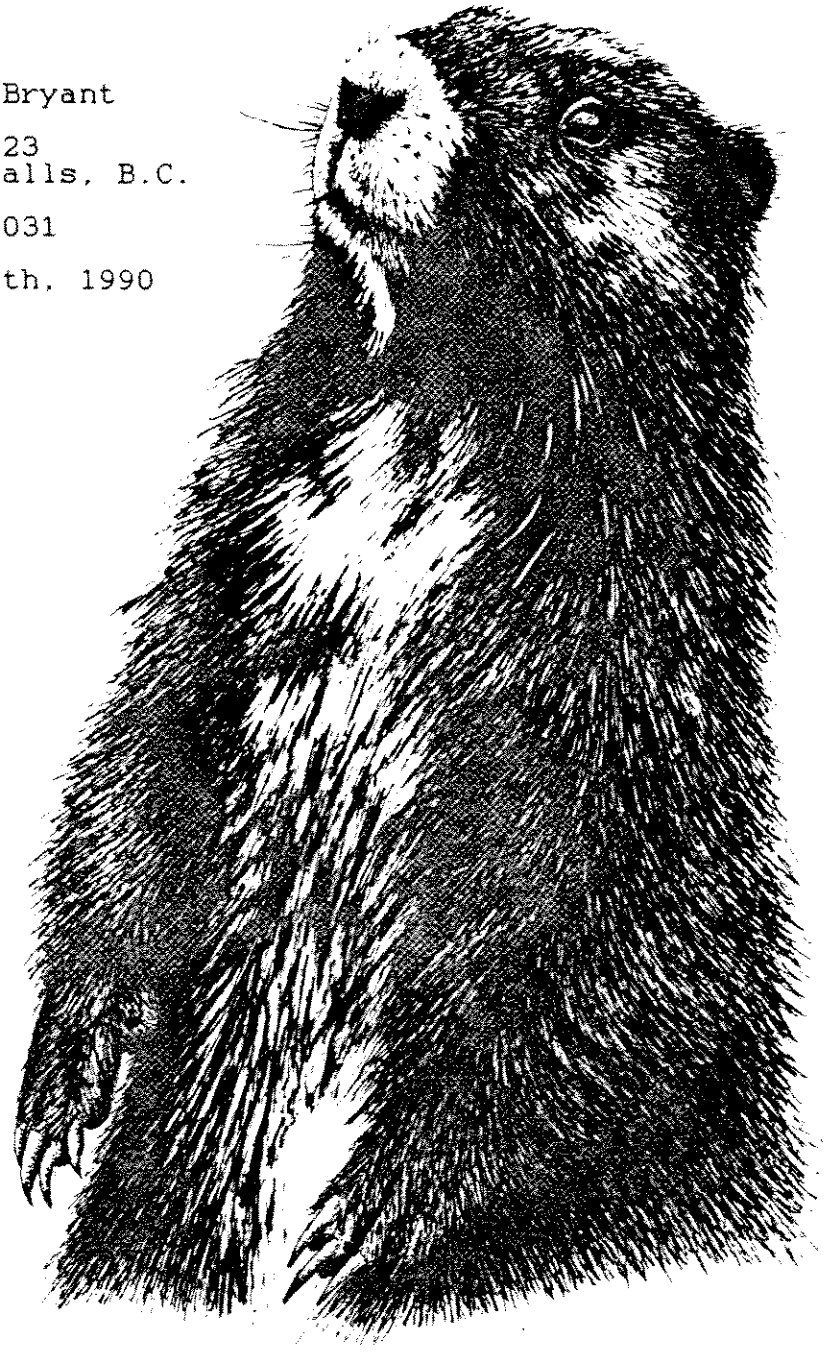
Final Report

Demography of Vancouver Island Marmots (*Marmota vancouverensis*)



Andrew A. Bryant

P.O. Box 523
Okanagan Falls, B.C.
V0H 1R0
(604)497-8031

December 5th, 1990

ABSTRACT

Research on Vancouver Island marmots (*Marmota vancouverensis*) continued in 1990. To date, *n*=55 individual marmots have been captured from two "natural" sub-alpine and two logged "slash" habitats. Although small, this sample represents a sizeable proportion of the known population of this species.

Year-to-year persistance of family-groups in "natural" habitats is significantly greater than those inhabiting "slash" (43% versus 13%). Survivorship of infants and yearlings from is low (<50%) in both "slash" and "natural" colonies. Adult survivorship rates are not significantly different (56% and 19% respectively), but this result is biased by small sample of "slash" data.

Litters of four are more common in "slash" habitats, but average fecundity of "slash" and "natural" females is not significantly different (1.14 young/adult-female-year). Females can reproduce at age three, but mean age-of-first-reproduction is probably closer to four. Maximum age is known to be at least six years, but could be considerably higher. Lifelong female reproductive contribution may be as low as two litters. Available data continue to support the logging-slash "sink" hypothesis.

CONTENTS

LIST OF FIGURES AND TABLES

Figures

Tables

ACKNOWLEDGMENTS

The 1990 Vancouver Island marmot project was carried out under contract with the Vancouver Island Marmot Recovery Team. I am indebted to W.T. Munro (chairman), who acted as contract monitor, and to C. Blumensaat, N. Dawe, D. Janz and D. Nagorsen, who also serve on the Team.

Project funding was provided by the Ecological Reserves Unit (B.C. Parks), World Wildlife Fund (Canada)/Canadian National Sportsmen's Show, Cowichan Valley Naturalist's Society (CVNS), and the Mountain Equipment Co-operative (MEC) of Vancouver. Administration services were generously provided, free of charge, by the Nature Trust of British Columbia.

As in past years, a field station and office privileges were provided by D.W. Janz and BCMOE personnel from Region 1 (Nanaimo office). Both MacMillan Bloedel Limited and Fletcher Challenge Canada permitted access to their lands; thanks are due to B. Kurtz and F. Berto, who ensured that I had keys to the various gates. Special thanks to C. Bryant, D. Janz, A. Haney and P. Gomerich, who accompanied me in the field as volunteers, and to C. Bryant, who drew the pen-and-ink marmot which appears on the cover.

INTRODUCTION

This report describes results of continued research on Vancouver Island marmots (*Marmota vancouverensis*) in 1990. The history and rationale of the project are described in Bryant (1990). This year's objectives were to:

1) monitor reproductive success and survivorship at the Haley Lake, Haley "slash", Green Mountain and Pat Lake study colonies.

2) monitor burrow-use by individuals and family groups.

3) capture and ear-tag marmots to facilitate continued monitoring.

4) surgically implant one radio transmitter in a yellow-bellied marmot (*Marmota flaviventris*) to assess the feasibility of using this technology to measure dispersal.

METHODS

Trapping and handling methods were identical to those used in previous years (see Bryant 1990). Field efforts began on July 6th. Twelve days were spent in July, including 42 "trap-days" (one trap used for one day) at Green Mountain, Haley Lake, Haley "slash" or Pat Lake. Comparable figures for August are nineteen field-days (86 trap-days), and nineteen field-days (76 trap-days) in September. As in past years, I attempted to spread my time evenly between

sites to facilitate inter-group comparisons. My last field-day was September 25th.

Blood samples from n=6, and measurements from n=7 new marmots were taken; n=5 animals from previous years were re-captured. To date, a total of n=55 individual marmots have been marked and released. DNA analyses are currently being performed on available (n=54) blood samples by Helix Biotech of Vancouver; results will be reported under separate cover. Financial constraints precluded any attempt to meet objective #4; the implantable radio unit was not purchased.

Statistical analyses were performed using QUATTRO (Borland 1987) with an IBM-compatible personal computer. Procedures follow Sokol and Rohlf (1980). Chi-square tests of 2x2 tables employ Yate's correction for continuity. Significance was evaluated at the 95% confidence level.

RESULTS

General observations:

Monel self-piercing ear-tags (first used in 1988) are more effective than the "rabbit-ear" aluminum tags used in 1987; only one missing tag of the former type was noted this year (at Pat Lake). The size record for *M. vancouverensis* is currently held by adult male #941942 ("Einstein") from Haley Lake (6.8 kg on August 23rd); age records are jointly held by adult females #1312 and #1820 ("Rocky Raccoon" and

"Betsy") from Green Mountain (both presumed to be three-year-olds in 1987, and therefore treated as six-year-olds).

A capture-related mortality almost occurred at Haley Lake on August 14th. Adult male #1112 appeared to be recovering normally from the Ketamine injection when it collapsed in the bottom of the trap. Heat exhaustion may have been the problem; it was sunny, the animal had been sunning itself for at least two hours prior to capture, capture and processing took place at noon and the animal was not shaded when I returned it to the trap to recover. After collapse, the animal was quickly brought into the shade and I massaged water into its fur. After approximately one hour, the animal appeared to recover sufficiently for it to be released. It evidently recovered fully (and was observed on August 18th).

Several new marmot locations were reported to me by various persons; these have been added to existing BCMOE files. On September 24th, D. Janz (BCMOE) and myself found three old marmot burrows amidst rocks below the summit of Mount Landhalt. Neither Mount Washington nor "P" Mountain were visited in 1990.

Pat Lake:

Numbers of marmots at this "slash" colony have declined from 1988 and 1989; my estimate of 20-25 in those years is now reduced to about nine (three ear-tagged individuals re-captured or positively identified, two "new" marmots and two or three others. No reproduction was observed at this colony

in 1990. Two of the four "established" burrow complexes were abandoned this year, but I also found several new burrows on the east-facing sidehill above road "J3".

Several golden eagles (*Aquila chrysaetos*), including at least one confirmed juvenile, were observed *every* day from July 9th-11th, August 4th-5th and August 11th-15th. Although I witnessed no predation, I am convinced that eagles nested above road "J3" and may at least partially account for the marmot population decline at this colony.

Recaptured marmots at this site included female #901902 (YOY in 1988) and #907908 (yearling in 1988, lactating in 1989). The former demonstrates that females do not *necessarily* breed in their third spring; the latter demonstrates that they can.

An interesting behavioral pattern was observed at this colony on hot, clear days. Consistently, marmots would emerge at about 6:00 A.M. from their burrows on the east-facing sidehill. After the sun rose above the west-facing ridge, marmots would move across the "bowl" to sit on rocks, stumps or logs in the shade. When the sun rose high enough that these sites were also bathed in direct sunlight, marmots returned to their burrows. This pattern (avoidance of direct sunlight by moving to the opposite side of the "bowl") was repeated during the late afternoon (i.e., by re-emergence and movement to the east-facing sidehill as soon as the sun disappeared behind the west ridge). I have not observed this behavior at any other colony.

Haley "slash":

Poor trapping success at this site is again apparent. The 24 trap-days spent here resulted in only one capture (#1516 on Sept. 21st). In early July, I counted a minimum of four marmots, all using the "Red-tail" burrow complex. At that time the "Menza", "Patches" and "New" burrows showed no signs (scats or mud-stains) of recent use.

Beginning on the 23rd of August, three marmots were observed using the "Patches" and "Menza" burrows. I was able to capture only one of these, but am convinced they were "new" (i.e., colonizing) marmots as the four marmots using the "Red-tail" complex were observed simultaneously. No reproduction was observed at this colony in 1990. Vegetation growth at this "slash" colony is quite apparent and some areas used by marmots in previous years (eg., the "old" burrow) showed no sign of recent use.

Haley lake:

This colony showed consistent burrow-use in 1990; the "Mom #1", "Mom #2" and "Tonto" burrows were all used daily. Some use of the "Newfie" burrows (potential family in 1988; used in 1989) was observed. The population appears to be fairly stable (with about ten adults, and three established family groups).

Reproduction at this colony in 1990 was limited to a single litter of three by "Oprah Winfrey" (recaptured in

full nursing condition). "Oprah" is a presumed five-year-old female (age two at first capture in 1987). This was apparently her first reproductive incident.

Although I watched for it, and although Haley Lake has a similar geometry to the Pat Lake colony, I did not observe any indication of "sun-avoidance" by marmots on hot, clear days.

Green Mountain:

Comparatively little time was spent at Green Mountain in 1990, (four days and eight trap-days) with no trapping success. A minor problem has occurred because Fletcher Challenge Canada is wary about "making an exception" and allowing access through the 2nd Lakes gate during periods of dry weather. An additional problem resulted from the otherwise admirable clean-up and road shut-down work done in late 1989 by Nanaimo sportsmen. Access to the Green Mountain colony is now possible only by foot from the level of the lower lodge. The net result is a virtual doubling of the time required to move traps and equipment up the mountain.

Neither of the two established burrow systems were abandoned at Green Mountain, although my highest daily count was only four marmots. One known three-year-old (#926927), Rocky Raccoon (#1312) and one large adult which had lost both 1987 "rabbit-ear" tags were seen; I believe the latter was "Betsy" (#1820) but was unable to confirm this. However,

given the style of tags, the latter marmot must be at least six years old.

A possible shooting incident was reported to me by BCMOE personnel in mid-September. As described to me, unidentified persons were overheard claiming to have shot four marmots "above the ski lodge" by another unidentified person, who in turn contacted the Fletcher Challenge gatekeeper. I could not confirm this report. No corpses or shell casings were found when I visited the Green Mountain study burrows on September 21st. However, I saw no marmots either, and found fresh scat at only one burrow.

Sex-ratio and age-structure:

Data suggest equal sex-ratio at birth, although sample sizes remain small (n=10 infants captured throughout the project). These data yield no significant difference from a 1:1 sex-ratio (χ^2=0.4 with 1 df, p>0.05). Encouragingly, I found that all young recaptured in subsequent years (n=3) had been sexed accurately at time of first capture, making me more confident in my ability to sex young marmots.

Sex-ratio of all (n=55) captured marmots does not significantly differ from 1:1 (χ^2=0.08 with 1 df, p>0.05). Similarly, there is no difference in sex-ratio of marmots captured from "natural" versus "slash" colonies (χ^2=2.09 with 1 df, p>0.05). Tests for differences in age-structure among captured males and females (Figure 1), or cumulative sex-age structure of "natural" versus "slash" colonies, are

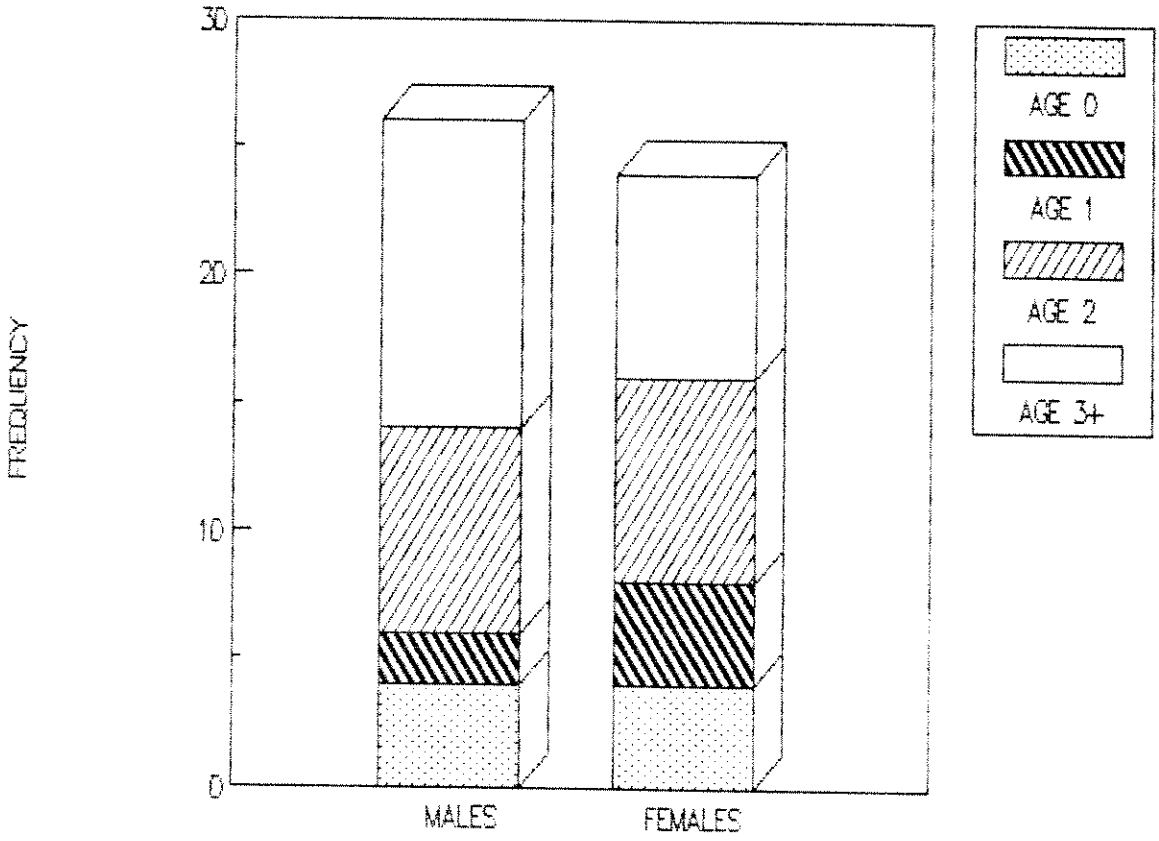


Figure 1: Cumulative age-structure of *M. vancouverensis* at time of first capture, 1987-1990.

not possible with existing data: small samples lead to expected cell frequencies <5 and invalid results.

That so few (n=10) young-of-the-year have been captured during the project can be explained both by lack of reproduction in some years, and by my unwillingness to attempt trapping of infants until comparatively late in any given season. However, I remain disturbed by the small number (n=8) of yearling marmots trapped throughout the project. Three factors may contribute to this. Obviously, low survivorship of infant marmots reduces the number available for re-capture one year later. In addition, preferential dispersal by yearling marmots would have the same effect on my data. Finally, over-estimated marmot age at time-of-first-capture (as would be the case if some presumed two-year-old marmots were in fact yearlings) would also depress yearling totals. All three of these factors may have influenced my data.

Family group persistance:

Data from 1987 through 1990 show differential persistance of family groups in "natural" and "slash" colonies (use of the same burrow in consecutive years by *at least* one member of a family group is defined as "persistance"). Pooled data from Haley/Green and Pat Lake/Haley-slash colonies indicate that family groups in "natural" colonies are more likely to persist from year-to-year (χ^2=5.44 with 1 df, $p<0.05$; see Figure 2).

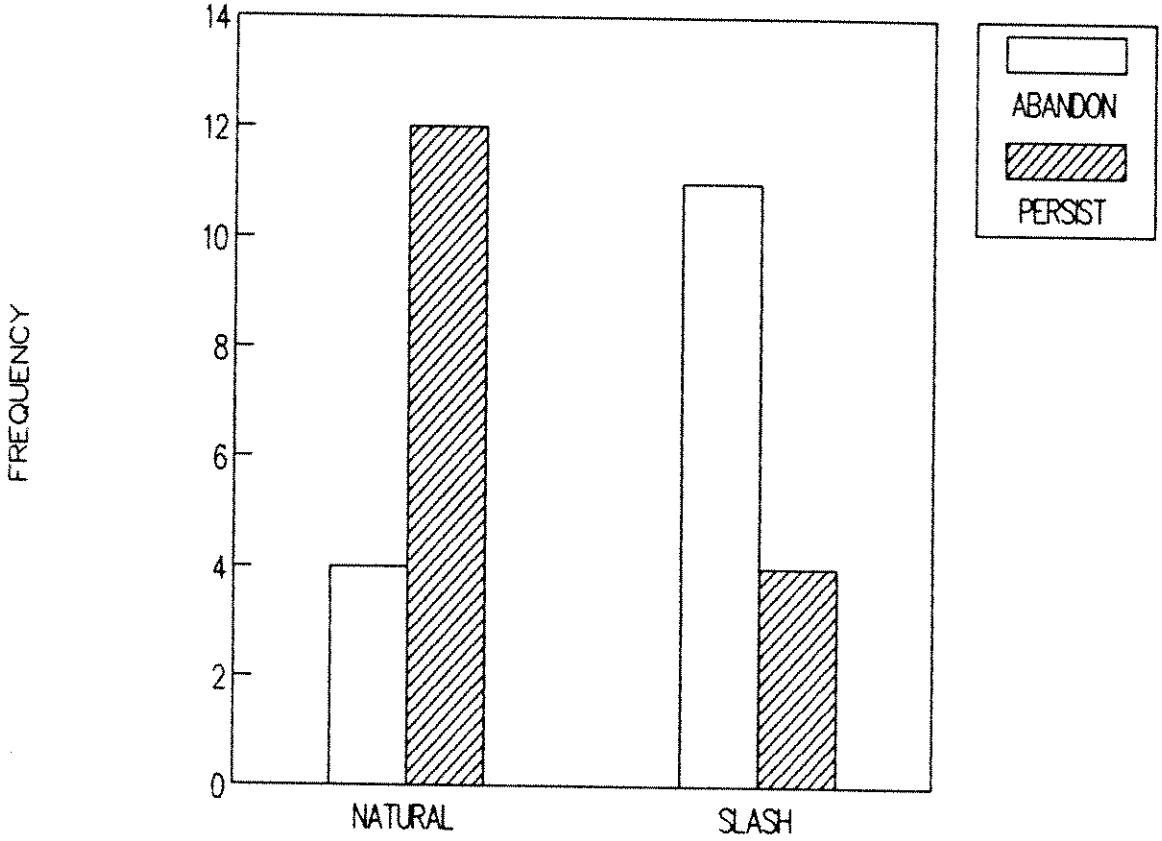


Figure 2: Persistance of family groups using "natural" and "slash" burrows. Persistance is defined by use of a given burrow in consecutive years by *at least* one member of a family group.

This effect is quite noticeable in the field. The probability of my finding *at least* one marmot from a given family group using the same burrow as it did the previous year is about 75% at the Green Mountain and Haley Lake colonies (n=16 cases), but only 27% at Pat Lake and Haley "slash" (n=15 cases). Such a result implies either differential survivorship, or dispersal, between the studied "natural" and "slash" marmot colonies.

Individual survivorship:

Mark-recapture data show differences in year-to-year survivorship of "natural" versus "slash" individuals (Figures 3 and 4). Unfortunately, available data are still too sparse to determine whether this is a "real" population trend or a sampling artifact. Data are summarized in Table 1: raw data are included as Appendix I.

Based on marked animals for which I have overwintering data (i.e., excluding "first-time" captures from 1990), infants show a 50% survival rate to yearling age. However, sample sizes are extremely small (n=2) for each of the four classes (i.e., "natural" males, "natural" females, "slash" males, and "slash" females). Data based on total number of infants observed (not necessarily captured) and total number of yearlings observed one year later suggest substantially lower first-year survivorship rates (7/21 or 33% in "natural" colonies, and 4/17 or 23% in "slash" colonies).

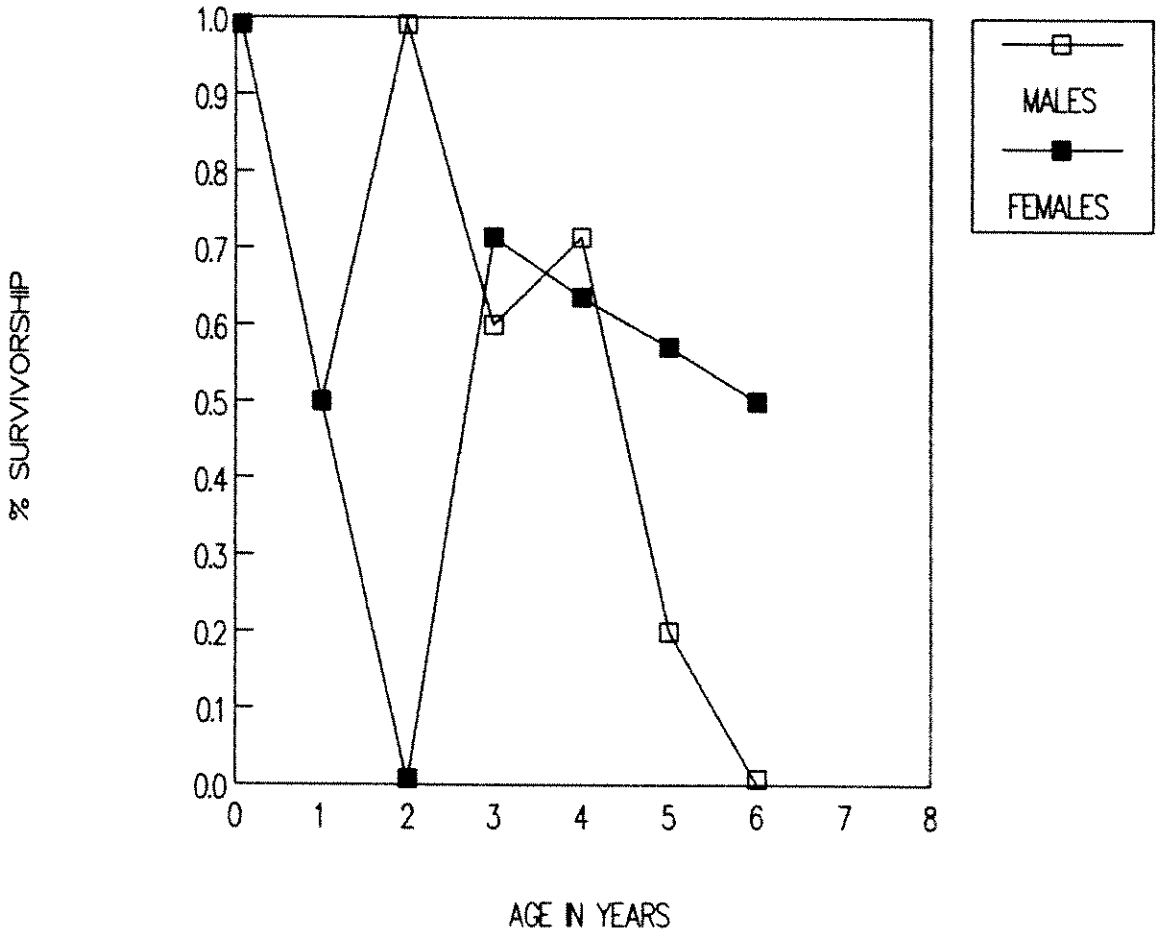


Figure 3: Age-specific survivorship of *M. vancouverensis* in "natural" colonies. Data are based on n=26 marked animals and three years of observation.

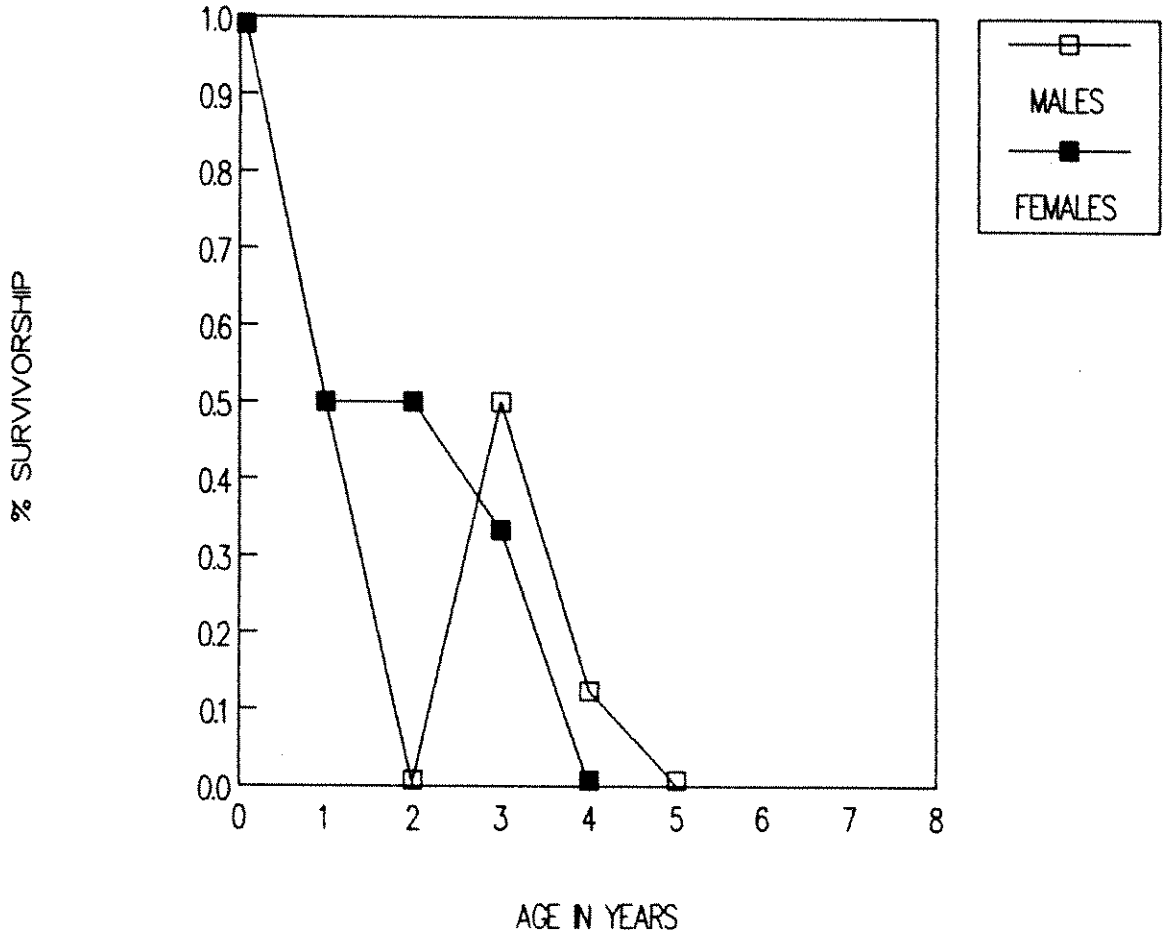


Figure 4: Age-specific survivorship of *M. vancouverensis* in "slash" colonies. Data are based on *n*=22 marked animals and two years of observation.

Table 1: Survivorship of marked *M. vancouverensis*, 1987-1990.

Sex and assigned age at 1st capture	*n*[a]	estimated age at recapture[b] 1-2	2-3	3-4	4-5	5-6	6-7
"natural" colonies[c]							
infants	2(2)[d]	1(1)	0(1)	0(0)			
yearlings	1(0)		0(0)	0(0)	0(0)		
2-year-olds	7(4)			5(3)	2(3)	1(0)	
3-year-olds+	6(4)				5(2)	3(1)	2(0)
"slash" colonies[e]							
infants	2(2)	1(1)	1(0)				
yearlings	3(0)		1(0)	1(0)			
2-year-olds	1(4)			0(2)	0(1)		
3-year-olds+	2(8)				0(0)	0(0)	
Total *n*	24(24)						

[a] See Bryant (1990) for aging criteria. Seven animals which were "first-time" captures in 1990 are not included in these data.

[b] Animals were often "recaptured" with spotting scope only. Given ear-tag loss and dispersal, these data represent minimum survivorship rates.

[c] Pooled data from Haley Lake and Green Mountain.

[d] Numbers in parentheses are males.

[e] Pooled data from Haley "slash" and Pat Lake. Note that the latter site has only been studied since 1988.

Estimated survivorship of yearlings is also biased by small number of marked animals (n=10). For example, persistance of a single "natural" yearling male leads to a rather unlikely estimate of 100% survivorship, while disappearance of two females result in the similarly improbable estimate of 0% survivorship. Overall, current estimates of survivorship in young (infant and yearling) marmots are of little value.

Data for older animals are somewhat better developed. Plots of age-specific survivorship rates suggest that two-year-and-older marmots survive more successfully in "natural" than "slash" colonies (Figures 3 and 4). Pooled data for adult marmots yield average year-to-year survival rates of 56% and 19% respectively. However, note that these rates are again based on small numbers of marked individuals (data for n=19 and n=13 adults respectively).

In addition, all but one "slash" animal was captured from the Pat Lake site after 1988 (work at Green Mountain, Haley Lake and Haley "slash" colonies began in 1987). Thus, I am essentially comparing "natural" sites, from which I have three years of overwintering data, with two years of data from "slash" marmots. Given methods of assigning age to marmots (Bryant 1990), one obvious result is that "natural" marmots could be a maximum of seven, while "slash" marmots could only be a maximum of six years old. A less obvious, but more critical, result is a substantial descrepancy in the number of cases in which tagged marmots *could be* alive

one year after marking (n=47 possible cases from "natural" colonies, but only n=21 cases from "slash").

Given these small samples, I have not attempted age-specific or sex-specific comparisons of survivorship. Perhaps due to sample sizes, the apparent difference in survivorship of two-year-and-older marmots in "natural" versus "slash" colonies (i.e., 56% versus 19%) is not significant (X^2=2.51 with 1 df, $p>0.05$).

Reproduction:

Marmots displayed poor reproductive performance in 1990. Only one litter of three was observed (by "Oprah" at Haley Lake). Average litter sizes therefore remain essentially unchanged from Bryant (1990); "natural" litters average 2.9 infants (range of two to three) and "slash" litters average 3.6 infants (range of three to four; see Table 2). Mann-Whitney U-test shows this difference to be significant ($U_{(5,9)}$=41, $p<0.05$). Litters of four are more common in "slash" colonies.

First reproduction by female *M. vancouverensis* may be at age three in the wild. Female #907908 (at Pat Lake), a presumed yearling in 1988, was recaptured in full reproductive (lactating) condition in 1989. However, this appears to be exceptional. One known three-year-old female (#901902, an infant in 1988), and five others which must be *at least* three-years-old, have *not* yet reproduced. Mean age-of-first-reproduction may therefore be closer to four than

Table 2: Fecundity of *M. vancouverensis* at "slash" and "natural" colonies, 1987-1990.

	n of litters	mean litter size	range	fecundity[a]	s.e.
"Natural" colonies	9	2.89[b]	2-3	0.96	0.29
"Slash" colonies	4	3.60[b]	3-4	1.87	0.84
All colonies	13	3.14	2-4	1.14	0.28

[a] fecundity is expressed as total number of young (of both sexes) produced/adult-female-year. An "adult-female-year" is one reproductive-age female alive in one year.

[b] litter size is significantly larger in "slash" colonies as determined by Mann-Whitney *U*-test ($U_{(5,9)}=41$, $p<0.05$).

three. Unfortunately I cannot test this with existing data, precisely because my aging methods assume that a reproductive female is at least three-years-old. Adult female #1820 ("Betsy") from Green Mountain remains the only animal known to have produced more than one litter (in consecutive years, 1987 and 1988).

Estimated female fecundity rates for both "natural" and "slash" females are given in Table 2. These are expressed as average-number-of-young-produced/adult-female-year, in which an "adult-female-year" is simply an ear-tagged, age-three-or-older female known to be alive in one year. Using these criteria, the average per-adult-female-year productivity of "natural" females is 0.96 young; for "slash" females it is 1.87 young. Assuming equal sex-ratio of infant marmots, respective fecundity estimates are 0.96/2=0.48 *female* young/adult-female-year and 1.87/2=0.93 *female* young/adult-female-year.

Note that the fecundity estimate for "slash" females is biased by small total number of adult-female-years (n=5). In addition, due to high disappearance rate of adult females from year-to-year at Pat Lake, only n=2 adult-female-years represent non-reproductive females. The resulting fecundity rate is therefore almost certainly overestimated. Not unexpectedly, a Mann-Whitney U-test shows the apparent difference between "slash" and "natural" fecundities to be non-significant ($U_{(5,24)}$=77, p>0.05).

DISCUSSION

Overall, 1990 was a mediocre year for marmots at the four study colonies. Low reproductive rate, poor trapping success at Haley "slash", and decline of the Pat Lake colony all combined to limit numbers of "new" marmots captured and released this year.

Persistance data continue to show that "slash" family groups use burrows less consistently from year-to-year than those inhabiting higher elevation "natural" habitats (see Bryant 1990). Age-specific survivorship also appears to be lower in "slash", although data are still too sparse to convincingly demonstrate that this is a "real" population trend and not an artifact produced by small samples.

The argument has been made (G.W. Smith, BCMOE, pers. com.) that my choice of "slash" study colonies is biased because both are relatively new. Marmots were first observed at Haley "slash" in 1985 (one animal seen), and at Pat Lake in 1986 (Smith *et al.* 1986). This is a valid point; possibly it takes several years for a new colony to develop consistent patterns of burrow-use which, in turn, permit higher family-group persistance and individual survivorship.

My results could therefore be considered to reflect a rather unfair comparison of "established" versus "new" colonies. On the other hand, given forest regeneration in "slash" environments (which is, after all, the point of forest management), presumably few "slash" habitats would

persist long enough to allow colonies to remain "established" for any length of time. The Butler Peak "slash" colony, which has existed for almost ten years, is clearly exceptional in this regard.

Observations of marmot behavior at Pat Lake suggest that thermoregulation may limit overall habitat availability. Daily movements from sunlit to shaded areas support the ideas of Türk and Arnold (1988), who proposed that higher temperatures at lower elevations force marmots to curtail daily foraging patterns, resulting in decreased seasonal growth and overwintering survival. In fact, measurements of Pat Lake marmots do not suggest slower-than-normal growth rates at this site (quite the reverse is true; see Bryant 1990); however, the observed behavior could explain why many "slash" habitats at lower elevations have *not* been colonized by *M. vancouverensis*.

Mean age-of-first-reproduction in females is probably closer to four than three years. Maximum age of *M. vancouverensis* in the wild is now known to be *at least* six years, but could be considerably higher. In only one case has an ear-tagged female produced more than one litter (consecutive litters by "Betsy" at Green Mountain in 1987 and 1988), although one female in captivity has also apparently done so (Munro *et al.* 1985). The hypothesis of alternate-year reproduction by females is not supported by existing data, despite observations of eleven females either known or presumed to be *at least* three years old (n=29

adult-female-years). Average female lifelong reproductive contribution may therefore be only two litters.

Litters of four are more common in "slash" habitats, but female fecundity rate is not significantly greater. This is the necessary consequence of annual disappearance of most "slash" adult females, and resulting small number of adult-female-years in this category (n=5). Assuming that marmots neither disperse as infants or as yearlings in the very early spring, family-group persistance data and individual survivorship observations indicate that few young survive their first winter in either "slash" or "natural" habitats.

In conclusion, the two studied "slash" colonies appear to provide similar numbers of potential dispersers, but poorer conditions for family-group persistance, and (possibly) reduced individual survivorship in comparison to the two "natural" colonies. Despite limitations of sample size, data therefore tend to support the "sink" hypothesis presented by Bryant (1990). Why this could be so, or whether a "sink" effect applies generally to other "slash" colonies, are questions which remain unanswered. Differential survival due to hibernacula microclimate, or levels of predation, are two hypotheses which need to be tested.

LITERATURE CITED

Borland International. 1987. Quattro: the professional spreadsheet. (Scotts Valley, Ca.).

Bryant, A.A. 1990. Genetic variability and minimum viable populations in the Vancouver Island marmot (*Marmota vancouverensis*). M.E.Des. Thesis (U. of Calgary). 101 pp.

Fry, K.S., J.A. Morgan and G.W. Smith. 1986. Vancouver Island Marmot Inventory-1986. Unpublished report, B.C. Fish and Wildlife Branch (Nanaimo). 68 pp.

Munro, W.T., D.W. Janz, V. Heinsalu and G.W. Smith. 1985. The Vancouver Island Marmot: status and management plan. B.C. Ministry of Environment Wildlife Bulletin B-39. (Victoria). 24 pp.

Sokol, R.R., and F.J. Rohlf. 1981. Biometry. W.H. Freeman and Company (New York). 859 pp.

Zar, J.H. 1974. Biostatistical Analysis. Prentice-Hall (New York). 620 pp.

Appendix I: Marmot survivorship at four colonies, 1987-1989.

KEY:

o =initial capture

+ =positive identification (recapture or confirmed tags)

x =young-of-the year which were not captured but where location of birth was certain.

? =non-positive identification because of ear-tag loss or damage.

* =animals positively identified one year before initial capture from pelage characteristics, scars etc.

– =no later observation of the animal.

Green Mountain

Family	tags	sex	age	1987	1988	1989	1990	Name
Betsy	1820	f	3	o	+	+	+	Betsy
" "	2726	m	3	o	+	–	–	O. Knox
" "	1514	?	0	o	–	–	–	
" "	1617	?	0	o	–	–	–	
" "		–	0	x	–	–	–	
" "		–	0		x	+	–	
" "		–	0		x	–	–	
" "		–	0		x	–	–	
Rocky	1312	f	3	o	+	+	+	R. Raccoon
" "	2522	m	3	o	+	+	–	F. Tuck
" "	923924	f	0		o	+	–	Delilah
" "	926927	m	0		o	+	+	Samson
" "		–	0		x	–	–	
Total *n* of adults				4	4	4	3	
Total *n* of young				3	6	0	0	
n of reproductive incidents				1	2	0	0	

Haley Lake

Family	tags	sex	age	1987	1988	1989	1990	Name
Triangle	3334	f	3	o	+	–	–	Tonto
" "	–	?	0		x	+	–	
" "	–	?	0		x	–	–	
" "	–	?	0		x	–	–	
" "	6162	m	3	*	o	–	–	Oscar
" "	2829	m	2	o	+	+?	–	H. Comet
" "	3132	f	2	o	+	–	–	Blackie
" "	3738	m	2	o	–	+	–	Boss
" "	3536	f	2	o	+	+	+	Oprah
" "	0506	m	0				o	Meanie
" "	0304	m	0				o	Zen
" "	–	?	0				x	
" "	1112	m	3				o	Dillenger
" "	941942	m	3				o	Einstein
Mom #1	5354	f	3		o	+	+	Mom #1
" "	4748	m	3	*	o	+	–	Cardinal
" "	–	?	0		x	+	–	
" "	–	?	0		x	–	–	
" "	–	?	0		x	–	–	
Mom #2	6970	f	3		o	+	–	Mom #2
" "	4950	m	2		o	–	–	No-name
" "	7172	f	2	*	o	+	+	Live-wire
" "	6364	m	2	*	o	+	+	Newfie
" "	–	?	0	x	–	–	–	
" "	8586	f	1	x	o	–	–	yrling #1
" "	–	?	0		x	+	–	
" "	–	?	0		x	+	–	
" "	–	?	0		x	–	–	
Mom #3	7879	f	3		o	–	–	Mom #3
" "	–	?	0		x	–	–	
" "	–	?	0		x	–	–	
" "	–	?	0		x	–	–	
" "	909910	f	2			o	+	Luna
" "	976977	f	2			o	–	Tweedledum
" "	978979	f	2			o	+	Alice
" "	980981	f	2			o	–	Tweedledee
Total *n* of adults				9	11	9	8	
Total *n* of young				2	12	0	3	
n of reproductive incidents				1	4	0	1	

Pat Lake

Family	tags	sex	age	1987	1988	1989	1990	Name
Endrock	919920	f	3		o	–	–	
" "	901902	f	0		o	+	+	GIJoe
" "	903904	m	0		o	+	–	
" "	905906	m	0		o	–	–	
" "	913914	f	0		o	–	–	
" "	957958	m	4			o	–	
" "	959960	m	3			o	–	
" "	961962	m	3			o	–	
Midrock	955966	f	3			o	–	
" "	911912	m	3		o	–	–	
" "	915916	m	2		o	+	–	
" "			0			x	–	
" "			0			x	–	
" "			0			x	–	
" "			0			x	–	
" "	943944	f	2				o	
" "	945946	f	3				o	Goldilocks
Triangle	907908	f	1		o	+	+	Cher
" "	932933	f	1		o	–	–	
" "	934935	f	1		o	–	–	
" "	928929	f	2		o	+	+	Sundance
" "	917918	m	3		o	–	–	
" "	921922	m	4		o	–	–	
" "	951952	m	2			o	–	
Apex	953954	m	3			o	–	
" "	930931	m	3			o	–	
" "	963964	f	2			o	–	

Total *n* of adults identified	>9	>10	5
Total *n* of young identified	>4	4	0
n of reproductive incidents	>2	1	0

Haley Slash

Family	tags	sex	age	1987	1988	1989	1990	Name
Tophat	4243	m	2	o	–	–	–	Sylvester
" "			2	+	–	–	–	Eyebrows
Patches		m	3		*	+	–	Patches
" "	1516	m	2				o	Ernie
Red-tail		f	3		*	+	+?	Red-tail
" "			1		*	–	–	Apex
" "			0		x	+?	+?	
" "			0		x	+?	+?	
" "			0		x	–	–	
" "			0			x	+?	
" "			0			x	–	
" "			0			x	–	
" "			0			x	–	
Menza		f	3		*	–	–	Menza
" "			0		x	–	–	
" "			0		x	–	–	
" "			0		x	–	–	
Total adults identified				2	4	4	5	
Total young identified				0	6	4	0	
n of reproductive incidents				0	2	1	0	