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Victoria, British Columbia

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SUMMARY

The Vancouver Island marmot (Marmota vancouverensis) is the rarest of all the North American species of marmot; it exists solely on Vancouver Island. In March 1980, it was officially designated an endangered species by Order in Council of the Province of British Columbia. Active management of the Vancouver Island marmot has occurred only recently. Information on distribution, population trends, biology, and habitat requirements initiated in the 1970's is receiving greater attention in the 1980's. Surveys in recent years and observations of some of the well-known colonies indicate that the Vancouver Island marmot population has increased in both numbers and distribution since the early 1970's.

The ultimate goal of the Vancouver Island marmot management plan is to establish and maintain the population of Vancouver Island marmots at a level and distribution that provides a reasonable likelihood of long-term survival of the species. Specific objectives of the management plan are:

(1) to ensure that six distinct reproducing populations are in existence by 1985 and ten by 1990,

(2) to secure habitat for key marmot colonies and prevent alienation and alteration of known marmot habitat,

(3) to maintain one small captive breeding colony,

(4) to encourage and support approved scientific research, and

(5) to encourage public participation in various aspects of the program and to keep the public informed of progress.

Implementation of the activities associated with each objective are detailed in the plan. The plan will be modified periodically in response to increasing knowledge, implementation progress, availability of funding, and management priorities.

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1.0 INTRODUCTION

The Vancouver Island marmot is one of 14 living species of marmots in the world (Barash 1974a). Six of the species live in North America and four of these in British Columbia (Cowan and Guiguet 1965; Frase and Hoffman 1980). The Vancouver Island marmot is the rarest of all the North American species and exists solely on Vancouver Island.

In 1973, the Vancouver Island marmot was given legal protection under the Wildlife Act. In 1979, it was given the status of endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), and, following the publication of "The Preliminary Plan for the Designation of Threatened and Endangered Species in British Columbia" (Munro and Low 1979), it was officially designated an endangered species by Order in Council in March 1980.

The purpose of this document is to collate information specific to the Vancouver Island marmot and other closely related species, to review the current status of the species, and to formulate a plan for management of the Vancouver Island marmot.

1.1 Description and Taxonomy

The species was discovered in 1910 and described by Swarth (1911) from 11 adult specimens taken from the King Solomon Basin, Golden Eagle Basin, and Mount Douglas south of Port Alberni.

Freshly molted animals are very dark brown with patches of white on the muzzle, forehead, and breast. The dark colour gradually fades until the fur is replaced at the next molt (Heard 1977). Adults generally weigh between 3-6 kg with a doubling of weight between emergence in the spring and the onset of hibernation in the fall (Heard 1977).

The Vancouver Island marmot is one of three closely related marmot species, all three of which may be considered in one superspecies (Hoffman et al. 1979). It is from studies of the hoary marmot (M. caligata) and the Olympic marmot (M. olympus) that we have gained much of our preliminary information for the Vancouver Island marmot.

1.2 Biology

Although intensive studies have been made of the yellow-bellied marmot (Marmota flaviventris) in western North America (Armitage 1973, 1977; Armitage and Downhower 1974; Andersen et al. 1976; Nowicki and Armitage 1979), fewer studies have been made of the Olympic and hoary marmots, and fewer still of the Vancouver Island marmot.

1.2.1 Hibernation

Marmots hibernate during the winter, the duration depending upon the altitude and latitude. Olympic marmots usually begin hibernation between mid-September and mid-October, and emerge in mid-May (Barash 1973). Barash (1976) also reported adult males and non-maternal adult females were the first to hibernate, followed by the yearlings, and finally maternal adult

females and their infants. Holmes (1979) reported emergence during the first week of May for hoary marmots in Alaska. For the Vancouver Island marmot, Heard (1977) considered emergence to be early May and hibernation of most individuals to begin by mid-September. However, there are many records of marmot sightings in late September and early October on file in the Region 1 Fish and Wildlife office. Our own observations suggest emergence of adults may occur as early as mid-April and some animals are known to be above ground until mid-October. Captive Vancouver Island marmots held at the Okanagan Game Farm near Penticton emerge in mid-April and are underground by late September (E. Lacey and O. Dyer, pers. comm.).

1.2.2 Population dynamics

Information on breeding biology is scarce. Copulation apparently takes place after emergence in the spring. Young Olympic marmots are born in late June and first appear above ground in late July (Barash 1973). Heard (1977) reported two litters of Vancouver Island marmots emerging for the first time on July 11. Swarth (1912) reported that several of the six adult females collected in the Mount Douglas area were lactating, but no infants were seen by the third week of July. The Fish and Wildlife survey crew observed two infant marmots on 1982 June 29.

Both hoary and Olympic marmots first breed as three-year-olds, and produce litters in alternate years (Barash 1973, 1974b; Holmes 1979). Heard (1977) believed the same was true for Vancouver Island marmots. Average litter sizes are similar, being 3.8 (n=38) in the Olympic marmot (Barash 1973; Wood 1973), 3.4 (n=8) in the hoary marmot (Holmes 1979), and 3.0 (n=5) in the Vancouver Island marmot (Heard 1977).

Dispersal, "the movement of an individual from its place of birth to its place of reproduction" (Shirer and Downhower 1969), begins in the Olympic marmot about 25 days after emergence of the two-year-olds, and seems inversely related to winter mortality (Barash 1973). The same author also suggested the greater the number of animals in the colony, the greater the chance of dispersal. The higher the winter mortality in the colony, the less likely are two-year-olds to disperse. Holmes (1979) found two-year-old hoary marmots in the harsh climate of Alaska dispersed only if their dam had another litter. Dispersing marmots of both sexes can cover long distances through a variety of habitats and elevation, over 13 km and occasionally down to sea level in the case of Olympic marmots (Barash 1973). Sightings of isolated Vancouver Island marmots in unusual locations are undoubtedly a result of such dispersal (Smith 1982). Non-dispersing movements rarely exceed 500 m in both hoary marmots (Holmes 1979)and Olympic marmots (D.P. Barash, pers. comm.).

There are several natural predators of marmots. The following species, which occur on Vancouver Island, have been known to prey on marmots: cougar (Felis concolor; Barash 1973; Heard 1977), wolverine (Gulo gulo), golden eagle (Aquila chrysaetos; Holmes 1979; Noyes and Holmes 1979), and probably red-tailed hawk (Buteo jamaicensis), goshawk (Accipter gentilis), wolf (Canis lupus), and possibly black bear (Ursus americanus), and bald eagle (Haliaeetus leucocephalus). Predation has not been shown to be a significant factor elsewhere. The accidental introduction of cottontail rabbits (Sylvilagus spp.) near Victoria in 1964/65, and their subsequent spread north, may attract more aerial predators, especially golden eagles, which may have an effect on small marmot colonies (Merilees 1980).

The major source of mortality appears to occur over winter, especially in the young and old animals. Holmes (1979) reported 37.5% winter mortality in young hoary marmots and Barash (1973) about 50% in young Olympic marmots. Winter mortality in Olympic marmots was inversely correlated with snow depth, presumably because of the insulating qualities of snow. However, Wood (1973) suggested precipitation (both snow and rain) was the greatest factor affecting population size in Olympic marmots because it affected the plant communities and thus the condition in which marmots entered hibernation.

1.2.3 Social organization

All three species live in colonies that vary from 2 to 16 animals before the young emerge. The average colony size before young emerge is 6.8 (n=12) in the Olympic marmot (Wood 1973), 8.3 (n=2) in the Vancouver Island marmot (Heard 1977), and 4.4 (n=16) in the hoary marmot (Holmes 1979). From the same authors, it appears that colonies are usually composed of one adult male, one or two adult females, some one- or two-year-olds, and some infants. Barash (1973) found that the most common colony make-up was one litter of infants, one litter of one-year-olds, one adult male, and two adult females. A similar situation probably occurs on Vancouver Island.

The geographic area occupied by a colony is not large. Heard (1977) reported colonies of Vancouver Island marmots of 3 ha and 4.5 ha in area. Barash (1973) determined the average area to be about 2.2 ha in the Olympic marmot, whereas Holmes (1979) found the average range to be about 13.8 ha in the hoary marmot. In the latter two studies, the authors found only one hibernaculum per colony. The mean distance between hibernacula in Olympic marmots was 250 m (n=6) and 449 m (190-520; n=6) in the hoary marmot.

Kilgore and Armitage (1978) defined a yellow-bellied marmot colony as "... a social grouping of marmots consisting of one or more polygamous units and some nonreproductive individuals (yearlings and young) occupying a circumscribed habitat." Holmes (1979) found hoary marmots in his study area in Alaska to be monogamous. Both the hoary and Olympic marmots also had nonreproductive two-year-olds associated with colonies. Holmes (1979) reported 10 of 11 colonies bounded on one or two sides by other colonies resulting in a nearly continuous distribution. Each colony was defended when its circumscribed area was violated by a member of a neighbouring colony. Such violations were infrequent. Wood (1973) found the number of burrows per colony of Olympic marmots to average 53 (13-79, n=11) or an average of 5.5 burrows per marmot (adults and juveniles only). Burrows for both species contained one hibernaculum, sleeping burrows, and short refuge burrows.

A review of the data for Vancouver Island presented in Heinsalu and Smith (1982) gave a comparable figure of 3.1 burrows per marmot although their inventory did not concentrate on sightings of animals. Considering that colonies may contain only one breeding female and alternate year breeding is likely, we will define a colony as a circumscribed habitat that, within a three-year-period, contains:

1. two or more marmots with evidence of reproduction determined by either verification of present use of historic colonies which implies population recruitment or direct observation of infants or yearlings; or,

2. five or more individuals in any single year as determined by direct observation.

A potential colony is defined as having, in a three-year-period, no signs of reproduction and fewer than five individuals.

As reported above, the geographic area occupied by colonies is small, and non-dispersing marmots are not known to wander more than 500 m from their colony. Thus, colonies separated by distances greater than that may be considered to be distinct. Therefore, we will define a colony complex as a grouping of two or more colonies, none of which are separated from their nearest neighbour by more than 500 m. Genetic interchange among colonies within a complex is probably common. Colonies or colony complexes separated by more than 500 m likely obtain genetic interchange only infrequently through dispersing two-year-olds, the frequency depending on the distance and terrain between the complexes and overwinter survival. In cases where the separation between colonies or complexes is less than 1 km horizontally, and less than 500 m vertically, the interchange is likely more frequent and the complexes may be considered to be part of a single subpopulation. We will use distinct subpopulation to mean a grouping of two or more colonies or colony complexes separated from their nearest neighbour by more than 1 km horizontal distance or 500 m vertical distance. Situations exist where only one colony or colony complex is documented, but can be considered a distinct subpopulation, due to long-term existence and isolation from other known colonies.

1.2.4 Habitat requirements

Food preferences for Olympic marmots have been described by Barash (1973) and Wood (1973) and for hoary marmots by Holmes (1979). Forbs and grasses, especially the flower parts, are preferred. Heard (1977) reported similar findings for the Vancouver Island marmot. Steep slopes appear necessary to provide food in the early spring when marmots first emerge from hibernation, as the majority of the area is often snow-covered and food is restricted to areas free of snow (Barash 1973; Heard 1977; Holmes 1979). Milko (1984) found that Vancouver Island marmots in subalpine habitats selected for grasses in spring and shifted to forbs during the summer.

Traditionally, Vancouver Island marmots have been reported inhabiting a specialized subalpine habitat characterized by talus debris, steep slopes, and lush, open areas. These areas generally occur between 975 m (3200 ft.) and 1430 m (4700 ft.) elevation, and usually exhibit a southern exposure (Swarth 1911; Carl 1944; Hardy 1954; Heard 1977). The plant communities are typical of the Parkland subzone of the Mountain Hemlock Biogeoclimatic Zone (Brooke et al. 1970). The slope (35-95%) and rock bluffs encourage snow creep and snow slide, thereby inhibiting the establishment of trees within the meadow areas. Adjacent tree growth consists of mountain hemlock (Tsuga mertensiana), yellow cedar (Chamaecyparis nootkatensis), subalpine fir (Abies lasiocarpa), and slide alder (Alnus sitchensis). The predominant feature of this specialized habitat is the diversity of forbs and grasses, providing a good food source.

Recently, however, we have found Vancouver Island marmots in areas other than traditional subalpine habitats. One type of habitat is openings created by clearcut logging. Within the cutovers, marmots have utilized the logging

debris for cover, shelter, and look-out spots. These newly opened areas have encouraged diverse plant forms to develop, supplying herbaceous food species. In 1984, eight colonies in five locations, consisting of 56 marmots including 25 young, were located in logging slash as low as 850 m (Smith et al. 1984). Although clearcuts in young primary stages provide a seemingly adequate habitat, they are subject to seral succession. It is unknown how long logging openings will be used by marmots.

Vancouver Island marmots appear to have successfully utilized habitat created for ski runs. These ski runs act as artificially created subalpine habitat, providing the marmot's requirements of food and shelter. This habitat is more stable than logging cutovers because the ski operators periodically remove trees and excessive shrub growth. The removal of this growth retards seral succession, encouraging the ground-layer plant forms to flourish. The Green Mountain marmot colony is a prime example of the Vancouver Island marmot's ability to live successfully within a ski area. Between 1973 and 1983, the Vancouver Island marmot expanded its distribution and abundance over much of the mountain, while over the same period ski operations were expanded.

In addition to cutovers and ski runs, used burrows and active Vancouver Island marmot sign have been found within timber stands and alder slides that are close to subalpine meadows. The increase in reported sightings of marmots outside traditional habitat may be a function of expanding population or improved inventory technique. Presently, it appears subalpine habitat will continue to support major concentrations of the Vancouver Island marmot. The population of Vancouver Island marmots within the newly reported habitat types will most likely fluctuate in response to the relatively rapidly changing habitat and winter weather conditions.

2.0 DISTRIBUTION AND ABUNDANCE

2.1 Historical (1900-1978)

Historically, the Vancouver Island marmot was not widely distributed nor abundant. Swarth (1912) did not find any on Mount Arrowsmith or on the mountains northwest of Great Central Lake. In 1931, Kenneth Racey and Ian McTaggart-Cowan collected six marmots from the Haley Lake colony. They were also told of marmots on Mount Buttle, but were unable to verify the report (I. Cowan, pers. comm.). Munro (1933) makes reference to a "Marmot Mountain" near Shaw Creek but does not specifically mention marmots. In 1938, I. Cowan (pers. comm.) reported seeing and hearing marmots on Mount Arrowsmith, in addition to locating occupied burrows on the northeast face. Carl (1944) reported animals from Mount Washington, Forbidden Plateau, Jordan Meadows, and the head of Shaw Creek. In 1942, a small colony on Mount Washington, and one active burrow and one animal on Mount Strata were reported by Hardy (1954). Finkelstein and Darling (1973) found marmots only at Heather Mountain. In 1973 and 1974, Heard (1977) recorded two colonies near Haley Lake, two on Green Mountain, and one each on Mount Washington, Butler Peak, Heather Mountain, and Gemini Peak.

Several authors have estimated the total historic population. Based on old reports, conversations with individuals, and museum records, Carson (1978) suggested 25 colonies existed historically. Munro (1978) suggested colonies existed historically on 12 separate mountains. Several other unpublished records, from prior to 1978, are held at the Nanaimo office of the Fish and Wildlife Branch, including a number of sightings by staff. Based on the above information through 1977, Munro (1978, 1979) estimated a population in 1977 of between 50 and 100 animals, distributed in five colonies on four separate mountains.

2.2 Current (1979-1984)

Regular surveys to locate sites occupied by Vancouver Island began six years ago. In the summer of 1979, three students were hired by the Vancouver Island Marmot Preservation Committee (a committee formed by the Federation of B.C. Naturalists), funded by a Canada Works Grant, with additional support from the Fish and Wildlife Branch and the Public Conservation Assistance Fund. Work was carried out under the auspices of that group or its successors for three summers. Routledge and Merilees (1980) reported 45 marmots and 166 burrows seen during inventories in 1979. Routledge (1981) reported 94 marmots and 225 burrows in field studies in 1980. In the 1981 field season, he reported 87 marmots and 222 burrows (Routledge 1982).

Fry (1981) reported marmots on three of six sites investigated for the Canadian Wildlife Service. A summary of status of the marmot up to 1981 was reported by Smith (1982).

The most detailed and systematic survey to locate areas occupied by marmots was conducted in 1982 by Heinsalu and Smith (1982). The inventory concentrated on active burrows, with sightings of marmots used as supplementary information. Twenty-two areas were thoroughly searched. A total of 409 active burrows was found and 148 marmots observed, including 16 infants (Table 1). Using the same survey techniques in 1983, the same

Table 1. Vancouver Island Marmot surveys, 1979 - 1984.

Colony or potential colony no.	colony	Number of marmots counted 1979[1]	1980[1]	1981[1]	1982[2]	1983[2]	1984[2]
COLONIES:							
1	Green Mt. ski hill, top	5	20(16Y[3])	9(7Y)	8(3Y)	10(5Y)	5
2	Green Mt. southeast talus	2	3	4(2Y)	2	5	2
3	Green Mt. northwest ridge	2	7(4Y)	8(4Y)	7	3	5
4	Green Mt. elk meadow					1	6(4Y)
5	Green Mt. west green		5(4Y)	8(2Y)	7	5	2
6	Green Mt. south slope		5(3Y)	3(1Y)	5(1Y)	7	5
7	Green Mt. road K44 A					10	11(5Y)
8	Haley Lk., bowl	11	15(3Y)	14(2Y)	24(4Y)	24(4Y)	18(6Y)
9	Haley Lk., Bell Ck.	3	3(2Y)	9(3Y)	10	13(4Y)	16(4Y)
10	Dunsmuir Ck. south fork, road G2C				2	1	5(4Y)
11	Dunsmuir Ck. south fork, Westerholm basin	6	2(1Y)	4(1Y)	9	9	17(3Y)
12	Dunsmuir Ck. south fork, Westerholm, meadow 1				4(2Y)	2	3
13	Bell Ck.: north				6	1	2
14	Dunsmuir Ck. middle fork, road DBE						15(7Y)
15	Dunsmuir Ck. north fork, road D					1	5(3Y)
16	Butler Peak east alder slide		1		2	3	6(3Y)
17	Butler Peak west	3	6(1Y)	6(1Y)	7	5(3Y)	13(4Y)
18	Butler Peak road K43E					9	9(4Y)
19	Butler Peak road K43F						6(2Y)
20	"P" Mt. south basin		5(3Y)		1	5	5
21	"P" Mt. north	8	1	3(1Y)	6	1	7(4Y)
22	"P" Mt. west				1	2	5(2Y)
23	Gemini Peak		17(9Y)	14(4Y)	16	16	11(3Y)
24	Mt. Buttle		1		3	4(1Y)	7(2Y)
25	Mt. Heather	1			1	3(1Y)	7(3Y)
26	Mt. Hooper	3	4(2Y)	3(1Y)	7(3Y)	4	7(4Y)
27	Hooper north				8(3Y)		1
28	Mt. Whymper: south burn					6(2Y)	8
29	Mt. Washington: mine quarry						4(1Y)
POTENTIAL COLONIES:							
30	Haley Lk. access road					2	3
31	Haley Lk. east of top parking area					1	2
32	Dunsmuir Ck. south fork, Westerholm meadow 2				4	2	
33	Dunsmuir Ck. north fork, road D15			3(2Y)[2]			
34	Butler Peak above road V7				3	1	2
35	Butler Peak road K 43 E 1C				2	2	3
36	"P" Mt. northwest ridge				3		
37	Gemini Peak: 2nd divide south					4	4
38	West Shaw Ck.		4(3Y)				
39	Mt. Whymper: west basin					3	1
40	Mt. Washington: ski hill	1		2			2
41	Mt. Moriarty						2
42	Mt. Landalt						2
	TOTAL	45	99(51Y)	90(31Y)	148(16Y)	165(20Y)	234(68Y)

1 Vancouver Island Marmot Preservation Committee report.
2 Wildlife Branch surveys.
3 Y-young.

observers searched 17 areas and recorded 165 marmots including 20 young (Heinsalu and Smith 1983). The 1984 survey was designed both to determine reproductive success of known colonies and to search new areas. A total of 234 marmots, including 68 young, was recorded (Smith et al. 1984).

Using the definitions outlined earlier, the results of surveys of the Vancouver Island marmot from 1979 to 1984 are summarized in Table 1. In 1984, four distinct and five isolated subpopulations existed (Tables 2 and 3). In addition there were five isolated colonies recently discovered which are not yet part of any subpopulation. Long-term existence of marmots on Mount Buttle, Mount Washington, and Mount Heather is indicated by historical records.

It must be emphasized that the major aim of the 1982 and 1983 surveys was to determine areas occupied by marmots, not to determine population figures specifically for each colony. Thus, the numbers of marmots seen at any location in these years were minimums. Further, many colonies were visited only prior to the emergence of young. The production of young was undoubtedly higher in these years than indicated in Table 1. The figures for 1984 more closely reflect population status as more effort was spent in each area to determine reproductive success.

Surveys in recent years and observations of some of the well known colonies indicate that the marmot population has increased in both numbers and distribution since the early 1970's. One area in which they have not apparently recovered is the type locality in the vicinity of Mount Douglas. Few marmots have been recorded in that area since Swarths' collecting expedition in 1910. This expedition collected five adult males and six adult females, several of which were lactating, and shot unknown numbers that managed to retreat down burrows (Swarth 1912). Other marmots were collected in this area in the 1920's (A. L. Frost, pers. comm.). Marmots were reported to be present on Mount Douglas in the late 1930's (L.W. Crowshaw, pers comm.). Current numbers are unavailable because the area has yet to be surveyed by Wildlife Branch personnel.

Table 2. Vancouver Island marmot subpopulations each consisting of two or more colonies (or colony complex), 1984.

Distinct subpopulation	Colony (colony complex)	Potential colony no.
Green Mt. proper	(1,2,3), 4,5,6,(7)[1]	
Haley Lk./Bell Ck./Dunsmuir Ck. south fork/Bell Ck. north/ Gemini Peak	(8),(9),10(11,12,13),23	30,31,32,37
Butler Peak proper	16,(17),(18,19)	34,35
"P" Mt. proper	20,21,22	36

[1] Numbers taken from first column in Table 1.

Table 3. Isolated colony sites considered to be subpopulations.[1]

Subpopulation	Colony no.	Potential colony no.
Mt. Heather	25[2]	
Mt. Whymper, south burn	28	39
Mt. Buttle	24	
Mt. Hooper	26	
Mt. Washington, mine quarry	29	40

[1] Colonies 14, 15, 27, 33, and 38 were only recently identified and are not yet part of any subpopulation.

[2] Numbers taken from Table 1.

3.0 TOPICS OF CONCERN

3.1 Extinction

The population size required to ensure long-term preservation and viability of the Vancouver Island marmot is unknown. One major concern is the maintenance of genetic variability within the population to allow response to environmental change. The importance of genetic variance, however, is poorly understood, and criteria for determining desirable levels of genetic diversity are not developed. In addition, little information is available from wild populations, although electrophoretic surveys, a technique for indicating genetic variability, are becoming more common. Denniston (1977) suggests a constant population of 50 animals over 10 generations will retain 0.90 of its genetic variance. The percentage increases with population size; 100 animals retaining 0.95, and 1000 retaining 0.99. Small populations that have been isolated for many generations should theoretically be devoid of recessive lethal genes (Cowan and Holloway 1974). Immigration and exchange of males, however, is essential to maintain gene flow within small populations. According to Bunnell (1978), exchange can be effective at intervals of 10 generations or less. Frankel (1970) suggests a minimum viable population of 200-300 individuals and, as a general rule, 50 breeding-age females should be maintained (Frankel and Soule 1981).

Another important factor influencing small populations is the probability of extinction owing to random events, such as natural catastrophes. The probability of extinction decreases as the ratio of death rate (d) to birth rate (b) decreases, and as population size increases (Ricklefs 1979). For a stable population in which b=d=0.5 (annual probability of death of an individual equals one-half), the relationship of extinction probability to population size over time is shown in Table 4.

Table 4. Probability of extinction when birth rate = death rate = 0.5 per year, for populations of initial size N within period t (from Ricklefs 1979: Table 35 - 1).

Population Size (N)	Time (t) (in years)			
	1	10	100	1000
1	0.33	0.83	0.98	0.998
10	$< 10^{-4}$	0.16	0.82	0.980
100	$< 10^{-48}$	$< 10^{-7}$	0.14	0.819
1000	$< 10^{-99}$	$< 10^{-79}$	$< 10^{-8}$	0.135

Extinction probability will decrease with lower population turnover rates. If b=d=0.25, for example, probability of extinction for N=100 at 100 years will be 0.02; an initial population size of 200 will have a probability of less than 10^{-3} at 100 years.

Assuming that the extinction probability from catastrophic events of each distinct population is the reciprocal of the number of animals, then the best strategy is numerous small viable populations rather than a few

large ones (McCullough 1969). For example, three distinct populations of 25 marmots each would have a probability of extinction of 1 in 15 625 (1/25 X 1/25 X 1/25) while 1 population of 25 and 1 of 50 animals would have a probability of 1 in 1250 (1/25 X 1/50) and a single population of 75 animals would have a probability of 1 in 75.

Based on the above theoretical considerations and present knowledge of the distribution of suitable habitat and marmot colonies, it is our view that a population of approximately 200-300 animals, distributed within 10 distinct subpopulations (by definition, each containing at least two colonies) will be sufficient to ensure long-term survival of the species. Although somewhat arbitrary, these criteria can be modified as our knowledge and experience increase. Also, with a more solid data-base, we will consult recognized experts in population dynamics and incorporate their recommendations into our objectives.

3.2 Adaptability to human activities

Concerns related to adaptability of the species to human activities include the effects and influence of ski operations and of logging. Potential adverse impacts of ski resorts that have caused public concern include elimination of habitat by the construction of ski runs, lifts, and access roads. Winter use of these areas contributes to snow compaction, which may detrimentally affect spring emergence.

From observations in 1982 at the ski resorts on Green Mountain and Mount Washington, it appears that ski areas and Vancouver Island marmots are compatible. This should not be surprising as the hoary marmot is productive and successful in ski areas in B.C. and Washington. The Vancouver Island ski areas, in fact, seem to be creating new habitat for the marmots by removing trees and maintaining a somewhat alpine meadow situation to form ski runs. Mount Washington, prior to the ski resort, was not characterized by open meadow. Instead, Vancouver Island marmots had to contend with shrub vegetation and subalpine firs (Heard 1977). The creation of ski areas by the resort encouraged meadows to develop. In 1982, the ski resort started a project of seeding clover/lupine/grass mixtures on the ski slopes to aid slope stability. This development has created suitable new habitat where before it was marginal.

In 1984, the Green Mountain ski area continued to support a viable subpopulation. On Mount Washington, marmots were observed in previous areas of utilization on the ski hill, and a new colony was located at an old mine site north of the ski area. Occupation of the abandoned rock quarry may indicate adaptability to non-typical marmot habitat.

Vancouver Island marmots in the Green Mountain ski area have expanded their range over much of the mountain. Between 1930 and the 1970's, only a few marmot burrows had been reported on Green Mountain. Since 1972, naturalists, hunters, and Fish and Wildlife staff have all reported a major expansion of marmots.

It is not known if or how logging or logged-over areas affect the Vancouver Island marmot. It has been speculated that slash, steep cut banks, and noise may adversely effect dispersal of marmots. Lack of cover in the

cutovers has been suggested as promoting predation of dispersing individuals.

From observations and sighting reports, it has been found that Vancouver Island marmots occupy young cutovers successfully. We have observed reproducing marmots living in various stages of recent logging in five separate locations. A newly cut slash area is quickly invaded by forbs and grasses, providing cover and food for marmots. On the topic of logging, I. McTaggart-Cowan and D. Heard (pers. comm.) stated that the removal of forest cover for a few years could permit displaced animals to move to adjacent mountain areas, which now appear to lack colonies.

Concerns about logging may be justified as succession advances to coniferous regeneration. Although some restocked cutovers will likely not provide long-term habitat, many high elevation, south-facing cutovers are difficult to regenerate with conifers, and will remain in early seral stages for long periods of time. Dispersers from these areas can serve both as a source of genetic variability to the alpine colonies and as a source of animals for captive breeding and transplants (K. Armitage, pers. comm.; R. L. Rausch, pers. comm.)

3.3 Harrassment

Access associated with ski operations and logging, and growth in the numbers of recreationists has caused concern over the potential for harrassment and disruption of daily activity patterns. In addition, the use of dogs for inventory purposes has caused some public concern. Our own observations on Vancouver Island marmots (reported above), coupled with information on other marmot species (K. Armitage, pers. comm.) indicate marmots readily accommodate to human noise and activity. In addition, human daily activity tends to occur after the early morning active period of marmots. The use of dogs is considered an effective technique for inventory of potential marmot habitat to determine presence/absence. Dogs should not be used when the objective is to census colonies to determine reproductive status.

Incidents of shootings (two verified reports in 1979 and 1981) and other vandalistic acts can be minimized by access control, local closures, and enforcement. Increased public awareness, generated by field signs and various public education activities, will hopefully result in maintaining public recreation in these areas without restrictive actions. Reports of marmot observations by hunters and naturalists has greatly aided our inventory program.

3.4 Captive colony

Loss of free-living marmots from some natural event is a major concern. Captive colonies could provide insurance against extinction. Prior to 1980, some thought had been given to establishing a captive breeding colony of marmots, with the objective of eventually releasing young captive-reared animals into the wild. The plan was first to experiment with hoary marmots and then apply the techniques to Vancouver Island marmots.

However, in 1980 July, the Fish and Wildlife Branch captured a Vancouver Island marmot that was damaging gardens, and took it to the Okanagan Game Farm. This capture marked the start of a pilot attempt at captive colonies. Later in 1981 another marmot was trapped at a Green Mountain colony and was sent to join the first one. In 1981, a third marmot was trapped in the Nanaimo River valley. All three captive marmots, on close examination, were males (the first was thought to be female). In the late summer of 1981, two females were captured and shipped to join the captive colony. One of the females did not emerge from hibernation in 1982; two males did not emerge in 1984. The captive colony now has two adult marmots and four young born in the spring of 1985. More detailed information on the behaviour of marmots in captivity can be found in Dyer (1982).

4.0 MANAGEMENT PLAN

The purpose of this section is to describe activities believed necessary for achieving the objectives for the management of the Vancouver Island marmot.

4.1 Goal and Objectives

The management goal for the Vancouver Island marmot is:

To establish and maintain the population of Vancouver Island marmots at a level and distribution that provides a reasonable likelihood of long-term survival.

To meet this goal, five objectives have been established:

1. To ensure that six distinct reproducing subpopulations are in existence by the summer of 1985, and ten by the summer of 1990.

Six subpopulations by 1985 will ensure continued effort and at the same time is realistic in terms of further inventories and possible transplants. When this requirement is satisfied, the official status will be reviewed by COSEWIC. The establishment of 10 discrete populations by 1990 was set as a tentative criterion for ensuring long-term survival of the species. The dates for achieving this objective are thought to be realistic, although modifications are possible as our information and experience progress.

2. To secure habitat for key marmot colonies and prevent alienation and alteration of known marmot habitat.

For this objective, we believe the habitat required for the population levels outlined in Objective 1 should have some form of long-term security. This security should take several different forms. We have reviewed many suggestions, e.g. Sierra Club (1982), and recommend several activities described in a later section.

3. To maintain one small captive breeding colony of marmots.

The maintenance of a captive breeding colony is an additional hedge against disaster, whether from disease or other sources. The facilities at the Okanagan Game Farm are good, but are far removed from the marmots' range and the people working on marmots. Consideration will be given to establishing the captive colony on the coast.

4. To encourage and support approved scientific research on the marmots and marmot habitat.

Management effectiveness will increase with greater scientific knowledge. Scientific studies with direct management implications will have top priority.

5. To encourage public participation in some aspects of the program and to keep the public aware of what is occurring.

Public support for wildlife programs is achieved largely through public information and participation. Wide dissemination of reliable information and directed participation with specific aims are the two basic elements of such a program.

4.2 Activities

4.2.1 Activities for ensuring population (Objective 1)

a. Inventory potential habitat for marmots.

The search for new colonies will be continued by Fish and Wildlife staff from our Nanaimo office each year during May and June. The first priority will be sites not yet examined but where we have recent, reliable observations of marmots. Subsequent searches will follow-u p on other less reliable sightings, remaining historical sites, and areas of potential habitat.

b. Monitor potential and known colonies with emphasis on whether or not they are reproducing.

Monitoring of potential and known colonies will be done annually by staff from our Nanaimo office during July to September. Recruitment and population trends will be documented. In future years, we will consider more widespread public input into monitoring, if interest and reliability is evident.

c. Transplant marmots (if and when necessary).

Transplanting of wild and captive-reared marmots may be required to meet the long-term objective of 10 discrete subpopulations. If such transplants are to be undertaken, the details will be in a separate project report.

4.2.2 Activities for securing habitat (Objective 2).

a. Protect the habitat of all known colonies.

Development proposals that are considered to be adversely impacting the habitat of existing colonies will, wherever feasible, be restricted. Continued liaison with private companies will be emphasized.

b. Support establishment of an Ecological Reserve around Haley Lake by the end of 1985.

The Haley Lake Bowl contains the colony with the longest recorded history. Two major research studies have been conducted on it. It has been the centre of numerous proposals for an Ecological Reserve. If made an Ecological Reserve, it will provide a benchmark to measure management efforts in other areas, and ensure opportunities for continued research.

c. Establish a Critical Wildlife Management Area on Green Mountain (Block 1392) by the end of 1985.

Block 1392 on Green Mountain recently came under Crown ownership. It contains a number of marmot colonies, a ski development, and is the most easily accessible area for people to view marmots in the wild. A Critical Wildlife Area (CWA) designation would permit us to prohibit those activities which are directly destructive to marmots or their habitat, while allowing non-destructive activities to continue. It would allow us to experiment both with the animals, in the case of transplants, or with the habitat, in the case of enhancement. It could also serve as the major public viewing area for marmots. If the area becomes designated as a CWA, a management plan will be prepared.

d. Establish Wildlife Management Areas on Butler Peak and "P" Mountain by the end of 1985, provided donations are finalized.

Portions of Butler Peak and "P" Mountain are promised to come under Crown control by donation from MacMillan Bloedel. We believe the suggested designation of a Wildlife Management Area will provide protection for the habitat while allowing opportunity for any active management that may be required.

e. Arrange with the appropriate forest companies to establish "company marmot reserves" for colonies on their private lands.

The two major forest companies owning most of the land occupied by marmots (Crown Forest and MacMillan Bloedel) have been very cooperative in the past in protecting identified areas. We believe that by negotiating with all companies, key marmot colonies will be officially designated as "marmot reserves" and the habitat essential to marmots left undisturbed.

f. Work with the Mount Washington Ski Resort Ltd. to enhance habitat for marmots on Mount Washington.

As meadow habitat is greatly restricted on Mount Washington, ski run development and maintenance will likely increase forage for marmots. We will keep in touch with the company and monitor marmot use of seeded areas. Fertilization, as tried successfully by Holmes (1979) for hoary marmots, may be a useful technique. Other enhancement techniques may be clearing and seeding small areas adjacent to the ski runs to provide areas where the snow will not be compacted and thus may melt earlier in the spring.

4.2.3 Activities for captive-rearing (Objective 3).

a. Follow development of 1985 production and try to learn techniques for successful rearing of young.

The female marmot was four-years-old in the spring of 1985 when she bred for the first time. Because of the distance from natural populations as well as from marmot researchers, we will consider re-establishing the facility on the coast.

4.2.4 Activities for increasing knowledge (Objective 4).

a. Identify research needs and implement a research plan.

With the recent completion of Milko's (1984) thesis, a priority listing of research topics should be addressed. The Ministry of Environment Research Section will be asked to conduct a problem analysis to identify and rank research needs.

b. Encourage universities to undertake studies on the species by writing to the appropriate professors outlining research needs - 1985.

We have sent letters to professors of wildlife management at universities in B. C. requesting they and their students consider studies on the Vancouver Island marmot for theses.

c. Provide logistical and monetary support for such projects - annually, if possible.

We will provide logistical and financial support for approved studies within our capabilities. The former is likely to be much more possible than the latter in the near future.

d. Provide written support for such studies when applications for outside funding are required.

As in the past, we will provide written support when requested for approved studies where funding from outside agencies is sought.

4.2.5 Activities for public education and participation (Objective 5).

a. Provide marmot observation forms to be filled in and returned by the public.

The observation form to be used is in Appendix A of this document. Copies will be distributed to all the outdoor-oriented clubs on Vancouver Island for which we have addresses. A covering letter will explain why we want the forms filled out. More specific projects are discussed under Section 4.2.1(b).

b. Guide interested members of the public and press to some areas where marmots can be seen - as public interest dictates.

Fish and Wildlife staff will arrange field trips for interested members of the public as appropriate.

c. Produce a "fact sheet" on marmots which will provide the public and press with accurate information on the current status of marmots - 1983 and updated as required.

We have written and published a fact sheet on the Vancouver Island marmot which provides accurate information on the status of the animal. It will be widely circulated and will be updated when necessary.

d. Maintain a close working relationship with various public interest groups.

Although there are very divergent opinions among the representatives of the groups on the public liaison committee, we believe it is a useful arena in which to exchange views, test ideas, and solve problems. We will continue to host semiannual meetings of the committee as long as it serves a useful function.

e. Cooperate in production of educational films.

We will cooperate with bona fide film producers in the production of approved projects for educational purposes.

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6.0 APPENDIX A

MARMOT REPORT FORM

OBSERVER NAME, ADDRESS AND TELEPHONE NUMBER: _____

_____

LOCATION: _____

Map number: _____ Aerial photo number: _____

DATE: _____ Time: _____

WEATHER: _____

% cloud: _____ Precipitation _____

temperature _____ sun: _____

snow conditions _____ wind: _____

TOPOGRAPHY: _____

slope: _____ Aspect _____

soil depth: (transplant sites only) _____ Suitable for burrows _____

MARMOTS:

Age class	number seen	(whistles only, animals not seen)	behaviour
adults	_____	_____	_____
subadults	_____	_____	_____
young	_____	_____	_____
unknown	_____	_____	_____
total	_____	_____	_____

SCATS: fresh: _____ old: _____ nil: _____

BURROWS: _____

active: # _____ inactive: # _____

LOOKOUT AND SUNNING SPOTS: _____

used rocks: _____ logs: _____ stumps: _____

FOOD SPECIES (if present indicate if browsed)

Cow Parsnip (*Heracleum lanatum*)	_____
Grasses and Sedges	_____
Hellebore (*Veratrum viride*)	_____
Indian Paintbrush (*Castilleja* spp.)	_____
Lupine (*Lupinus latifolius*)	_____
Meadow Rue (*Thalictrum occidentalis*)	_____
Mtn. Valerian (*Valeriana sitchensis*)	_____
Orange Tiger Lily (*Lilium columbianum*)	_____
Purple Pea (*Lathyrus nevadensis*)	_____
Spreading Phlox (*Phlox diffusa*)	_____

Additional observations and comments
(e.g. red tailed hawk, black bear)

_____

_____

_____

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