the so-called border area (7.5 m wide) around a grid. A further assumption is made, when calculating densities, that no animals originating from outside a grid are recorded as being residents. In fact, many animals have a home range which barely enters the grid so that the effective trapping area may be much larger than the apparent grid area. This is known as the "edge effect". "The larger the area under survey, providing it does not depart appreciably from a square shape, the less important the edge effect becomes."[1] This is because perimeter per unit

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1 Delany, 1974, p. 13.

area decreases with increased area. The four different sized grids used in this experiment were expected to give four different densities which, when plotted, would yield a curve. Extrapolating the curve into infinity would give the "true"[1] density (i.e., the value of density approached as grid size approaches infinity). I am pleased to say that the results obtained were as expected.

Assuming the density analysis method used in this study is reasonably valid (which I believe it is) and taking the liberty of merely averaging the low and high estimates to simplify calculations, the average densities of mice obtained from the different sized grids are:

3 x 3 grid = 14.69 per hectare

4 x 4 grid = 10.38 per hectare

6 x 6 grid = 6.97 per hectare

8 x 8 grid = 6.52 per hectare

These values are plotted against grid area (in hectares) in Figure 4. A distribution was obtained closely fitting the curve one would theoretically expect. Such a curve can be described by,

$$y = \frac{a}{x} + b,$$

where y = observed density, x = area, a = a constant related to the actual experimental conditions (habitat, home range, density, other species characteristics, etc.), and b = the true resident density. Given any two

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1 The trappable segment of the population only. No consideration is given to juveniles which may have still been in the nest (this applies to all density estimates over the past 5 years of field work). Generally, *Peromyscus maniculatus* exhibits high trapability (Stickel, 1946, in Archibald, 1976).

points (x,y) on the curve, it is a simple matter to calculate the values of 'a' and 'b'. Since data from four grids (and thus four points) are available, there are six possible pairs of points from which 'a' and 'b' can be calculated. These values are presented in Table 7. Sample calculation:

(x,y) for 3 x 3 Grid = (.2025,14.69)

(x,y) for 6 x 6 Grid = (.8100,6.97)

for 3 x 3 Grid

1. $14.69 = \frac{a}{.2025} + b$

2. $14.69 \times .2025 = \left(\frac{a}{.2025} + b\right) \times .2025$

3. $2.9747 = a + .2025b$

For 6 x 6 Grid

4. $6.97 = \frac{a}{.8100} + b$

5. $6.97 \times .8100 = \left(\frac{a}{.8100} + b\right) \times .8100$

6. $5.6457 = a + .8100b$

$$
\begin{array}{lrl}
 & 6. & 5.6457 = a + .8100b \\
- & 3. & 2.9747 = a + .2025b \\
\hline
= & 7. & 2.6710 = .6075b
\end{array}
$$

8. $b = 2.6075/0.6075$

9. $b = 4.40$

It will be noticed that the values in each of the 'a' and 'b' columns of Table 7 are rather similar with the exception of the last ones (i.e., the 6 x 6 and 8 x 8 pair). This is readily explained by the relative closeness of the observed densities from these two grids. The difference in density between them was only 0.45 individuals per hectare. Such a small separation is very susceptible to error, much more so than the differences between any of the other grid combinations. When all the 'a' and 'b' values are averaged (unfortunately lacking any statistical measure of accuracy[1]) to give the equation:

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1 This is indeed possible but beyond my present capabilities and no doubt time consuming.

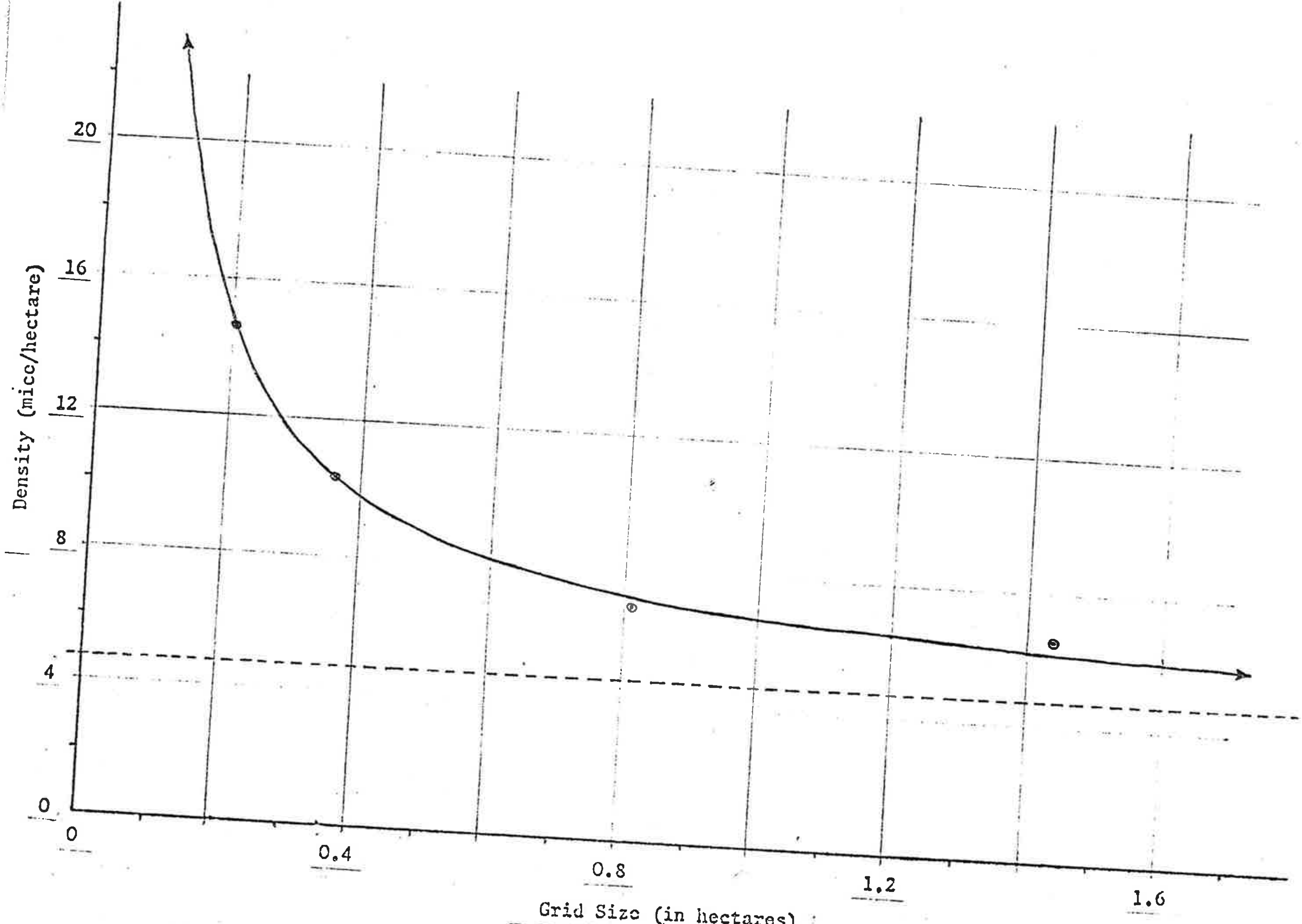

Figure 10. Observed average *Peromyscus maniculatus* densities plotted against grid area in hectares (circled points), in the test grid in the Burn. The curve shown was derived from the formula: $y = \frac{2.0199}{x} + 4.78$, where 4.78 is the density approached as grid size approaches infinity.

$$y = \frac{2.0199}{x} + 4.78,$$

the curve described corresponds very well with the observed data (total deviation = 0.03). This is the curve plotted on Figure 10. I conclude then that the true *Peromyscus maniculatus* density in the vicinity of the test grid is approximately 4.8 residents per hectare. A 4 x 4 grid in the Burn, unattached to a transect, therefore yields a density which exaggerates the resident population by about two times (calculated value = 2.17). In 1973 and 1975 the transects gave density estimates about 2/3 that of the grids. Although these were attached, I would now venture a guess that 2 x 30 transects exaggerate densities by roughly 1/3 to ½. In addition, the success of this experiment tends to lend a certain amount of credibility to our methods of density determination.

Table 7. Calculated values of 'a' and 'b' (from pairs of data obtained from the test grid) via systems of equations.

Grid Pairs Used	a	b
3 x 3 & 4 x 4	1.9949	4.84
3 x 3 & 6 x 6	2.0844	4.40
3 x 3 & 8 x 8	1.9252	5.18
4 x 4 & 6 x 6	2.2097	4.24
4 x 4 & 8 x 8	1.8528	1.23
6 x 6 & 8 x 8	0.8331	5.94

Other Incidental Results

The test grid also gave some information on home range sizes, transients, and other phenomena. Often mice recorded as residents on one of the component grids were also caught as transients on other component grids. A number of mice were recaptured only a few minutes after being released. *Peromyscus* H952R (♂) travelled 81 m in 10 minutes one morning, while *Peromyscus* H938L (♂) covered a distance of 257 m in less than an hour on another occasion. On the basis of seven captures, *Peromyscus* H757L (♂) showed a home range (including boundary strip[1]) of 6862.5 m^2. *Peromyscus* H759L (♂) exhibited a home range of 3825 m^2 based on four captures. One very important thing noticed about the grids was that their operation was more time-consuming than for the transects we used regularly.

On line D-1, *Spermophilus* 802L from 1973 was recaptured at the same trap location. This individual was a juvenile in that year and is now well over 3 years old.

At about 6.00 a.m. on August 21, line UB-4, *Clethrionomys* H838R (♀) was released from capture while in labour. She had already given birth to 2 juveniles (each of which was 30 mm long and weighed 2 gms). They were placed in a protected place in the hopes that the mother might return to collect them (it is not unusual for some voles to carry their young in their mouths (Banfield, 1974).

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1 see Delany, 1974, p. 8.

ACKNOWLEDGEMENTS

I would like to thank Dr. Stuart Harris and the staff of Banff and Kootenay National Parks for allowing me to undertake this study. I am very much indebted to my assistant, Greg Wagner, who carried out the bulk of the fieldwork.

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OTHER MAMMALS

Over the summer, my assistants and I observed a number of animals other than those directly involved in the study.

Only one marten was observed this year, as compared with thirteen last year. It was in the vicinity of Y-3 at Marble Canyon. One mink was seen on the shores of Vista Lake within the Burn.

Bears seemed to be more noticeable this year. Two separate young black bears occasionally visited the camp at Eisenhower Junction. One adult black bear was observed in the Burn. Two separate grizzly bear sitings were made within the Burn during June (one near pin 11C-SW and the other in the gravel pit close to the Great Divide).

At least three porcupines were present in the Burn. At higher elevations, the hoary marmot was very common. I would estimate that many tens of them inhabit the uppermost portions of the Burn and the immediately adjacent alpine and talus slopes. A dead snowshoe hare was found beside the road in the successional forest just east of Storm Mountain Lodge. A Canada lynx visited our camp early one morning. A coyote frequently made similar appearances. Other coyotes included one regular in the Burn area near Boom Creek and another one about a kilometer south of the Great Divide parking lot. Three moose (a bullmoose and a cow with her calf) were frequently seen near the Upper Altrude Lake. Another bullmoose was sited about 2 km east of Storm Mountain Lodge. Two mule deer were often observed at Eisenhower Junction, while at least four were known from the Burn. Elk, of course, were everywhere. Within the Burn, we identified 37 individuals. Present were 3 yearling stags, 4 second year stags, 3 adult stags, 7 yearling hinds, 1 second year hind, 13 adult hinds, and 6 calves--definitely more than in 1975. High on the cliffs of Mount Whymper, above the Burn, we once spotted a single mountain goat.