

Photos (clockwise from top left) Shayn McAskin, Ryan Tidman, Adam Taylor

ANNUAL REPORT

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The Marmot Recovery Foundation works on the traditional territories of the Namgis, Kwakiutl, Wei Wai Kum, K'omoks, Mowachaht/Muchalaht, Snaw-Naw-As, Qualicum, Hupacasath, Tseshaht, Snuneymuxw, Stz'uminus, and Songhees First Nations and Cowichan Tribes.

This report was prepared by Kevin Gourlay, Malcolm McAdie, and Adam Taylor.

EXECUTIVE SUMMARY

The endangered Vancouver Island marmot (*Marmota vancouverensis*, Swarth, 1911) is one of only five endemic land mammals in Canada (Nagorsen, 2004). The Vancouver Island marmot is recognized as a protected species under the B.C. *Wildlife Act* and is on the B.C. Red List of species at risk. Nationally, it is listed under Schedule 1, Endangered, on the Species-at-Risk Act. Internationally, the International Union for Conservation of Nature (IUCN) lists the species as Critically Endangered. A recovery program for the marmot was launched in 1996, and 2023 was the 27th year of intensive recovery efforts.

During the 2023 field season, the Foundation conducted core recovery activities intended to: (i) increase the number of marmots in the wild and protect the persistence of existing colonies, (ii) support wild reproduction, and (iii) relocate marmots found in unsuitable habitat. The Wilder institute helped the Foundation to monitor marmots at several colonies while also investigating the relationship between supplemental feeding and reproduction in the wild. Data from their team have been incorporated into the results reported here.

In total, 42 new captive-bred marmots and 11 marmots with some level of previous wild-living experience were released or translocated to augment fifteen priority colonies. Thirty-six feeders were installed at 24 colonies to improve the reproductive potential of ~239 marmots. Seventeen natural colonies produced 59 pups over 23 litters. There were 29 mortalities detected in 2023. Five marmots were brought into captivity during the summer and subsequently re-released or translocated for various reasons. Since 2003, the captive breeding program has resulted in the release of 619 captive-bred marmots into the wild. Currently there are 149 marmots in captivity, including 39 or more potential breeding pairs for 2023.

Wild population counts of marmots increased for all age classes compared to the previous year. Approximately 303 marmots were observed in the wild by the end of the season, distributed across 33 colonies in two main regions. Survey effort was similar to the previous 4-year rolling average at most colonies, with the notable exception of the 4 new colonies discovered this year.

This report presents the results from the 2023 field season and trends in recent years.

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1. INTRODUCTION

This report is primarily intended for partners in the Vancouver Island Marmot recovery effort to facilitate planning of 2024 recovery actions. Others may find it informative or useful for research. In this report, you will find descriptions of the approach, methodology and results of activities conducted by the Marmot Recovery Foundation during the 2023 field season. These results include data collected by the Foundation's field crews, as well as observations from the Wilder Institute research team. Collectively, this document refers to all these groups as "field teams". The information shared here is current and accurate to the best of our ability. If you are looking for additional information about recovery planning for the Vancouver Island Marmot, please refer to the Provincial Recovery Plan (Vancouver Island Marmot Recovery Team 2017), Federal Recovery Strategy (Environment and Climate Change Canada, 2020), or visit the Foundation's website. Within this report, any mention of the "Recovery Plan" refers to the Provincial document, unless otherwise noted.

2. ABOUT THE VANCOUVER ISLAND MARMOT

The Recovery Plan describes the species as follows:

"The Vancouver Island Marmot (*Marmota vancouverensis*) is British Columbia's only endemic mammal species; it lives only in mountainous areas on Vancouver Island. For 7–8 months of the year (approximately early October to May), family groups of Vancouver Island Marmots hibernate in underground burrows called hibernacula. During the 4 to 5-month active season in which they breed, raise young, and regain weight, marmots continue to use their underground burrow systems for resting, avoiding summer heat, and protection from predators. They also spend considerable time above ground foraging, resting, sunning, and interacting with other marmots. Marmots typically live in colonies and when above ground, they rely on alarm calls to warn others in the colony that a predator is nearby. The main predators of the Vancouver Island Marmot are Golden Eagles, Cougars, and Grey Wolves," (Executive Summary, p.v).

"Because of their reliance on alpine and subalpine habitat, Vancouver Island Marmots are not distributed uniformly on the landscape. On a small spatial scale, marmots live in colonies that typically include one to two family groups (Nagorsen, 2005). Multiple colonies can live on a single mountain. Within this document, the term "site" is synonymous with "mountain." Marmots living at the same site can, therefore, disperse or move between colonies without leaving the alpine or subalpine habitat; marmots dispersing between sites must travel through lower-elevation forest habitats. Because alpine and subalpine areas on mountains are separated by areas of unsuitable marmot habitat, it is thought that Vancouver Island Marmots have a metapopulation structure (Bryant, 1996); marmot colonies on the same mountain form a subpopulation, and subpopulations are linked by occasional dispersal. The subpopulations that are (or could be) linked by these dispersal events comprise the metapopulation. Dispersal events do not occur between marmot metapopulations because they are isolated by distance. Two metapopulations of Vancouver Island Marmots currently exist, one in the Nanaimo Lakes area of south-central Vancouver Island and one further north in the Strathcona region," (Section 3.2, p.3).

3. ABOUT THE RECOVERY EFFORT

The Vancouver Island Marmot initially was designated as endangered in 1978 by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). Additional protections have been provided by Canada's Species at Risk Act, and British Columbia's Wildlife Act, Forest and Range Practices Act, Private Forest Land Management Act, and Oil and Gas Activities Act. Intensive recovery efforts have been ongoing since 1996 to increase the population size and distribution. Perhaps the most critical recovery activity was the initiation in 1997 of a captive breeding and reintroduction program that continues to date. There are presently three facilities that breed marmots for the recovery program: the Calgary Zoo, the Toronto Zoo, and the purpose-built Tony Barrett Mount Washington Marmot Recovery Centre operated by the Marmot Recovery Foundation. Since 2003, the captive breeding program has released 619 captive-bred marmots, and re-released 11 wild-born marmots that had been brought into the captive breeding program. During the same period, the number of occupied marmot colonies has grown from 5 to 30.

The Recovery Plan describes as its goal the establishment of two or more persistent, geographically distinct metapopulations of Vancouver Island Marmots within the species' historic range. It also specifies seven key objectives:

1. Increase the number of marmots through augmentation and, if possible, by increasing survival rates and reproductive rates in the wild.
2. Maximize opportunities for successful dispersion between colonies.
3. Maintain a large and genetically diverse captive breeding population that can produce adequate numbers of release candidates to support population recovery.
4. Prioritize the maintenance of genetic variability in the global population until recovery goals are met.
5. Reduce knowledge gaps surrounding: (a) natural levels of variability in survival and reproductive rates in the wild; (b) factors that determine key demographic rates; and (c) the best method to monitor population size and key demographic rates long term.
6. Develop and implement a plan for reducing intensive management as metapopulations recover.
7. Develop and implement a sound strategy to ensure sufficient resources are available to support recovery efforts until recovery goals are met.

Objectives 1-3 are the focus for this report of 2023 activities, results, and observations.

4. WILD POPULATION

The known, wild-living population of Vancouver Island Marmots is currently distributed in two metapopulations and two isolated colonies. The Nanaimo Lakes metapopulation (Figure 1a) includes 15 occupied colonies and 49% of wild-living marmots. The Strathcona metapopulation (Figure 1b) includes 15 occupied colonies and 48% of the wild-living marmot population. Clayoquot Plateau Park, in west-central Vancouver Island, is believed to include approximately 3% of the wild-living population.

The Foundation classifies a colony site as “unoccupied” when there was no marmot sign detected on its most recent two surveys. Colonies were classified as “data deficient” when Foundation staff felt there was insufficient data to assess their occupancy. Some data deficient colonies have not been surveyed for several years.

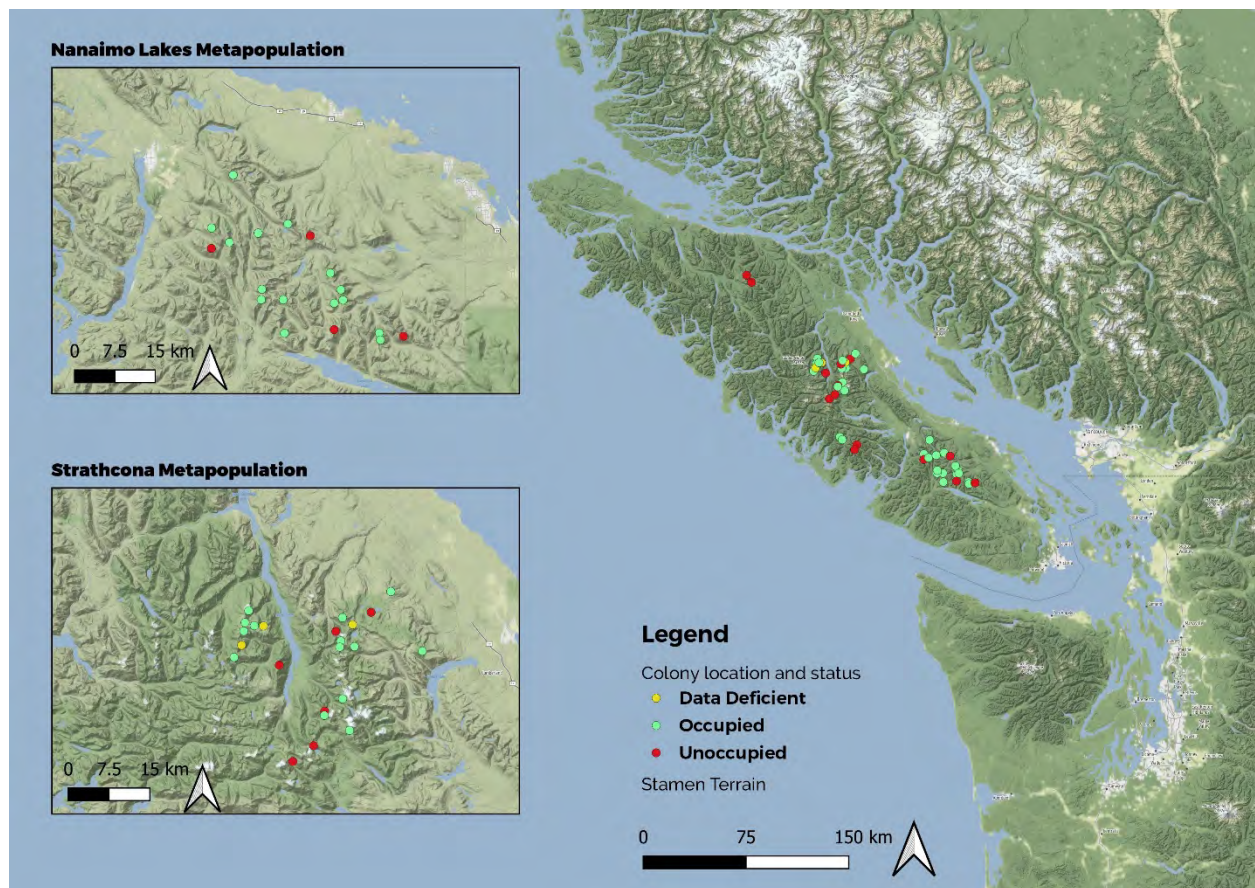


Figure 1. Distribution of the Vancouver Island Marmot in the wild (November 2023), including occupied, unoccupied and data deficient colony sites in the (a) Nanaimo Lakes and (b) Strathcona regions.

4.1 Summary of the Wild Population

The 2023 season marks the 20-year anniversary since the lowest point of the Vancouver Island marmot population, when fewer than 30 individuals were counted in the wild. That same year also marked the first release of four captive-bred marmots to the wild. This year, over 300 individuals were counted, a 10-fold increase. The 2023 field season saw improvements in the wild-living population of Vancouver Island marmots in nearly every metric. Population numbers increased from 2022 in all regions and age classes, and the distribution of marmots increased on the landscape in all regions. Strathcona Provincial Park experienced the most significant increase, and now holds roughly the equivalent proportion of the wild population as the Nanaimo lakes region (49% vs 48%), a similar number of adults (n=75 vs. n=76), and a greater proportion of the pups (n=34 vs. n=26). Wild-born yearlings were the only age-class which did not see a significant increase this year, likely due to suppressed reproductive output in 2022; however, increased numbers of captive-released yearlings and improved survival of these individuals resulted in an overall increase of yearlings from 2022. The age class which experienced the greatest increase were pups (322%; n=60 vs. n=19), followed by 1+ yo (144%, n=246 vs. n=171).

Survey effort in 2023 was 119% of the average over the previous four years (680 person-days vs 573 person-days), with the increase in effort concentrated at newly discovered colonies and other infrequently surveyed colonies (see table 15).

The Foundation observed a significant increase in the distribution and/or density of marmot colonies in 2023. Each region included a small number of colonies with higher numbers, but the vast majority of colonies remained relatively small in size. During our spring emergence survey flight in Strathcona, we discovered occupation at an historical site on Shepherds Ridge, as well as occupation at a new colony on Mt. McBride. Following a hiker report from this spring, the Foundation also confirmed marmot occupation at a new colony near Mt. Celeste, south of Buttle lake in Strathcona. These discoveries suggest that connectivity between larger established colonies within the park may be improving. Field crews also confirmed that the previously discovered colonies in 2021 and 2022 remain occupied in 2023.

In the Nanaimo Lakes region, reproduction was documented at El Capitan, suggesting this relatively new site may be an established colony. In the Clayoquot Plateau region, the Foundation attempted a reintroduction to a site without known marmot occupation at the direction of the Recovery Implementation Group. Three out of four marmots were confirmed in place and alive at the end of the year, and we look forward to tracking the success at this site.

Table 1. Mean hill counts of wild marmots by age class.

REGION	Colony	Counts						
		Unk. Age	≥2yo	1yo	0yo	Total		
Nanaimo Lakes		Mean	Mean	Mean	Mean	Low	High	Mean
	Arrowsmith	2	11	4	10	25	28	27
	Big Ugly	0	8	2	6	13	17	15
	Butler	2	5	3	0	8	11	10
	Douglas	1	6	2	3	10	14	12
	El Capitan	0	2	0	2	2	2	2
	Gemini	0	2	3	0	4	5	5
	Green	2	2	4	0	7	8	8
	Haley	0	3	2	2	7	7	7
	Heather	1	3	3	0	6	7	7
	Hooper	1	6	3	1	10	12	11
	Landale	2	7	2	0	10	11	11
	McQuillan	1	11	0	1	10	15	13
	Moriarty	1	7	4	0	11	12	12
	P Mountain	1	3	1	0	4	6	5
	Sadie Peak	1	2	1	0	2	4	3
	Cutblocks (combined)	1	1	1	0	2	3	3
Sub Total	n=15	14	75	34	24	131	162	147
Strathcona								
	Albert Edwards	1	8	2	7	15	19	17
	Becher	1	2	3	0	6	6	6
	Castlecrag	3	10	1	4	15	19	17
	Celeste	1	2	0	0	3	3	3
	Flower ridge	0	0	0	0	0	0	0
	Greig Ridge	1	6	0	1	6	9	8
	Marble Meadows	2	10	1	2	12	17	15
	McBride	2	6	2	2	11	12	12
	Morrison Spire	3	5	0	4	9	13	11
	Red Pillar	3	4	1	3	10	11	11
	Shepherds Ridge	1	4	0	2	6	6	6
	Sunrise	4	0	0	0	2	5	4
	Tibetan	0	0	0	0	0	0	0
	Washington	0	20	8	6	32	36	34
	Wheaton lake	0	2	0	4	4	6	5
Sub Total	n=15	20	75	18	34	131	162	147
Extralimital								
	Steamboat	3	3	0	0	5	7	6
	Lions North	0	2	2	0	4	4	4
Sub Total	N=2	3	5	2	0	9	11	10
TOTAL:	32 colonies	37	156	54	57	270	335	303

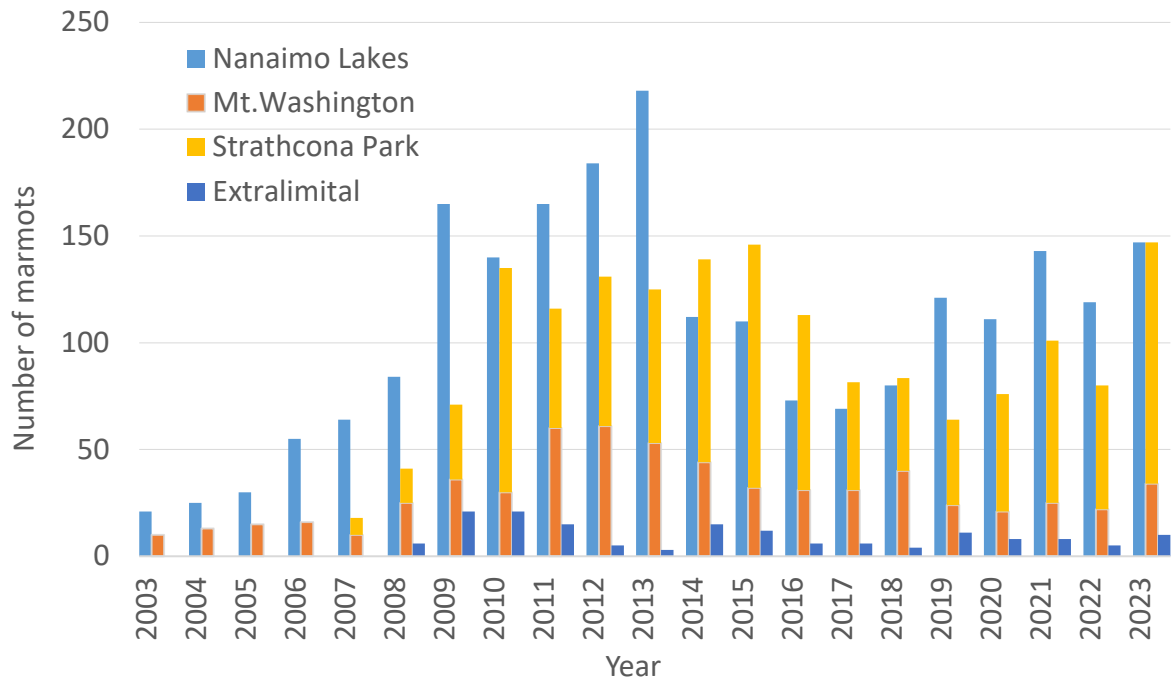


Figure 2. Mean population counts by region (2003-2023).

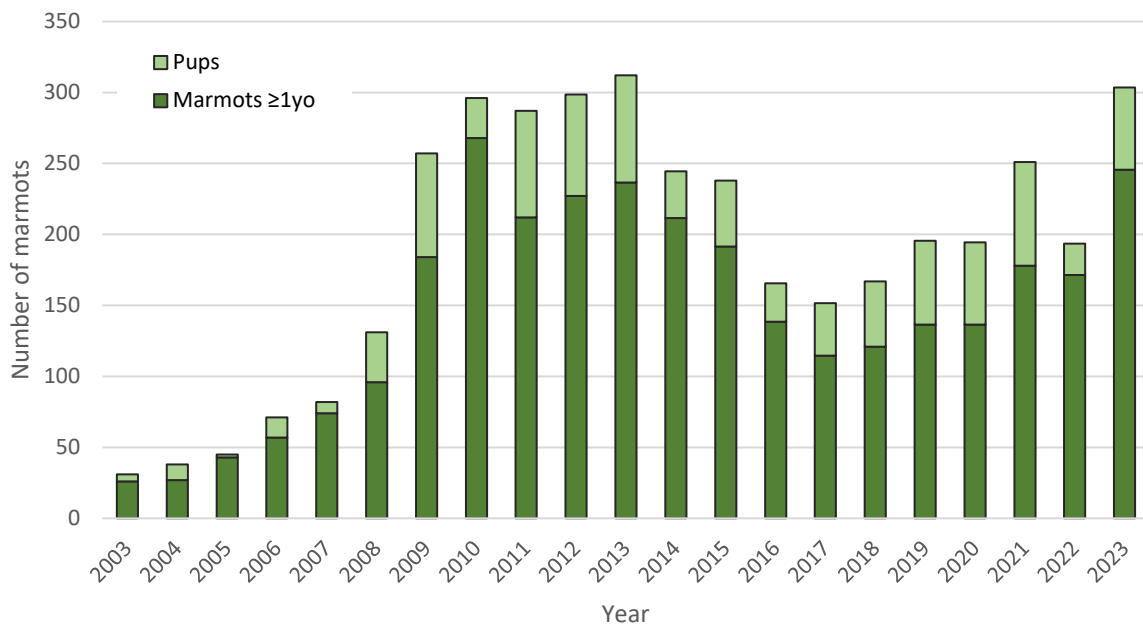


Figure 3. Mean population counts by age class (2003-2023).

4.2 New Colonies

Four new colonies were discovered and one re-introduction was completed in 2023, a very positive sign for the species. Three new colonies in Strathcona Provincial Park were a particularly exciting discovery, following the continued growth curve observed over the past 3 years in this metapopulation. Two of these colonies, Mt. Celeste and Shepherds ridge, are located on the south side of Buttle lake and are strategically located between the larger well-established colonies to increase connectivity within the park. The third, Mt. McBride, is in close proximity (~1km) to the well-established colony of Marble Meadows on the north side of Buttle Lake. This site contains a significant amount of suitable habitat, several well-developed burrow systems, and marmots of different age classes. Marmots were also observed around circlet lake near mount Washington, however there was insufficient evidence to suggest this location is an established colony.

In Nanaimo Lakes, reproduction and several established burrows were documented at El Capitan, a location where marmots were first observed in 2022. In Clayoquot Plateau Provincial Park on the west coast, four marmots were re-introduced to Lions North after severe weather inhibited the foundation from completing a re-introduction at the intended location on Mount 5040. The remote access and rugged terrain of Lions North makes this site difficult to survey, but a fall aerial telemetry survey confirmed the 4 marmots were still near the release site, and at least 3 were still alive. The foundation looks forward to tracking to success of this reintroduction attempt going forward.

Table 2. New colonies discovered in 2023.

Region	Colony	# 1+ yo	# Pups	Notes
Strathcona Provincial Park	McBride	10	2	Discovered in 2023 by the Foundation. No historical records of marmot occupation at this site. Likely dispersers from the large nearby colony at Marble Meadows (~1km away)
	Shepherds Ridge	5	2	Discovered in 2023 by the Foundation. Historical site of reintroduction. Subsequent surveys confirmed presence of marmots of varying age classes and well-developed marmot infrastructure, suggesting extended occupation.
	Celeste	3	0	Reported in 2023 from hikers. Follow-up survey confirmed occupation and extensive marmot habitat in area.
Nanaimo Lakes	El Capitan	1	1	Discovered in 2022 by the foundation, confirmed as an established colony in 2023 due to the presence of pups and well-developed burrow systems.
Clayoquot Provincial Park	Lions North	4	0	Reintroduction site. Releases confirmed in place and alive at season-end. Too early to determine if they will be successful here.

4.2.1 Change in Colonies since 2019

In both the Nanaimo Lakes and Strathcona metapopulations new colonies have been documented since 2019. These colonies have been established by marmots dispersing unassisted from other, established colonies. In the Nanaimo Lakes, marmot hibernation and reproduction have been documented at Landale

and El Capitan. This is also the case in Strathcona for Becher, the Red Pillar, Celeste, Wheaton Lake, McBride, and Shepherd's Ridge colonies.

In Clayoquot Plateau, Lion's North is a new colony at was intentionally established by releasing marmots to the site. All four marmots were detected in place and at least three of four alive at the end of the season.

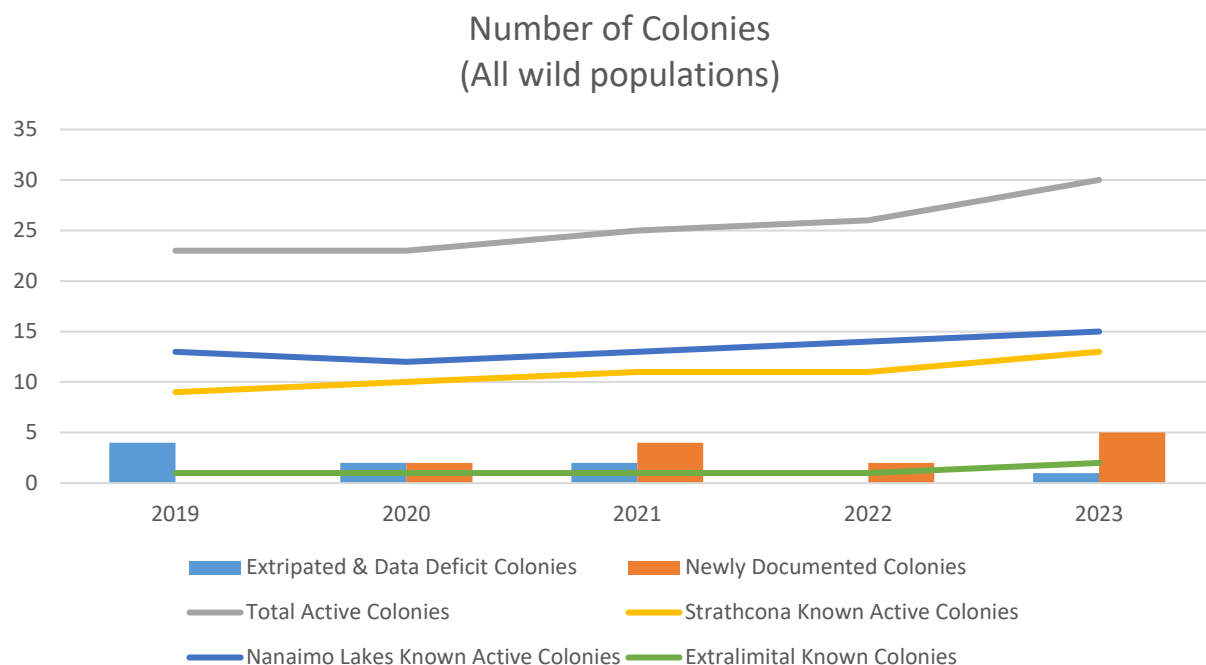


Figure 4 Number of Occupied Colonies by Year

4.3 Mortalities

The Foundation tracks mortalities using temperature-sensitive radio transmitters, allowing us to determine the body temperature of the individual remotely. Mortalities can only be conclusively detected during the core field season while marmots are active (June 1st -August 31st). Once a mortality has been detected, staff attempt to recover the mortality promptly to determine the cause of death, usually by analyzing the location, timing, and condition of the remains. Please contact the Foundation for a more exhaustive explanation of our process of determining cause of mortality.

The Foundation detected 29 mortalities during the 2023 field season (Table 3), including 19 marmots which are believed to have died this season, and an additional ten which may have died at an earlier date. Fifteen mortalities were of marmots recently released or translocated, which is consistent with average survival rates of captive-bred marmots in their first year in the wild. Two of 13 recovered mortalities are believed to be hibernation related, one was struck by a vehicle on the Mt. Washington Parkway, another died from an injury to the head of unknown cause. Of the remainder where a cause of death could be attributed, selective consumption of the remainder suggested cougar predation. Cougars continue to be the primary predator of marmots.

Table 3. Summary of the mortalities detected in 2023 and their suspected causes.

2023 Mortalities					
Region	Colony	Marmot	Date Detected	Suspected cause of mortality	Note
Nanaimo Lakes	Big Ugly	Seymour2	2023-08-14	Unknown	Not recovered
	Butler	Paisleigh	2023-08-01	Unknown	Bare transmitter recovered
	Gemini	Buttercup2	2023-04-19	Hibernation	Confirmed alive at end of 2022. Bare transmitter recovered
	Haley Lake	Gregson	2023-08-08	Unknown	Not recovered
		Tolmie	2023-08-02	Unknown	Bare transmitter recovered
	Landale	Lennon	2023-08-22	Cougar predation	Pattern of consumption of remains recovered
	P Mtn	Hawkeye	2023-06-05	Hibernation	Confirmed alive at end of 2022. Not Recovered
		Flower	2023-08-09	Unknown	Not Recovered
		Dallas	2023-07-11	Cougar predation	Pattern of consumption of remains recovered
	Sadie	Barb	2023-08-10	Cougar predation	Pattern of consumption of remains recovered
		Martina	2023-08-10	Cougar predation	Pattern of consumption of remains recovered
		Cinnabar	2023-08-21	Unknown	Not Recovered
Strathcona	Washington	Ezekiel	2023-09-16	Cougar predation	Pattern of consumption of remains recovered
		Flossie	2023-08-28	Cougar predation	Pattern of consumption of remains recovered
		Mr. T	2023-09-08	Cougar predation	Pattern of consumption of remains recovered
		Data	2023-07-31	Unknown	Not Recovered
		Nutella	2023-06-26	Head injury	Recovered, unknown cause
		Tobias	2023-07-27	Struck by vehicle	Found on parkway with blunt force trauma
		Deebo	2023-08-28	Unknown	Not recovered
Total:		19			

Historic Mortalities discovered in 2023					
Nanaimo Lakes					
	Green	Talisker2	2023-05-16	Unknown	Not recovered
	Heather	Bedwell	2023-06-05	Unknown	Bare transmitter recovered
	McQuillan	Rocket	2023-07-04	Unknown	Not Recovered
	Sadie	Groundsel	2023-08-09	Unknown	Not Recovered
		Quill	2023-06-14	unknown	Not Recovered
Strathcona	Marble Meadows	Rex2	2023-08-15	Unknown	Not recovered
	Washington	Matchlee	2023-06-20	Unknown	Not recovered
Clayoquot Plateau	Steamboat	Jane2	2023-07-17	Unknown	Not Recovered
		Burnet	2023-07-17	Unknown	Not Recovered
		William2	2023-05-20	Unknown	Not Recovered
Total:		10			



Photo 1 Releasing a marmot. By Adam Taylor

4.4 Reproduction

Marmots typically breed in May after arousing from hibernation. Pups typically emerge above ground when they are weaned in late June-early July after a one-month gestation and a one-month lactation. Female marmots typically reproduce every second year in order to regain sufficient body condition to successfully wean a litter of pups, a phenomenon known as reproductive skipping.

Reproductive success increased substantially in 2023. Many marmots did not reproduce in 2022 due to heavy spring snowpack and a strong reproductive year in 2021. This year, early-season snow melt-off and increased supplemental feeding resulted in increased food availability and better body condition for females.

Table 4. Weaned pups counted in 2023.

Region	Location	# of litters	# of pups
Nanaimo Lakes	Arrowsmith	2	10
	Big Ugly	1	6
	Douglas	1	3
	El Capitan	1	1
	Haley	1	2
	Hooper	1	1
	McQuillan	1	1
Strathcona	Albert Edwards	2	7
	Castlecrag	2	4
	Greg Ridge	1	1
	Marble Meadows	2	2
	McBride	1	2
	Morrison Spire	1	4
	Red Pillar	1	3
	Shepherds Ridge	1	2
	Washington	3	6
	Wheaton lake	1	4
Total	17 colonies	23 litters	59 pups

4.5 Dispersals

The Foundation tracks marmot movements in point data using manual radio telemetry. This means it is not possible to determine the exact route a marmot takes while dispersing, however we are able to determine if a marmot makes a move from one colony to another, or into ephemeral habitat.

The Foundation believes one marmot, Camas, successfully hibernated in a lower-elevation cut block over winter 2022-23. We were not successful in trapping this marmot in the cut block, however less than 1 month later we received a report of a marmot in Errington and confirmed this marmot to be Camas. Camas was subsequently translocated to a colony in Strathcona.

Table 5. Overwinter survival and mortality in 2023.

Origin	Destination	Marmot	Age	Sex	Straight-line distance	General Comments
Shaw Lake Cutblock	Errington	Camas	3	M	30km	Trapped and brought into captivity for translocation
Hooper	Sadie	Gabbro	1	M	1km	New release dispersed to neighbouring colony.

4.6 Hibernation

The Foundation defines a marmot as having survived hibernation when it was detected on active telemetry signal, or not active but tracked to a burrow, on or after September 15 of the previous year, and on active signal again by mid-June of the current year. By this definition, 95% of monitored marmots in the wild survived hibernation (41 of 43).

Table 6. Overwinter survival and mortality in 2023.

Population	Suspected Overwinter Mortalities	Overwinter Survival for Monitored Population (x of y)
Nanaimo Lakes	Buttercup2, Hawkeye	88% (15 of 17)
Strathcona	None	100% (26 of 26)
Extralimital Sites	Unknown	Unknown
TOTAL		95% (41 of 43)

4.7 Environment

The Foundation tracks changes in marmot habitat characteristics within each active season, and from year to year. Several environmental variables have been identified that influence key characteristics of marmot habitat which support marmot persistence over time. Winter snowpack has a significant influence on every aspect of marmot life history and the habitat which supports them, from snow energy clearing tree ingress, to melt water supporting vegetation growth and forage availability well into the summer. Within-season weather patterns can also significantly influence marmot persistence. Severe weather events such as heat domes and changing precipitation patterns affect marmot activity patterns, predator detection efficacy, and forage availability.



Photo 2 Harebell in marmot habitat by Adam Taylor

4.7.1 Snowpack

The 2022-23 winter saw slightly below average snowpack in all regions, and relatively early spring melt-off. This likely supported the strong reproduction observed this year by increasing availability of early-season forage for females to regain body condition post emergence. In the past, low snow years have been associated with lower overwinter survival due to less thermal insulation creating greater temperature fluctuation inside the hibernaculum, however we did not observe elevated hibernation-related mortality this year.

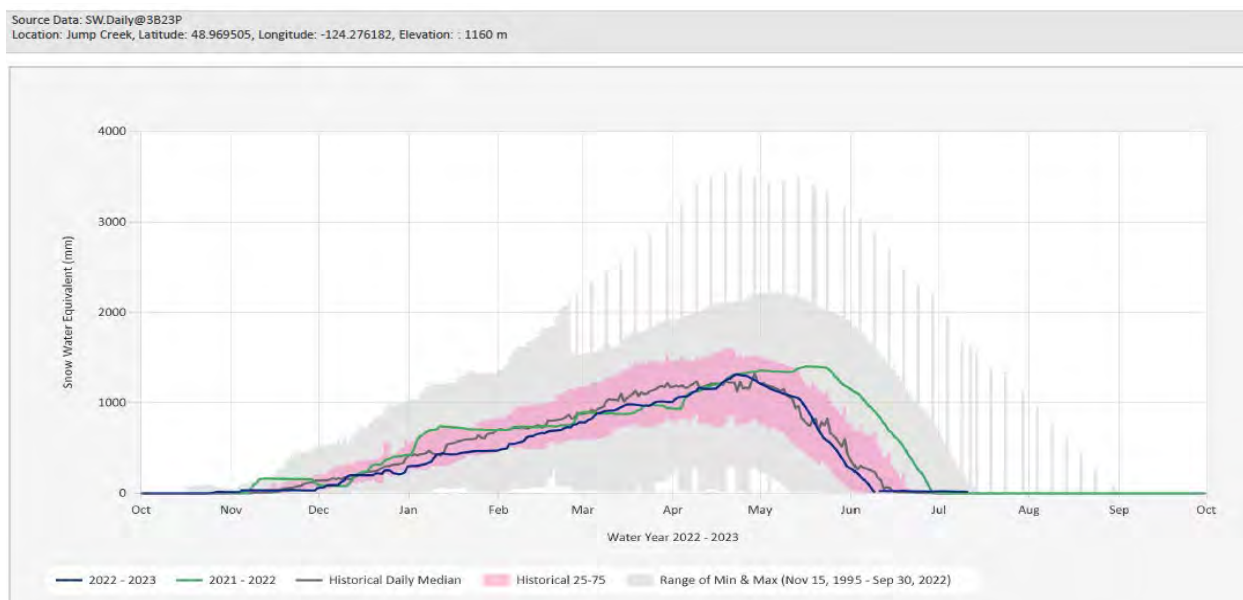


Figure 5 Snow water accumulation in the Nanaimo Lakes region (2022-23; MOF 2023).

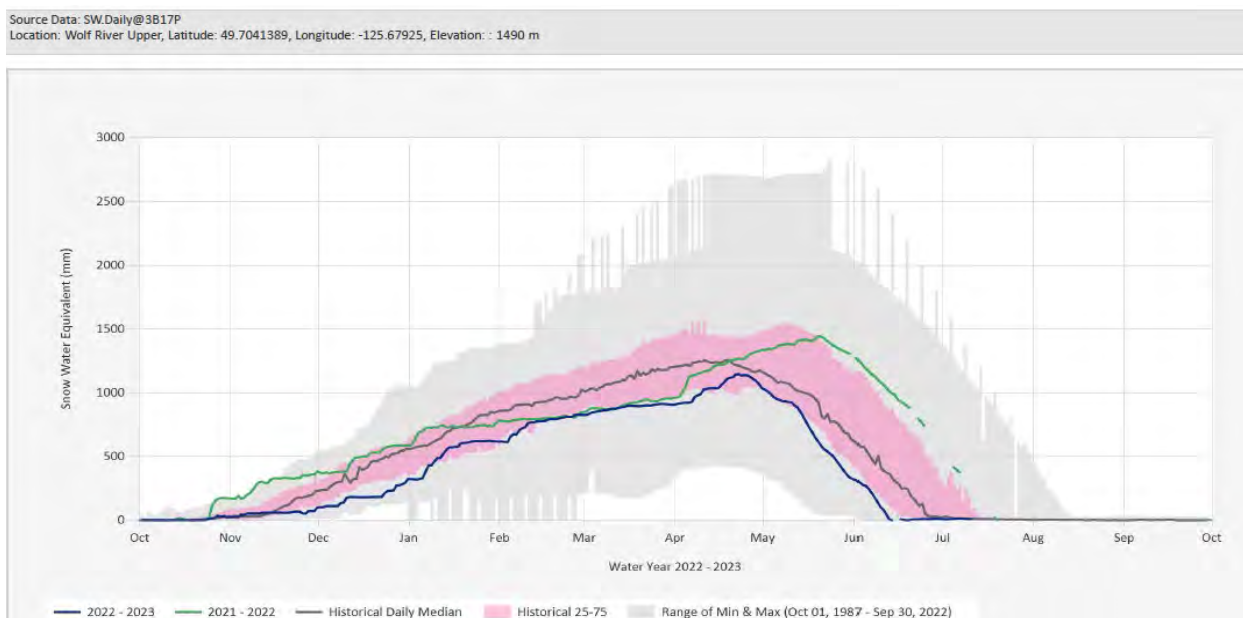


Figure 6. Snow water accumulation in the Strathcona region (2022-23; MOF 2023)

4.7.2 Weather

Summer 2023 saw relatively dry conditions with several significant wildfires adjacent to marmot habitat in August (BC Wildfire Service, 2023). Despite relatively dry conditions and high number of wildfires, crew did not observe early season vegetation senescence in the alpine, and wild-living marmots generally appeared to have good body condition.

Fall 2023 air temperature, snow-water equivalent, and raw precipitation volumes were within recent historic normal ranges for alpine weather stations in both meta-populations. Marmots were first detected in torpor and in a plugged burrow on Mt. McQuillan on October 22nd, which is consistent timing with previous years.

4.7.3 Vegetation

Despite the dry conditions, the Foundation did not observe excessive vegetation senescence leading to decreased forage availability. We continue to observe marmots switching to habitat on the northern aspects of mountains later in the season where more persistent snowpack prolongs vegetation growth.

Field teams continued to note that tree ingress is a problem at many colonies (Table 6). Tree ingress degrades historic marmot habitat in two ways: (1) immature trees become established and obstruct sightlines from marmot refuges and lookout boulders, and (2) as trees become established, they provide significant stalking cover at the ground level, an impact already documented at several colonies (Table 6). Both issues improve the hunting success of predators, especially cougars, and may result in poor survival outcomes for marmots at these locations. This tree ingress is symptomatic of climate change-induced succession of high-elevation habitat from the subalpine and alpine ecosystems on which marmots rely to forest ecosystems.

Tree ingress significantly impacts marmot habitat and eventually replaces it altogether (Laroque et al., 2000). In early stages, young trees facilitate predation as discussed above, and make colonies more vulnerable to extirpation. Marmot habitat is already highly constrained, and declining habitat quality or habitat loss will make recovery of the species more difficult and costlier. Ideally, the Foundation or another entity would conduct habitat improvement activities before predation or vegetation succession becomes a significant problem for a colony. Early action also means the clearing work is more efficient because trees are smaller and less numerous.



Photo 3 Flying above marmot habitat by Michael Lester

Table 7. Observations of habitat conditions at marmot colonies

Region	Site	Sublocation	Notes
Strathcona	Castlecrag Mountain	West Shelf, Main Meadow, Talus Bowl	Recommended focal site for future habitat improvement efforts. 2023 field observations continued to see dense forests below well-used hibernacula in all three sublocations. Tree ingress is an ongoing concern within this sublocation and efforts should focus on restoring sightlines from marmot habitat features, with a particular focus on those impacted by dense forests downslope (Figure 6).
	Flower Ridge	Price Pass	Recommended focal site for future habitat improvement efforts. 2022 field observations saw heavy, dense tree cover within the main drainage system once occupied by marmots at this sublocation. Future actions should prioritize addressing tree ingress within this area, particularly upslope where denser forests are (Figure 7).
Nanaimo Lakes	Arrowsmith	South Meadow	Recommended focal site for future habitat improvement efforts. 2022 field observations continued to see heavy tree ingress in the direct vicinity of well-used hibernacula, with some burrows completely enclosed by dense forest.
	Gemini	Main Meadow	2021 focal site for habitat improvement – tree ingress report available. Significant tree ingress remains, and this site remains a recommended focal site for future treatments. Two distinct stands of dense trees formed within the Main Meadow, dividing this sublocation into three micro meadows.
	Haley Lake	Main Meadow	2023 focal site for habitat restoration. Considerable tree ingress was removed over 5 days in core marmot habitat, focusing on opening up sightlines from around important marmot habitat features.
		Bell Creek	Recommended focal site for future habitat improvement efforts. 2023 field observations continued to see moderate tree ingress towards the center of the meadow, particularly within the north end of this sublocation. Future restoration efforts should focus on removing tree ingress within meadow habitat, and thin established patches of forest at it's periphery and towards areas of known marmot travel (e.g. the upper ridgeline).

	Hooper	Main Meadow	Recommended focal site for future habitat improvement efforts. 2023 field observations saw heavy tree ingress within micro-meadows – both the main meadow, as well as in micro meadows adjacent to drainage features at lower elevations. Future restoration efforts should prioritize building upon previous restoration efforts in 2017 by addressing tree ingress at the periphery of the sublocation.
	Moriarty	LDL Meadow	2021 focal site for habitat improvement – tree ingress report available. This site remains a focal priority site for future work due to the extent of the tree ingress remaining. Concerns in this area focused on a stand of trees bordering the south side of three well-used hibernacula. Previous habitat improvement efforts were made here in 2017 – wherein trees on the north side of the 3 hibernacula were treated.
	McQuillan	West Talus	Recommended focal site for future habitat improvement efforts. 2023 field observations saw considerable tree ingress along the periphery of this sublocation, as well as especially dense forest patches. Future restoration efforts should focus on thinning dense forest in known travel corridors, as well as heavy tree ingress within talus fields.
	Sadie	North Bowl	2023 focal sight for habitat restoration. Efforts were concentrated on removing small tree ingress in the bowl and thinning the larger stands on the periphery.



Photo 4 Tree growth in marmot habitat on Castlecrag – Main Meadow. Photo by Kevin Gourlay.



Photo 5 Tree growth in marmot habitat on Flower Ridge – Price Pass. Photo by Kevin Gourlay.



Photo 6 Tree growth in marmot habitat on Haley – Main Meadow. Photo by Shayn McAskin.



Photo 7 Marmot in trees. Photo by Adam Taylor

5. RECOVERY EFFORTS

The Foundation's recovery work is supported by our partners and stakeholders, including the Provincial Government, Mosaic Forest Management, Mount Washington Alpine Resort, the Wilder Institute/Calgary Zoo, the Toronto Zoo, and the Recovery Implementation Group. The Marmot Recovery Foundation's efforts for the 2023 field season aimed to increase the overall number of marmots in the wild, protect the persistence of existing colonies through augmentation and the promotion of breeding opportunities, increase the distribution of marmot colonies on the landscape through re-introduction, and support the growth and future breeding capacity of the wild colony on Mt. Washington.

5.1 Captive-bred releases

Vancouver Island Marmots are bred in captivity at the Calgary Zoo, the Toronto Zoo, and the Mount Washington Tony Barrett Marmot Recovery Centre. The young of the year originating from the Zoos are transported to the Marmot Recovery Centre in the fall and spend their first hibernation there before becoming release candidates for the wild as yearlings. Release decisions are made based on individual animal health, genetic contributions, and the needs of the captive breeding program.

In 2023, there was a significant increase in the number of captive-bred marmots released to the wild. See the captive breeding program update below for a full update on the status of the captive population.

Table 8. Captive-bred releases

Region	Release Site	Marmot	Age	Sex	Release Date	Origin	2023 Mortality
Clayoquot Plateau	Lions North	Balvenie2	3	F	2023-07-17	Toronto Zoo	
		Marmite	2	M	2023-07-17	Toronto Zoo	
		Crusher	2	F	2023-07-17	Toronto Zoo	
Nanaimo Lakes	Big Ugly	Feld	2	F	2023-07-07	Calgary Zoo	
		Seymour2	2	M	2023-07-07	Tony Barrett Mt Washington	TRUE
	Butler	The Borg	2	M	2023-07-14	Toronto Zoo	
		Tatum	2	F	2023-07-14	Tony Barrett Mt Washington	
		Paisleigh	2	F	2023-07-14	Tony Barrett Mt Washington	TRUE
	Gemini	Rhubarb	2	F	2023-07-14	Tony Barrett Mt Washington	

		Juniper	2	F	2023-07-14	Tony Barrett Mt Washington	
	Green	Nanaimo	2	F	2023-07-07	Calgary Zoo	
		Sven	2	M	2023-07-07	Tony Barrett Mt Washington	
		Galena	2	F	2023-07-07	Calgary Zoo	
	Haley Lake	Gregson	2	F	2023-07-14	Tony Barrett Mt Washington	TRUE
		Chloro	2	M	2023-07-14	Tony Barrett Mt Washington	
		Gracelyn	2	F	2023-07-14	Tony Barrett Mt Washington	
		Tolmie	2	F	2023-07-14	Tony Barrett Mt Washington	TRUE
	Heather	Crevette	2	F	2023-07-14	Tony Barrett Mt Washington	
		Lucky2	2	F	2023-07-14	Tony Barrett Mt Washington	
		Phyll	2	M	2023-07-14	Tony Barrett Mt Washington	
	Hooper	Gabbro	2	M	2023-07-07	Calgary Zoo	
		Nora	2	F	2023-07-07	Calgary Zoo	
		Landon	2	M	2023-07-07	Tony Barrett Mt Washington	
	Landale	Lennon	2	F	2023-07-14	Tony Barrett Mt Washington	TRUE
		Worf	2	M	2023-07-14	Toronto Zoo	
	P Mtn	Rhodes	13	M	2023-07-07	Calgary Zoo	
		Flower	2	F	2023-07-07	Calgary Zoo	TRUE
		Dallas	2	M	2023-07-07	Calgary Zoo	TRUE

	Sadie	Barb	2	F	2023-07-07	Tony Barrett Mt Washington	TRUE
		Martina	2	F	2023-07-07	Tony Barrett Mt Washington	TRUE
		Dunmor	2	M	2023-07-07	Calgary Zoo	
		Cinnabar	2	M	2023-07-07	Calgary Zoo	TRUE
Strathcona	Washington	Olaf	2	M	2023-06-23	Tony Barrett Mt Washington	
		Warden	2	M	2023-06-23	Calgary Zoo	
		Marmalade2	2	F	2023-06-23	Toronto Zoo	TRUE
		Data	2	F	2023-06-23	Toronto Zoo	TRUE
		PB	2	M	2023-06-23	Toronto Zoo	
		Nutella	9	F	2023-06-23	Toronto Zoo	TRUE
		Tobias	2	M	2023-06-28	Tony Barrett Mt Washington	TRUE
		Ernie2	2	M	2023-06-28	Tony Barrett Mt Washington	
		Aubergine	2	F	2023-06-28	Tony Barrett Mt Washington	
		Honey2	2	F	2023-07-17	Toronto Zoo	
Total	Sum	42		F=24 M=18			14

5.1.1 Fates of Released Marmots

Significant research has gone into improving outcomes for released and translocated marmots (Falconer, 2021; Lloyd et al., 2019; Jackson et al., 2016; Jackson, 2012; Aaltonen, 2009; Bryant et al., 2005), but significant research gaps remain, and a wide range of site and temporal variables influence decision making and outcomes. It is worth noting that captive-bred marmots have greater success when released to the Nanaimo Lakes meta-population (Lloyd et al., 2019). What factors create this difference between the two meta-populations has not been researched, but possibly differences in the length of the species' extirpation in the two regions, as well as climate and elevation differences, influence the success rates of captive-bred marmots experience.

In the past five years, there have been two significant changes to captive-bred marmot releases and translocations: implementing the results of the stepping stone study and increasing the capacity of the captive breeding population.

Fates of Captive-Bred Marmots released to the Nanaimo Lakes and Mount Washington

Captive-bred marmots are typically released at 1 year of age. For these marmots to contribute to population growth, they must reach breeding age. The average age of first breeding for female marmots is 3.6 years old, with some females breeding as early as 2 years old and others beginning at 4 or later (Bryant, 2005). Between 2019 and 2023, 104 captive-bred marmots were released in the Nanaimo Lakes region or at Mount Washington. Of those, 36% (n=14) survived to 3 years old, and 26% (n=10) survived to 4 years old.

Fates of Released Captive-bred Marmots

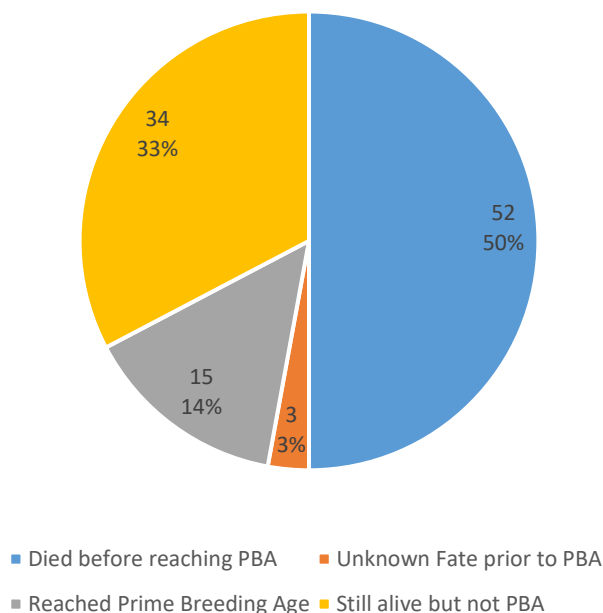


Figure 7 Fates of Captive-bred marmots released to the wild between 2019 and 2023. “PBA” means “Prime Breeding Age.”

5.2 Moving Marmots

Marmots can follow many different life pathways as we manage the population by moving marmots to accomplish various recovery objectives such as augmenting small colonies and maximizing genetic outbreeding. This means it can be difficult to label all possible scenarios that a marmot may take. After their initial captive-release, some captive-bred marmots are recaptured and subsequently re-released to the same colony, or translocated to a different colony for various reasons. Wild born marmots are sometimes trapped and brought into captivity for various reasons. They may stay in captivity as part of the breeding program, or only for a short period of time and then may be re-released to the same colony or translocated to a new colony. All marmot movements, excluding captive-bred marmots which are being released to the wild for the first time, are accounted for here.

5.2.1 Re-releases and Translocations

There were 11 marmots with some level of previous wild-living experience that were released back into the wild this year. Marmots which were released to the same colony where they were captured after a period of time in captivity are considered re-releases, whereas if they were moved to a different colony they are considered translocations.

Table 10. Marmots translocated or re-released

Release Region	Release Colony	Source Colony	Marmot	Age	Sex	Origin	Deceased
Clayoquot Plateau	Lions North	Washington	Everett	3	M	Tony Barrett	
Nanaimo Lakes	Gemini	LDL Cutblock	Russell2	2	M	wild-born	
Strathcona	Becher	Washington	Cooper	2	M	wild-born	
	Castlecrag	Errington	Camas	4	M	Calgary Zoo	
		K-Block	Shiloh2	2	F	wild-born	
	Red Pillar	Washington	Septimus	3	M	Calgary Zoo	
		K-Block	Teo	2	M	wild-born	
	Washington	Washington	Lorna	3	F	wild-born	
		Washington	Mayzie	3	F	wild-born	
		Washington	Lilibet	2	F	wild-born	
		Washington	Deebo	2	M	wild-born	TRUE
		Washington	Honey2	1	F		
Total			11		F=4 M=7		1

5.2.2 Fates of Translocated and Stepping Stone releases in Strathcona Provincial Park

Preliminary results of the Stepping-stone release methodology (Lloyd et al., 2019) were available to the Foundation in late 2017. Results indicated that taking a stepping-stone approach to releasing captive-bred marmots to the Strathcona meta-population greatly improved outcomes, and that translocated wild-born marmots also had high success rates. By comparison, outcomes for direct released captive-bred marmots in Strathcona Provincial Park were poor. Beginning in 2018, only wild-born or stepping-stone marmots were translocated into colonies in Strathcona Provincial Park.

While sample sizes are very small, marmots released into Strathcona Provincial Park since 2018 have experienced survival rates in line with those found in the study for the wild-born and stepping-stone cohort. During this period, the majority of translocated marmots have been wild-born, located either in inappropriate habitat or from the Mount Washington colony (n=15). The low number of stepping-stone marmots (n=1) is due to small cohorts of captive-bred release candidates until 2021, and then an

unexpected predation event at Mount Washington in 2021. In the future, the Foundation expects that larger numbers of stepping-stone marmots will be released in the Strathcona region.

Fates of Marmots Translocated to Strathcona Provincial Park

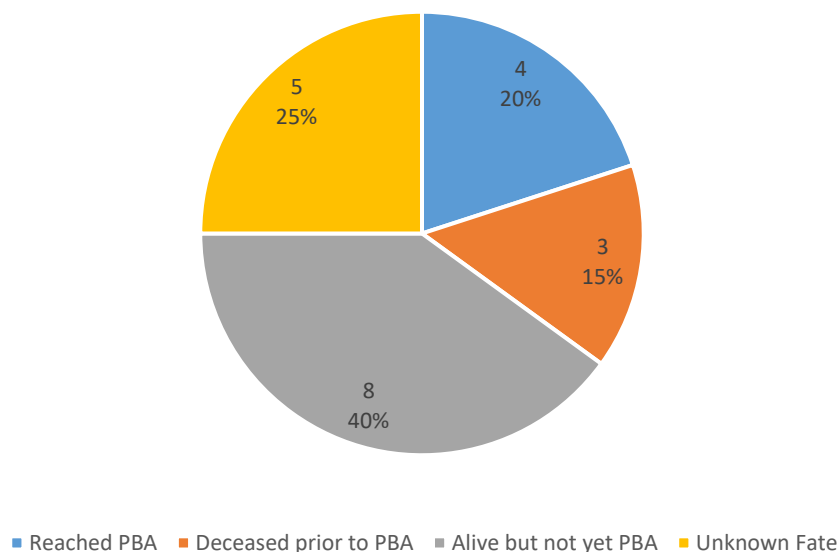


Figure 8 Fates of marmots translocated to Strathcona Provincial Park 2019 to 2023

5.2.3 Brought into Captivity

Wild-living marmots frequently show up in areas of ephemeral or unsuitable habitat. The Foundation continues to manage marmots living in unsuitable habitat based on their unique circumstances and projected timeframe for the habitat issues. When possible, these marmots are trapped and receive a thorough health evaluation at the Tony Barrett Mount Washington Marmot Recovery Centre, and are translocated in Strathcona Provincial Park to augment existing colonies there.

The capacity of the Foundation to respond to situations of marmots in unsuitable habitat has been greatly improved over the past three years, with year-round operations in place at the Marmot Recovery Centre. In 2023, four marmots were trapped in the spring and were subsequently translocated back into the wild in July. An additional marmot was trapped in a utility shed on Mt. Washington, and subsequently re-released back to Mt. Washington.

There were no marmots captured from the wild with the intent to augment the breeding program in 2023.

Table 6. Marmots brought into the Marmot Recovery Centre from the wild in 2023.

Colony	Marmot	Age	Sex	Date	Reason	Fate
Cut block	Teo	1	M	2023-05-31	Unsuitable habitat	Translocated into Strathcona
Cut block	Shiloh2	1	F	2023-05-31	Unsuitable habitat	Translocated into Strathcona
Errington	Camas	3	M	2023-07-05	Unsuitable habitat	Translocated into Strathcona
Washington	Septimus	2	M	2023-06-27	Stepping-stone marmot	Translocated into Strathcona
Washington	Honey2	1	F	2023-08-31	Unsuitable habitat	Trapped in utilities shed, re-released.

5.3 Wild Transmitter Implants

The Foundation surgically implants radio telemetry transmitters in a subset of the wild-living population to facilitate the monitoring of their survival, hibernation, and location. Transmitter batteries last three to four years, and then can sometimes be replaced. Collecting radio-telemetry data informs a variety of management decisions about the allocation of resources, such as the distribution of supplemental feeders, selection of sites needing augmentation, identification of successful colonies able to provide wild-living marmots for translocation, and the rescue of marmots from unsuitable habitat.

In 2023, all transmitters were implanted by the Foundation’s veterinarian, Dr. Malcolm McAdie. Implanted marmots (see Table 10) were aged 1yo or older, and surgeries were conducted in or after June to allow marmots to regain some body condition following their hibernation. The Foundation conducted five implant sessions over the field season, including one in Nanaimo Lakes, one session at Mt. Washington, and two sessions at other Strathcona colonies. All captive-bred and translocated marmots are released with active radio-transmitters.

Table 7 Transmitter implants of wild-living marmots

Region	Colony	Marmot	Sex	Recapture	Fate
Nanaimo Lakes	Arrowsmith	Grubby Mitts	F	New	Re-released
		Mister	M	New	Re-released
		Murray	M	New	Re-released
		Moth	F	New	Re-released
		Grubby Mitts	F	New	Re-released
	K-Block	Teo	M	New	Translocated
		Shiloh2	F	New	Translocated
	Albert Edward	Stitch	F	New	Re-released
		High Roller	M	New	Re-released
	Marble Meadows	Elly May	F	Recapture	Re-released
	Washington	Ezekiel	M	Recapture	Re-released
Total		12	F=6 M=5		

5.4 Supplemental Feeding

Anecdotal evidence suggests that supplemental feeding may improve the overwinter survival and reproduction of Vancouver Island Marmots. Despite the potential impact on recovery efforts, the Foundation has never had the capacity to properly investigate these relationships. In 2018, the Calgary Zoo's Centre for Conservation Research (now Wilder Institute) initiated a pilot study to test potential methodology for a study on supplemental feeding and its benefits to marmot reproduction. After a shortened season in 2020, the Calgary Zoo Research team was able to return for a full field season in 2021 to 2023 with two field teams. From May to July, Calgary Zoo field staff collected data, trapped marmots for weights, as well as installed remote cameras and empty feeders at their study sites. Throughout July and August, they swapped camera cards and batteries and re-filled each feeding site up to eight times during the month of August. They also trialled a digital remote weigh scale to collect marmot weights this year, results pending.

The Foundation provides supplemental food (also Mazuri leaf-eater biscuits) to marmots in the spring, when snow limits the amount of available food for marmots, and bears are less likely to discover and empty the feeders. Spring Feeding effort increased by 188% this year (32 feeders), compared to last year (17 feeders).



Photo 8 Newly installed feeder and biscuits. Photo Jakob Andrian.

Table 8 Supplemental Feeding in 2023. * indicates colony where supplemental food was provided by Wilder Institute/Calgary Zoo

Region	Colony	Timeframe	# Feeders	# Marmots Benefiting	Biscuit Quantity (Kg)
Clayoquot Plateau	Lions North	May-July	1	Unknown	11.33
	Steamboat	May-July	2	6	22.66
Nanaimo Lakes	Arrowsmith*	August	4	27	36.00
	Gemini	May-July	1	6	11.33
	Green	May-July	1	8	11.33
	Haley*	August	2	7	14.49
	Heather	May-July	1	7	11.33
	Hooper	May-July	2	11	21.33
	Landale	May-July	2	11	22.66
	McQuillan	May-July	1	13	11.33
	P Mountain*	August	2	5	3.71
	Sadie	May-July	1	3	11.33
Strathcona	Albert Edward	May-July	2	17	22.66
	Castlecrag	May-July	3	17	34.00
	Flower Ridge	May-July	1	Unknown	11.33
	Greig Ridge	May-July	1	8	11.33
	Marble Meadows	May-July	2	15	22.66
	McBride	May-July	2	12	11.33
	Morrison Spire	May-July	1	11	11.33
	Red Pillar	May-July	1	11	11.33
	Shepherd's Ridge	May-July	1	6	11.33
	Sunrise	May-July	1	4	11.33
	Tibetan	May-July	1	Unknown	11.33
	Washington*	May-June	5	34	41
Total	24 colonies		41 feeders	239 marmots	400Kg

The Foundation has expanded our feeding effort in recent years. More helicopter time has been allocated to feeding, and feeders have been redesigned to allow more feeders on a helicopter per flight. Not all colonies can be provided with feeders, particularly colonies with where avalanche terrain makes safe deployment impossible. The Wilder Institute supplemental feeding study began in 2019, with feeders at three colonies in the Nanaimo Lakes region each year. These are included in the chart below.

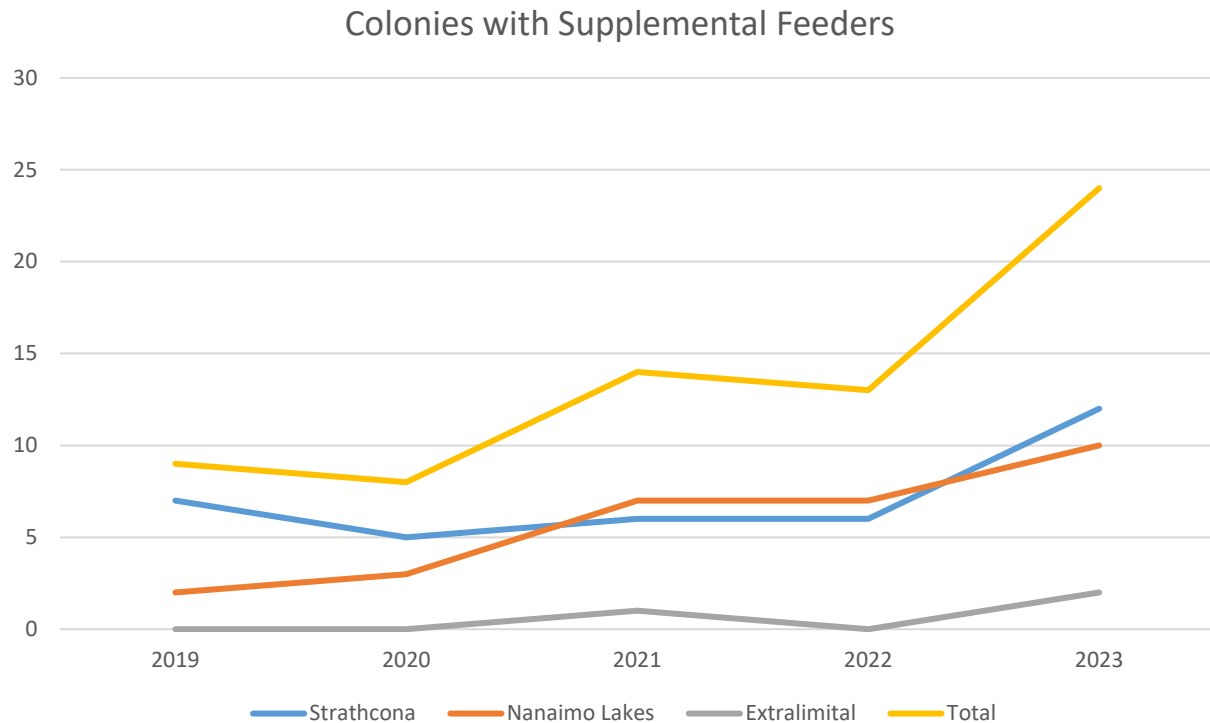


Figure 9 Number of colonies with supplemental feeders by year

5.5 Habitat Improvement

In some years, the Foundation has conducted habitat improvement activities at colonies with the goal of increasing local survival rates and preserving long-term habitat suitability. Recent habitat improvement has included the removal or partial delimbing of ingressing trees in marmot habitat. These trees and low branches provide stalking cover to terrestrial predators. By regaining long, continuous lines of sight, marmots may have a better opportunity to detect and evade predators.

For the third year in a row, the Foundation was granted funding for habitat improvement projects during the months of October – November. With the use of chainsaws and large crews, we were able to complete considerably more work than the Foundation has done in past efforts. All habitat improvement occurred within the Nanaimo Lakes region, following a specific set of Best Management Practices for methodology. This included mitigation efforts to avoid short-term and/or long-term damage to known burrows and/or hibernacula. Further details on methodology, best management practices, and photo analysis results can be found within the Foundation’s “Tree Change in Vancouver Island Marmot Colonies: Best Management Practices, Past Efforts, & Photo Analysis” report.

Table 9 Habitat Improvement

Colony	Hectares improved	Description of Work
Sadie	2	Single day of work with large crew concentrating in core habitat area. Current marmot occupation, documented cougar predation, and significant tree ingress classified this site as high priority for restoration work.
Haley	4.3	Five days of restoration work completed in core habitat area. Current marmot occupation, documented cougar predation, and significant tree ingress classified this site as high priority for restoration work. Work completed with permit from BC Parks.

5.6 Invasive Species of Concern

In 2023, at least three Yellow-bellied marmots were located on Vancouver Island. Of these, one was successfully trapped and re-released on the mainland, one was trapped but in extremely poor condition, and died in care, and one was not successfully trapped, and could not be re-located.

Yellow-bellied marmots (*M. flaviventris*) are a species of colonial marmot found in western mainland Canada and the United States. Although *M. flaviventris* can live in mountains at high elevations, in British Columbia they are often associated with low-elevation habitat in the Thomson Okanagan and Kootenay regions. In these areas, they often occupy a range of natural and artificial habitat, including orchards, farmlands, and golf courses where they are frequently viewed as a pest species. As urban centres in these areas have expanded, *M. flaviventris* has also been found to thrive in more developed areas of towns and cities.

Unlike the Vancouver Island Marmot, *M. flaviventris* is not native to Vancouver Island, but they have been sighted on the Island with increasing frequency in recent years. This is likely part of a province-wide problem in which marmots have been unintentionally transported from colony locations to non-historic habitat, traveling in bus baggage compartments, vehicle engine bays, and shipments of equipment and agricultural supplies. Of particular concern to the Foundation is the capacity for *M. flaviventris* to introduce novel diseases and pathogens that could potentially decimate Vancouver Island Marmot colonies. Transmission could result from direct contact, or via an intermediate host, such as the soles of hiking boots. The Recovery Plan assesses the risk of Invasive & other problematic species, genes & diseases as medium-to-high impact with slight to serious severity (Vancouver Island Marmot Recovery Team 2017).

On Vancouver Island, *M. flaviventris* have been sighted at various urban and rural locations from Victoria up to Courtenay.

5.7 Monitoring

The Foundation monitors the status of Vancouver Island Marmots in the wild in order to make strategic and informed decisions about recovery efforts. Monitoring provides information about colony locations, rates of survival and reproduction, causes of mortality, and the age- and sex- structure and size of colonies. This information directly influences the selection of release sites and release candidates, the installation of spring supplemental feeders, and the identification of habitats needing improvement to facilitate

colony growth and persistence. Information about annual mortality and reproduction forms the basis of our understanding of the species' population and conservation status.

5.7.1 Methodologies

Effectively monitoring marmots can be challenging due to the difficulties accessing their sub-alpine habitat, the marmot's semi-fossorial behaviour and activity patterns. For this reason, the Foundation used several approaches to monitoring. Prior to marmots being released or translocated, all marmots were implanted with radio-telemetry transmitters (Holohil A1-2TH) that have a battery life of ~4 years. These transmitters send out a pulse that changes speed in response to temperature; living marmots are warm, and their transmitters send out a faster pulse than those of deceased or hibernating marmots. This facilitated survival and location monitoring of these marmots which enabled the Foundation to evaluate a marmot's post-release success. The Foundation also implanted a subset of wild marmots, which provided the same survival and location data.

For a typical telemetry survey, 2-4 crew members hiked into marmot habitat and used receivers and antennas to scan through a set of frequencies specific to individual marmots. When crew heard a pulse indicating that a signal was detected on one such frequency, the number of pulses per minute indicated whether the marmot was alive (≥ 30 ppm), possibly alive (29ppm) or dead/hibernating (≤ 28 ppm). If a dead marmot was accessible for recovery, field teams attempted to track the transmitter to its resting location to collect information about the cause and timing of the mortality and recover the transmitter for refurbishing and reuse. Aerial telemetry conducted from helicopters was also an important monitoring tool, particularly for colonies in Strathcona where a significant proportion of the population is telemetered and needs to be monitored closely to evaluate release success.

Visual surveys of marmot colonies formed a significant component of the responsibilities of annual, seasonal field crew hired by the Foundation. During a visual survey, one or more team members sat at vantage points near a marmot sublocation and used binoculars and/or a spotting scope to count and age marmots based on their size, pelage, and presence or absence of ear tags. Crew used telemetry to identify the known individuals in the area (whether observed or just detected) and then summarized the number of untelemetered tagged and untagged individuals that were observed.

Field crew typically conducted surveys in the morning (6-10am) or if on overnight trips, during the late afternoon and evening (3-9pm). On daytrips, most visual surveys lasted for 1-3 hours and at several sublocations depending on the size of the field team. On overnight trips, field crew often surveyed a colony for closer to 8 hours in a single day. It took several daytrips over the course of a field season for the Foundation to feel confident in the estimate of a colony's size and composition; overnight trips typically provided the Foundation with a faster and more comprehensive understanding of colony size and composition.

Wildlife cameras were deployed at marmot hibernacula and burrows and at supplemental feeders to capture video and audio footage of marmots. Cameras were also used to confirm that unsuitable habitats have not been recolonized by marmots, and to identify predators in or near marmot habitat, although these scenarios were less common. Cameras proved essential at remote colonies such as those in Strathcona that could not be accessed for regular, on-the-ground surveys. The Foundation used the unique appearance of marmots, particularly their molt pattern, size, and the presence or absence of ear tags, to count pups and identify and age individuals. The Foundation also evaluated marmot behavior in

the videos, because this can provide clues about the social structure of the colony. Videos were reviewed quickly during the field season, and in greater depth in the off-season (November and December). The foundation uses the program Timelapse2 to tag and archive videos.

In 2023 the Foundation greatly benefitted from the regular presence of teams from Calgary Zoo/Wilder Institute. The Calgary Zoo/Wilder Institute visited six colonies regularly in the Nanaimo Lakes area, plus numerous exploratory trips into other sites. See Table 15 for more information on how this impacted search effort.

For a greater level of detail about monitoring methodologies, please contact the Marmot Recovery Foundation.

5.7.2 Remote camera results

Camera traps contributed significantly to our hill counts and understanding of marmot habitat use by both marmots and other species. Some commonly observed species using marmot habitat features include Black Bear, Black-tailed Deer, Pine Marten, Ermine, Grouse, Elk, and Cougars.

Table 10 Footage captured by select remote cameras in 2023.

Region	Colony	Timeframe	# of unique marmots detected			Other species of note	Notes
			Adult	1yo	Pup		
Nanaimo Lakes	Arrowsmith*	May-Oct	4	1	8	Marten	Supplemented by CZWI
	Big Ugly						Completed by CZWI
	Butler	May-Oct	5	1		Bear, Deer	
	Cutblock – KBlock	May- July	1	1			
	Cutblock- Knight Lake	May					
	Cutblock- Labour Day Lake	May- July					
	Douglas						Completed by CZWI
	Gemini	May-Aug	2			Cougar, Bear, Deer, Marten, Ermine, Grouse	
	Green	May-Oct	2	1		Deer, Bear,	
	Haley Lake						Completed by CZWI
	Heather	May-Oct	3			Cougar, Deer, Bear	
	Hooper	May-Oct	5		1	Cougar, Deer, Bear, Marten, Grouse	
	Landale	May-Oct	6	1		Bear, Marten, Ermine	
	McQuillan	May-Oct	2		1	Deer, Marten, Ermine, Grouse	

Region	Colony	Timeframe	# of unique marmots detected			Other species of note	Notes
			Adult	1yo	Pup		
	Moriarty						Completed by CZWI
	P Mtn*						Completed by CZWI
	Sadie	July-Oct	1			Cougar, Marten, Ermine,	
Strathcona	Albert Edward	May-Oct	5	2	2	Marten, Ermine, Grouse	
	Becher	May-Oct	2	2		Bear, Ermine, Grouse	
	Castlecrag	May-Oct	5		4	Deer, Marten, Ermine, Grouse	
	Flower Ridge	May-Oct				Ermine	Poor installation, not serviced until retrieved
	Greig Ridge	May-Sept	2		1	Deer, Bear	
	Marble Meadows	May-Oct	7	1	1	Bear, Marten, Ermine, Grouse	
	McBride	May-Sept	6	2	1	Deer	
	Morrison Spire	May-Oct	3	1	4	Marten, Ermine,	
	Red Pillar	June-Oct	3		1	Marten, Grouse	
	Shepherds Ridge	Aug-Sept	2		1		
	Sunrise	Failed					Camera Failed, not serviced until retrieved.
	Tibetan	May-Aug				Bear	
	Washington	May-Oct	2	1	2	Deer, Bear, Marten	Supplemented by CZWI
Clayoquot Plateau	Steamboat	May-Oct	3			Ermine	
	Lions North	Failed					Camera Failed, not serviced until retrieved.
TOTAL	32 colonies						

5.7.3 Summary of monitoring effort by location

In 2023, the foundation expanded its field presence to three full time field teams. Along with the continued presence of the CZWI team at seven focal colonies, search effort increased considerably this year from the previous 4 years. The additional resources also allowed us to explore new sites and infrequently-surveyed sites, particularly in Strathcona Provincial park and Clayoquot Plateau Provincial Park.

Visual Survey effort is measured in number of total person-hours spent observing marmot habitat at each colony, including ground surveys, drone flights, and helicopter flights. Some historic colonies are not reported in the table below.

Table 11 A comparison of monitoring effort in 2023 to previous years.

Region	Site	Average rolling four-year Effort (Person Days)	2023 Effort (Person Days)	% of three-year average effort	Notes
Nanaimo Lakes	Arrowsmith	54	70	131%	CZWI study site
	Big Ugly	45	44	99%	CZWI study site
	Butler	9	15	167%	
	Douglas Peak	37	40	110%	CZWI study site
	El Capitan	0	5	2000%	New colony in 2023
	Gemini	14	15	111%	
	Green	8	16	206%	
	Haley/Bell	49	54	111%	CZWI study site
	Heather	9	15	171%	
	Hooper	2	15	1000%	
	Landale	8	21	280%	New colony in 2021
	Limestone	4	0	0%	
	McQuillan	14	13	91%	
	Moriarty	31	28	91%	CZWI study site
	P Mtn	32	31	98%	CZWI study site
	Sadie Peak	7	17	262%	
	Tangle	0	2	N/A	Not survey recently
Strathcona	Whymper	1	1	100%	
	Cutblocks-all	28	25	88%	
	Albert Edwards	1	16	3200%	Trapping trip site
	Becher	8	26	315%	New colony in 2021
	Castlecrag	9	15	171%	
	Celeste	0	9	N/A	New colony in 2023
	Flower Ridge	5	2	40%	Surveyed sporadically
	Greig Ridge	2	9	450%	

Region	Site	Average rolling four-year Effort (Person Days)	2023 Effort (Person Days)	% of three-year average effort	Notes
	Marble Meadows	9	18	195%	
	Marble Peak	5	3	67%	
	McBride	0	7	N/A	New colony in 2023
	Morrison Spire	1	5	500%	
Extralimital	Red Pillar	2	9	600%	New colony in 2022
Total	Shepherds Ridge	0	9	N/A	New colony in 2023
	Sunrise	2	7	311%	
	Tibetan	3	1	31%	
	Mt. Washington	174	90	52%	VIU team not present this year
	Wheaton Lake	1	5	1000%	Not survey before 2021
	5040	0	15	N/A	Not surveyed recently
	Lions North	0	2	N/A	Not surveyed recently
	Steamboat	5	5	95%	Surveyed sporadically
Total:	N=37	573	680	119%	

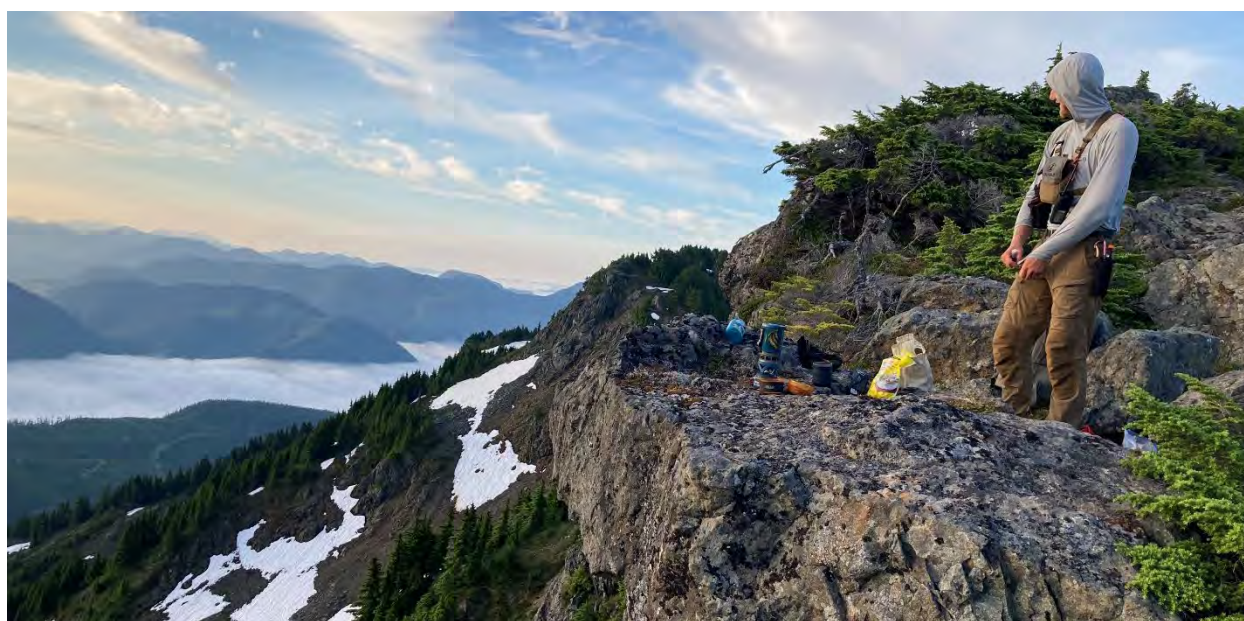


Photo 9 Overlook of marmot habitat. Photo by Geric Coutts.

5.7.4 Community contributions to monitoring

Reports from the community at large, particularly those who work or recreate in or near marmot habitat, make important observations that can improve recovery efforts. Since 2017, the Foundation has made greater outreach efforts to solicit observations, and looks forward to building more partnerships with hiking and outdoor recreation organizations in the future. In 2023, the Foundation received over 30 marmot reports, including a number of significant observations.

Table 12 Significant reports from the public in 2023.

Region	Location	Nature of Report(s)	Significance
Nanaimo Lakes	Errington	Report, photographs, location	Reported Camas, a dispersing marmot that had found his way into a low-elevation rural area. Trapped and re-released.
Strathcona	Mt Celeste	Hiker report, photos, location data	Documented a new colony site. The Foundation confirmed occupancy later in season.
	Mt. McBride	Hiker report,	Confirmed ongoing habitat use at Mt McBride.
	Mt. Washington	Hiker reports, photographs.	Many reports from visitors documenting resident marmots.
Clayoquot Plateau	Steamboat	Biologist report, photos, location data	Marmot occupation in new sublocation adjacent to existing colony
Invasive Species	Victoria-area, Nanaimo-area	Reports, photographs	Several reports of Yellow-bellied marmots in the Greater Victoria area and one in the Comox Valley.

6. TONY BARRETT MOUNT WASHINGTON MARMOT RECOVERY CENTRE

6.1 Background

The Tony Barrett Mount Washington Marmot Recovery Centre ("the Centre") received its first marmots on October 15, 2001, and in 2023 the facility completed its 22nd year of operation. From 2001 to 2012 the Centre functioned as a quarantine, pre-release, and breeding center. Captive reintroductions (which began in 2003) resulted in significant growth of the wild population, and because of this success, the captive program was intentionally downsized in 2012. From 2013 to 2017 the Centre was used as a seasonal quarantine, pre-release (i.e., VIM coming from the other captive facilities in the spring and being prepared for release) and staging facility (temporary holding of VIM prior to translocation, primarily from the wild Mount Washington colony to sites in Strathcona). Inventory conducted in the years following 2012 indicated that the wild population was slowly declining and that its status remained precarious and at risk. In response, the Centre was recommitted to overwintering release marmots during the winter of 2017 / 18 and returned to being a year-round, multipurpose facility (including hibernation and preparation of release marmots, maintenance of breeding pairs and future breeders) in 2019.

Year-round operation of the Centre significantly increases the program's capacity for captive breeding and releases, and it has given MRF staff greater flexibility in responding to management situations (for example recapturing wayward releases or marmots under predation threat, holding marmots unsuitable or not ready for release or temporary holding of translocation marmots). The establishment of remote monitoring at the Centre (including internet access CCTV cameras, real-time temperature sensors and a power outage alert system) has allowed us to safeguard its winter operation with a significantly reduced on-site presence, while ensuring the safety of the hibernating marmots. Staff from the Mount Washington Alpine Resort have continued to play an essential role in snow management and staff support.

6.2 Operations in 2023

In the fall of 2022, prior to the 2022/23 hibernation, 3 marmots from the Centre were transported to the Calgary Zoo and 2 were moved to the Toronto Zoo. A total of 18 marmots were received from Calgary and 12 from Toronto. Overall, there were a total of 35 moves. These moves are made to establish suitable breeding pairs and to position the young release candidates at the Centre so they can be overwintered and released in the following year. At the onset of hibernation in October / November 2022 there were 102 marmots at the Centre. A 12.5-year-old female was found dead in her nest-box during a routine hibernation weighing in mid-December. She was subsequently diagnosed with pneumonia.

In the spring of 2023, there were 101 marmots at the Centre. This included 16 breeding pairs (where the male and female were two years of age or older). There were 9 successful litters (indicating 56.3% of the pairs were successful) and 37 weaned pups. This represented the Centre's second most successful year with respect to number of litters and pups. A litter with a single pup was also observed on one of the nest-box cameras, however it was not observed beyond a few days of its birth. Experience over the years indicates that approximately 4% of captive marmot litters are nonviable and fail to survive to weaning age.

Releases and marmot moves were completed by July 17, 2023, and involved 49 marmots that had spent the 2022/23 winter at the Centre and 4 marmots (2 wild and 2 captive-releases) that were captured and moved during the 2023 season. This includes:

- *41 x captive-born yearlings released.*
- *2 x captive-born two-year-olds released.*
- *2 x wild-born, two-year-old females (captured as yearlings) returned to Mount Washington*
- *4 x wild-born yearlings returned to the wild (all were captured as pups and temporarily held due to predation of their mothers)*
- *2 x translocation (wild-born yearlings translocated to non-natal sites)*
- *2 x pre-conditioned (captive-born releases with wild experience) moved to different sites.*

Wild experience = 1+ winter in the wild

6.3 Outlook for 2024

In the September of 2023, prior to the 2023/24 hibernation, 2 yearling males were moved from the Centre to the Calgary Zoo. A total of 17 pups were received from Calgary and 11 from Toronto (overall total = 30 moves). Currently there are 115 marmots hibernating at the Centre, including 22 breeding pairs and 62 potential release candidates.

6.4 Impact of Resuming Breeding Operations

Between 2013 and 2019, the Tony Barrett Mount Washington Marmot Recovery Centre did not breed marmots. The decision to stop breeding at the Centre was made as the marmot population in the Nanaimo Lakes approached levels that the Recovery Team thought might be sustainable without captive breeding support. Unfortunately, the marmot population in the Nanaimo Lakes area collapsed in 2014 and failed to recover in subsequent years. The decision was made to restart captive breeding at the Marmot Recovery Centre beginning in 2019. Expanding the captive breeding program included retaining young marmots in the program rather than release them and capturing young marmots from wild from unsuitable habitat and genetically underrepresented populations. As with initial establishment of the captive breeding program, marmots with low likelihood of survival were targeted for capture.

Captive Breeding Population and Releases

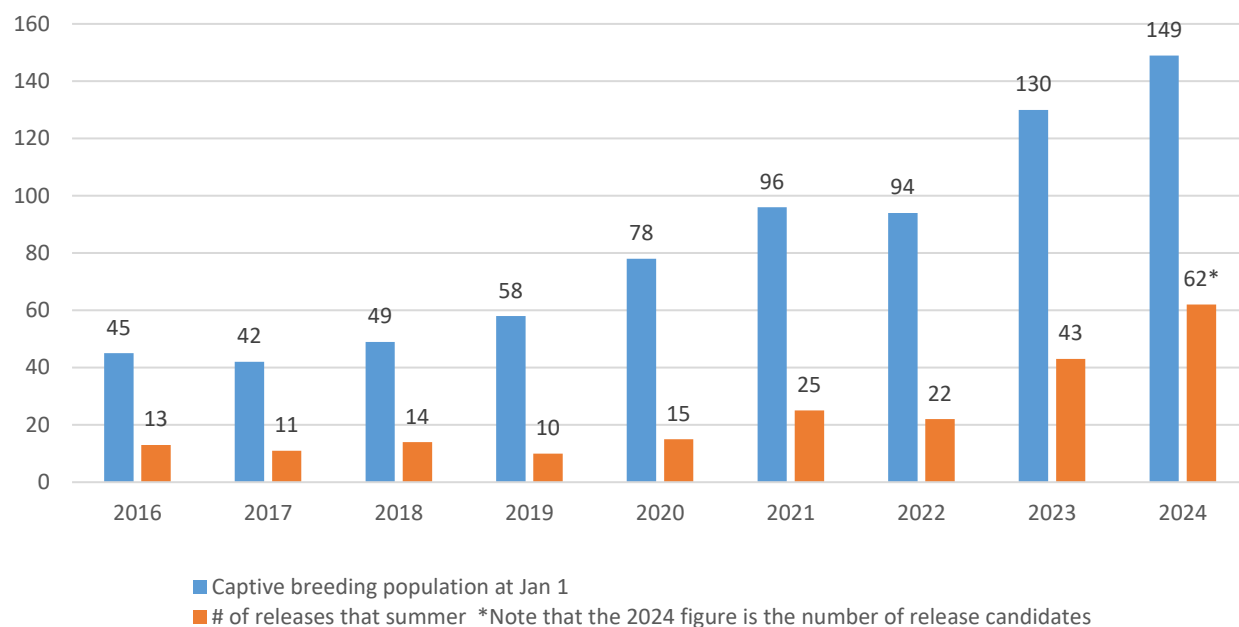


Figure 10 Captive Breeding Population and Releases. *Note the 2024 "releases" figure is the number of current release candidates.

Though it took several years for younger marmots to reach breeding age, restarting breeding operations at the Marmot Recovery Centre is now making a sizeable contribution to the number of marmots born in the program and released to the wild annually.



Photo 10 A marmot at the Wilder Institute Captive Breeding Centre. Photo by Adam Taylor.

7. SUMMARY OF CAPTIVE BREEDING PROGRAM

7.1 Project Chronology

Late 1980s and throughout the 1990s – The rare Vancouver Island marmot's (VIM) wild population demonstrates steady and precipitous declines.

1996 – An attempt to translocate 6 wild VIM from ephemeral, logged habitat to a natural, historical subalpine meadow ends in failure. The 4 marmots that remained at the release site died in a communal burrow during hibernation.

1997 – Six wild marmots are captured and sent to the Toronto Zoo (TZ). This is done pre-emptively to serve as a safeguard against a catastrophic event in the wild and to provide zoo staff with an opportunity to work out the best practices for managing and breeding captive VIM.

1998 – The Calgary Zoo (CZ) joins the fledgling captive program and receives 4 VIM. This is done to provide additional space and to manage risk by not having all of the captive VIM in a single facility. Ongoing declines in the wild lead to the conclusion that there were too few wild marmots to support a program of wild translocations or other management activities, and that the wild population would not spontaneously rebound on its own. Rather than just serving as a safeguard measure, captive breeding (with the ultimate goal of reintroduction) is identified as the only reasonable option for minimizing the imminent risk of species extinction and ultimately increasing wild populations within a reasonable period of time.

The Marmot Recovery Foundation is established as a registered charity to “fund, facilitate, promote, and carry out activities necessary to assist and enhance the survival of this species” including intensive captive breeding and reintroduction.

2000 – The captive program celebrates its first breeding success at the CZ.

The Mountain View Conservation and Breeding Society (MVF) joins the program as a third captive facility.

Construction begins on the Tony Barrett Mount Washington Marmot Recovery Centre (MRC)

2001 – The MRC receives its first marmots, just prior to the 2001/02 hibernation. The program now consists of three zoological institutions and a dedicated facility located within the natural range of the marmots.

2002 – TZ and MVF welcome their first litters of pups.

2003 – All four captive facilities have successful reproduction. The captive population is reliably growing due to captive births.

The program conducts its inaugural release of captive marmots into Nanaimo Lakes. The four released marmots do well for 45 days, but then three are killed by a cougar within the course of two days. The remaining survivor is brought back into captivity.

2004 – As the captive population grows, captive releases continue in Nanaimo Lakes and Mount Washington, incorporating the difficult lessons learned in 2003.

A captive male, released in the early spring, successfully breeds with a solitary, wild female. Released marmots successfully survive the summer.

2005 – Captive releases emerge from their first wild hibernation and survive their second summer.

2006 – After emerging from their second successful hibernation, a pair of captive-release marmots produce their first litter in the wild.

2007 – In addition to Nanaimo Lakes and Mount Washington, captive releases are initiated in Strathcona Park and Mount Cain.

2009 – Captive marmots are released in the Clayoquot Plateau.

2012 – After a decade of releases, the wild population has grown significantly from less than 30 marmots at 5 sites in 2003 to an estimated 375 marmots at 25 sites. The size of the captive population and the number of releases are significantly downsized. Releases into Nanaimo Lakes (NL) are curtailed and the focus shifts to augmenting the Strathcona population. The MRC becomes a seasonal, non-breeding facility.

2014 – After 14 years of operation, MVF leaves the captive program.

2016 – Declines in the wild population indicate that the wild population has not yet achieved sufficient resiliency or sustainability and that it is still small and vulnerable to stochastic events like drought, predation, harsh winters, etc. Resestablishing intensive captive breeding and reintroduction is considered to be important in supporting continued growth of the wild population. Wild marmots are strategically captured to reinvigorate the demographic and genetic integrity of the captive population.

2017 – MRC recommitted to overwintering release marmots during the winter of 2017/18. Captive releases resume in Nanaimo Lakes.

2019 – MRC returned to serving as a year-round, multipurpose facility, including hibernation and preparation of release marmots, maintenance of breeding pairs and future breeders.

2022 - Breeding success at all three of the participating facilities allows for resumption of operational captive releases in 2023.

2024 – The captive program enters its 27th year with renewed breeding and reintroduction capability to support augmentation of an estimated 34 wild sites.

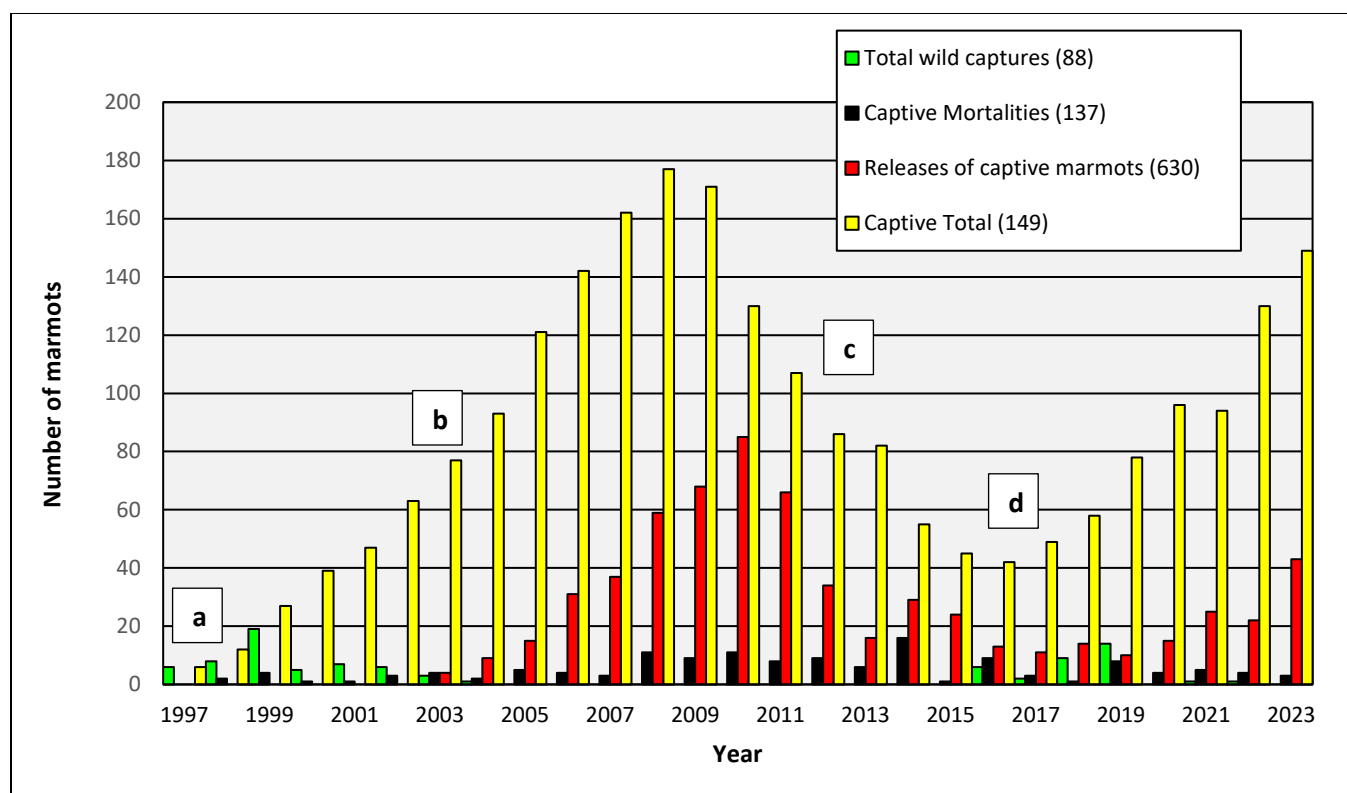


Figure 11 Captive population numbers (1997 to 2023)

- a) 1997 – captive program is initiated with six wild marmots being sent to the Toronto Zoo.
- b) 2003 – wild population reaches nadir with 22 known individuals at 5 sites. Captive reintroduction efforts begin.
- c) 2012 – Captive population and captive releases are curtailed due to apparent success of program.
- d) 2016 – Captive program is genetically and demographically reinvigorated due to declines in the wild population.

7.2 Founders

A total of 55 wild marmots were originally captured from the wild between 1997 and 2004 and these became the foundation of the breeding program. Due to the apparent success of reintroductions and growth of the wild population, the captive program was intentionally downsized in 2012. The wild population subsequently declined and in 2016 the Recovery Team approved the capture of additional wild marmots to reinvigorate the demographic and genetic integrity of the captive population. An additional 31 wild-born individuals were strategically or opportunistically captured between 2016 and 2019. In 2021 a two-year-old, wild-born female was opportunistically captured at Mount Washington due to the late season predation risk. She successfully bred at the MRC in the spring of 2022 and has been retained in the captive program. In 2022 two wild pups were captured from the Labor Day Lake cut block following the death of their mother and one of these individuals has been retained for breeding. No wild marmots were added in 2023. To date, a total of 88 wild marmots have been captured for the captive program.

7.3 Reproduction

2023 represented the 26th potential breeding season and the 24th consecutive year of successful breeding in captivity (2000 – 2023). The program has produced 824 weaned pups (450 males, 368 females and 6 unknown) or 9.4 pups for every wild marmot captured for the breeding program. In the spring of 2023, there were 32 breeding pairs (where the male and female are both 2 years of age or older). The Toronto Zoo produced 3 litters and 11 pups (from 8 pairs), the Calgary Zoo produced 6 litters and 17 pups (from 8 pairs) and Tony Barrett Mount Washington Marmot Recovery Centre produced 9 weaned litters and 37 pups (from 16 pairs). Overall, this amounts to a total of 18 litters and 65 weaned pups. The 56.3% success rate of breeding pairs in 2023 represents the program's highest annual total and the number of pups is tied as our third most successful year.

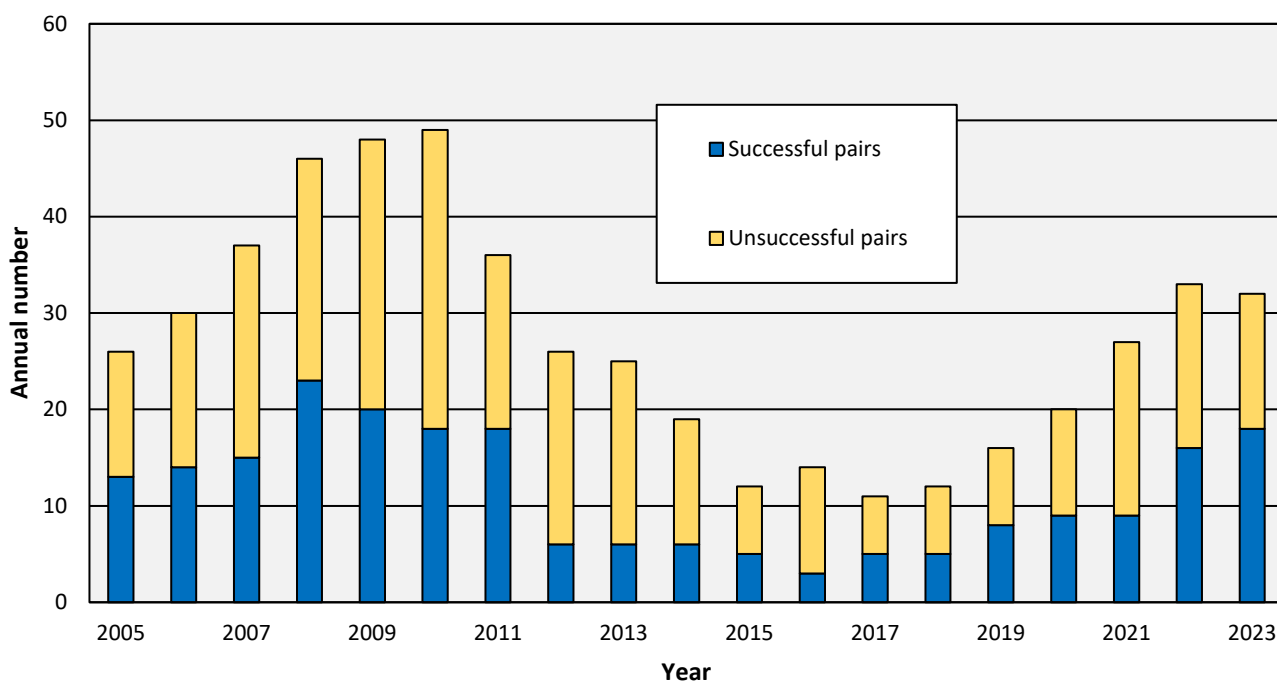


Figure 12 Annual totals of successful and unsuccessful breeding pairs (2005 to 2023). Note: Captive breeding pairs were managed in a consistent manner at all facilities from 2005 onwards.

7.4 Hibernation

From the winter of 1997/98 to the winter of 2022/23 there have been a total of 2,209 individual marmot hibernations in captivity with 36 mortalities. Therefore, 2,173 or 98.4% of the captive hibernations have been successful over 26 winters. During these 26 winters there has been 1 pup hibernation mortality and no mortality in yearlings. Over 70% of the hibernation mortalities have been associated with age-related conditions, predominantly cardiovascular disease, and neoplasia. Presumably, older, compromised marmots get to a point where they are unable to cope with the extreme physiological

alterations and challenges imposed by hibernation. Typically, they die during hibernation or remain active without properly entering torpor. In some cases, the marmots succumb after hibernation, possibly due to the demands of an increased metabolic rate. Most cellular activity may be senescent during hibernation; however, activity of neoplastic cells may be particularly aggressive once the marmots are once again euthermic and cellular activity is increased.

7.5 Mortalities

There have been 137 captive mortalities since the program began in 1997. The causes include 39 cardiovascular, 34 infectious / inflammation, 25 neoplasia, 13 iatrogenic / management, 9 cardiovascular & neoplasia, 6 congenital / early onset, 4 quarantine-associated, 2 intervertebral disc degeneration, 3 unknown causes and 2 mesenteric torsions.

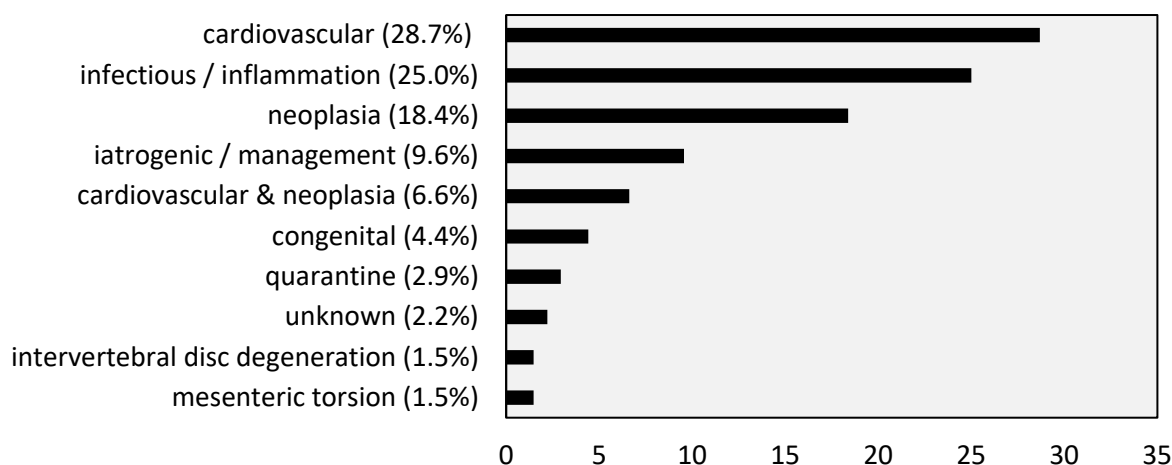


Figure 13 Causes of captive marmot mortality (total = 137)

7.6 Releases

Releases began in 2003 and from 2003 to 2023 (21 seasons) a total of 630 captive marmots have been released to the wild (11 wild-born and 619 captive-born marmots). This represents 7.0 captive-born pups for every wild capture. Overall, 75.1% of the captive-born pups have been released to the wild (not including 2023 pups) with an average of 30 releases per year (range 4 to 85).

Of the 619 captive-born pups that have been released, 150 were born in Toronto, 168 were born in Calgary, 98 at Mountain View and 203 at MRC

Of the 630 total releases, 249 went to Nanaimo Lakes (39.5%), 149 to Mount Washington (23.7%), 22 to Mount Cain / Mount Schoen (3.5%), 23 to Clayoquot (3.7%) and 187 to Strathcona (29.7%). It should be noted that captive-born marmots are no longer released directly into Strathcona. A more effective

strategy has been to release captive marmots into the wild at Mount Washington (where survival is normally high) and then translocated to Strathcona if they survive their first wild hibernation.

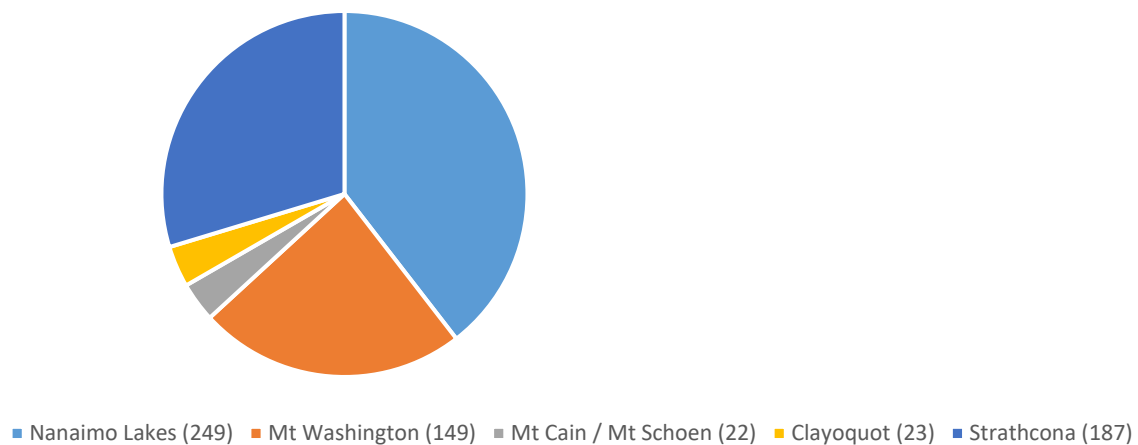


Figure 14 Distribution of Captive Releases (2003 to 2023)

7.7 Current numbers

There are currently 150 marmots in captivity including 115 marmots at MRC (including 22 breeding pairs in 2024), 16 marmots at Toronto Zoo (8 pairs) and 19 marmots at the Calgary Zoo (9 pairs).

Approximately 62 of the marmots currently at the MRC will be release-candidates in the summer of 2024. Exact numbers will depend upon individual marmot health, individual reproductive performance, and overall reproductive performance of the captive population in 2024.

OVERALL CAPTIVE POPULATION NUMBERS (1997 to January 2024)

88 wild captures + 824 weaned pups – 630 releases – 137 mortalities + 4 recaptures = 149 (Note: this total does not include one wild-born yearling female that is being temporarily held at MRC)

Table 13 Wild marmots brought into the captive program (1997-2023)

COLONY SITE	COLONY TYPE	ADULT S	2-YEAR- OLDS	YEARLIN GS	PUPS	TOTAL
SHERK LK	LOGGED	4	3	1	4	12
K44	LOGGED	2	0	2	8	12
MT FRANKLIN	LOGGED	2	0	1	1	4
D13	LOGGED	1	0	0	0	1
PAT LK	LOGGED	1	0	0	0	1
MT WASH	SKI HILL	5	1	2	11	18
KNIGHT LAKE	LOGGED	0	0	0	2	2
NW BAY	LOGGED	1	0	0	5	6
LDL TRAILHEAD	LOGGED	0	0	0	1	6
WHISKEY CK	EXTRALIMITAL	0	1	0	0	1
TOTAL – OTHER		16	5	6	32	59
GREEN SUMMIT	NATURAL	0	2	1	2	5
“P” MTN	NATURAL	0	0	0	4	4
BIG UGLY	NATURAL	0	0	1	2	3
MT MORIARTY	NATURAL	1	0	0	2	3
HEATHER MTN	NATURAL	0	0	0	2	2
HOOPER	NATURAL	0	0	1	1	2
Sadie.	NATURAL	0	0	0	1	1
McQUILLAN	NATURAL	0	0	0	1	1
HALEY LAKE	NATURAL	0	0	0	2	2
ARROWSMITH	NATURAL	0	0	0	2	2
MARBLE MEADOWS	NATURAL	0	0	0	2	2
CASTLECRAG	NATURAL	0	0	0	2	2
TOTAL – NATURAL		1	2	3	23	29
OVERALL TOTAL		17	6	9	54	88

Table 14 Captive-bred marmots released to the wild

YEAR	NUMBER OF RELEASES	% OF PREVIOUS YEAR	ADULTS	2 YEAR-OLDS	YEARLINGS	PUPS
2003	4		3	1	0	0
2004	9	225%	2	7	0	0
2005	15	167%	2	6	7	0
2006	31	207%	5	9	17	0
2007	37	119%	3	12	22	0
2008	59	159%	6	17	30	6
2009	68	115%	9	5	48	6
2010	85	125%	16	12	46	11
2011	66	78%	19	6	29	12
2012	34	52%	5	5	24	0
2013	16	47%	0	0	16	0
2014	29	175%	9	3	17	0
2015	24	83%	10	0	14	0
2016	13	54%	0	0	13	0
2017	11	85%	0	0	11	0
2018	14	127%	0	0	14	0
2019	10	71%	0	0	10	0
2020	13	150%	0	0	13	0
2021	27	208%	0	2	25	0
2022	22	81%	0	3	19	0
2023	43	195%	0	2	41	0
TOTAL	630		89	90	416	35

Table 15 Marmots released and moved by type, location, and year

Year	Nanaimo Lakes			Mount Wash	Mount Cain / Schoen		Strathcona			Clayoquot		Annual total of captive releases	Annual total of wild-born translocations	Annual total of stepping stone
	Captive-release	Wild-born translocation	Pre-conditioned	Captive-release	Captive-release	Pre-conditioned	Captive-release	Wild-born translocation	Pre-conditioned	Captive-release	Wild-born translocation			
2003	4	1	0	0	0	0	0	0	0	0	0	4	1	0
2004	7	0	0	2	0	0	0	0	0	0	0	9	0	0
2005	13	0	0	2	0	0	0	0	0	0	0	15	0	0
2006	29	0	0	3	0	0	0	0	0	0	0	31	0	0
2007	24	0	0	0	4	0	9	0	0	0	0	37	0	0
2008	29	1	0	10	6	0	14	0	0	0	0	59	1	0
2009	27	0	0	0	12	1	22	0	0	6	0	68	0	1
2010	2	0	0	0	0	0	77	0	0	6	0	85	0	0
2011	26	0	0	17	0	0	19	0	0	4	0	66	0	0
2012	0	0	0	17	0	0	17	9	4	0	1	34	10	4
2013	0	0	0	16	0	0	0	16	11	0	0	16	16	11
2014	0	0	0	15	0	0	14	13	8	0	0	29	13	8
2015	0	0	0	13	0	0	11	12	4	0	0	24	12	4
2016	0	0	0	9	0	0	4	8	5	0	0	13	8	5
2017	6	1	3	5	0	0	0	3	0	0	0	11	4	3
2018	9	2	0	5	0	0	0	8	1	0	0	14	10	1
2019	6	8	2	2	0	0	0	4	1	2	0	10	12	3
2020	6	0	0	7	0	0	0	3	0	0	0	13	3	0
2021	17	0	0	8	0	0	0	4	0	2	0	27	4	0
2022	14	1	0	8	0	0	0	3	0	0	0	22	4	0
2023	30	0	0	10	0	0	0	2	2	3		43	2	2
TOTAL	249	14	5	149	22	1	187	85	36	23	1	630	100	42
# of years	16	6	2	17	4	1	9	12	8	5	1	21	14	9
21	268			149	23		308			24		772		

8. RESEARCH PARTNERSHIPS

The Marmot Recovery Foundation relies on science to make sound, evidence supported decisions as we work to recover the wild population of the Vancouver Island Marmot. While the Foundation is not a research organization, it collaborates with research partners to answer questions which will advance recovery efforts. In 2023, the Foundation collaborated on the projects noted below.

- Food Supplementation (Wilder Institute / Calgary Zoo Centre for Conservation Research)
- Endoparasites of captive and wild marmots (Kevin Gourlay and Jamie Gorrell, Vancouver Island University)
- Home range estimates of free-ranging marmots (Haley Andersen and Jamie Gorrell)
- G.I.T. Microbiome (Pauline Van Leeuwen, Laurentian University)
- Stress evaluation using hematology, etc. and stress effects of post release survival (Sarah Falconer, Laurentian University)
- Genetic basis of melanism in different marmot species (Kendall Mills and Link Olsen, University of Alaska)
- Diet, lipid metabolism, body composition, and hibernation (Jessica Aymen, University of Guelph)
- Genetic evaluation of degenerative heart conditions (Jaimie Warren and Doug Whiteside, University of Calgary)
- Diet metagenomics (Jasmine Janes, Vancouver Island University)
- Marmot nutrition (Sarrah Gourlie, Beth McGregor, Captive Management Group nutrition advisors at Toronto Zoo)
- Morbidity and mortality (Malcolm McAdie)
- Factors influencing reproduction (Laura Graham)
- Social reproductive suppression (Phoebe Edwards)
- Seasonal changes in vegetation and its impact on habitat suitability and predation risk (Julia Kobetitch/Royal Roads University)

Research published in 2023 and January 2024 that involved the Foundation's collaboration include:

- Graham LH, Leishman EM, Demers K, Whiteside DP, McAdie M. Factors Associated with Reproductive Success in Captive Vancouver Island Marmots (*Marmota vancouverensis*). *Animals*. 2024; 14(3):387. <https://doi.org/10.3390/ani14030387>
- S Falconer, M McAdie, G Mastromonaco, A I Schulte-Hostedde, Assessing stress physiology within a conservation breeding program for an endangered species, *Conservation Physiology*, Volume 11, Issue 1, 2023, coad041, <https://doi.org/10.1093/conphys/coad041>

9. FIELD SAFETY SUMMARY

There were no serious safety incidents in 2023. Field teams continued to take a proactive approach to hazard identification and mitigation, and were quick to report new hazards as they emerged. Close calls were discussed as a team and have now been incorporated into the Foundation's job safety documents for next season.

9.1 Minor Incidents

Bear Banger ignited small fire:

Crew working in a cut block deployed a bear banger to deter a bear that was encroaching on their work site and not responding to shouts and hazing. The projectile came into contact with the ground before burning out and ignited a small spot fire, approximately 1 sq. foot in size. Crew were able to extinguish flames immediately using water from their backpack. More water was brought from the truck's fire kit and dumped on the site (approximately 20 liters in total). The crew then dug out the site to ensure the entire site was damp and cool to the touch. They monitored the fire site for 45 minutes, and remained on site for another 6 hours to continue trapping. Mosaic has been notified of the incident. Fire hazard was "high" in areas where MRF crews worked for much of the summer. Crew were instructed to use bear bangers as a last resort only, and to take all fire precautions in the Job Safety Analysis.

Bear attacked marmot in trap:

On the last day of a 5-day trapping trip in Strathcona, crew were packing up camp in preparation for returning back to town and were passively monitoring an active trap 100m upslope of them, not anticipating trapping anything given the late time of day. Suddenly, a marmot came above ground, entered and triggered the trap, and a bear appeared from behind a nearby bush and started attacking the trap. The commotion caught the attention of the crew, who immediately started yelling and trying to haze the bear off of the trap. The trap became dislodged and was rolled downslope with the bear pushing it, attempting to get at the marmot. Crew were able to haze the bear away and retrieve the marmot in the trap. The marmot was immediately sedated and a full health checkup was conducted on site. Other than a small cut across the nose, the marmot was determined to be in good health and was implanted and re-released. Subsequent surveys this fall have confirmed the marmot, "High Roller", is alive and successfully hibernating in a plugged burrow.

10. RECOMMENDED APPROACH FOR 2024

The Provincial Recovery Plan for the Vancouver Island Marmot (VIM RT 2017) recommends several recovery objectives for the wild population (Table 4, pages 29-31). This section lists several activities that the Foundation believes will contribute to these objectives. These plans are subject to change at the advice of the Vancouver Island Marmot Recovery Implementation Group. In the simplest terms, the Foundation recommends providing support to the wild population when possible and prioritizing long-term recovery actions over short-term gains.

The overall direction for this year should be to continue to build existing colonies and support marmots that are establishing new colonies, while identifying habitats and points that support dispersal. This includes three primary recommendations for 2024:

- Release captive-bred marmots strategically to maximize their recovery impact.
- Continue restoring the size and breeding capacity of the Mount Washington colony after heavy predation losses at the colony in 2021.
- Restore marmot habitat to mitigate degradation resulting from climate-change-induced tree creep.

Even with approximately 60 marmots available for release, there will likely be relatively few marmots available for translocation to the small colonies in Strathcona Provincial Park in 2024.

10.1 Proposed Supports for the Wild Population

(i) *Captive breeding releases*

There are 62 marmots currently at the Tony Barrett Mount Washington Marmot Recovery Centre identified as potential release candidates for 2024. The Foundation recommends prioritizing release of captive-bred yearlings onto Mt. Washington to support the recovery of this colony and restore its reproductive potential. Because this colony is already populated and there have been past indications of social stress when the colony grew too large, the Foundation will set a limit on the number of new releases for this colony. This means that the majority of captive-bred marmots will also be available for other purposes, such as release to the Nanaimo Lakes region and/or to extralimital colonies on Steamboat Mountain and Lions North in Clayoquot Plateau Provincial Park.

(ii) *Translocations*

The Foundation will assess translocation candidates in the wild colony on Mt. Washington, including stepping stone candidates and wild-born marmots. Wild-born marmots for translocation could come from Mount Washington or from marmots found in unsuitable habitats. At this time, no marmots are known to occur in unsuitable habitats, such as cutblocks, but there are several potentially occupied sites. These sites will be monitored in the spring once access allows.

(iii) *Trapping and implants*

The Foundation will spend at least four weeks trapping in the Nanaimo Lakes and Strathcona regions with the goal of increasing the number of active transmitters and

improving their representation across colonies. The Foundation will prioritize trapping at colonies with few functioning transmitters, lots of young marmots that may eventually become dispersers, and colonies that are important to our research partners.

(iv) *Managing marmots in unsuitable habitat*

The Foundation will respond to reports of dispersing marmots that are observed in unsuitable and/or unsafe locations, and if appropriate, will translocate these individuals to active colonies or bring them into the captive program.

(v) *Managing marmots on Mt. Washington Alpine Resort land*

The Foundation will continue to monitor marmots on Mt. Washington, and will maintain strong communications with Resort staff and managers about unsuitable locations where marmots are spending time. Unsuitable locations may include features like roads, bike runs, water reservoirs, buildings and structures, and places with past or ongoing development activities. The Foundation will work with Resort staff to educate visitors about marmots, marmot viewing, and how to keep marmots safe during their time at the Resort. The Foundation will also investigate whether technology can be used to increase marmot safety. For instance, the Foundation could trial ultrasonic devices that would produce a warning sound when equipment or vehicles move down a trail when marmots have been sighted nearby.

(vi) *Supplemental feeding*

The Foundation will install supplemental feeders at 18 to 24 colonies, as weather and snow conditions allow. For each feeder that is installed, the Foundation will also install a motion-detecting remote camera that will record feeder use by marmots and the presence of other species. The Foundation will continue to provide support to the Wilder Institute/Calgary Zoo research team in the form of training, safety monitoring, and data sharing as they conduct another year of their summer supplemental feeding study in the Nanaimo Lakes region.

(vii) *Habitat improvement*

The Foundation will conduct the manual removal of in-growing trees on 6 hectares.

(viii) *Predator deterrence*

In 2024, the Foundation plans to develop a methodology for deploying and assessing the effectiveness of Foxlights and other sound and light deterrents. Foxlights use programmable, irregular flashing lights that may deter predators from spending time near the lights during twilight hours. Research from California has suggested that the effectiveness of Foxlights may decline after a few weeks. Other technologies deployed will include radio-devices that play human voices, and motion sensitive devices that produce sound and light. In hopes of achieving the best results, the Foxlights and other devices will be deployed in mid to late August when the highest rates of predation typically occur.

10.2 Proposed Monitoring and Inventory

(i) *Inventory*

The Foundation will conduct visits, repeated where possible, to each of the main colonies in the Nanaimo Lakes and Strathcona regions. This may include emergence flights (both

- helicopter and drone) in the spring to check for marmot presence at colonies believed to have been extirpated, new locations where colonies recently may have become established, and to locate hibernacula at known colonies lacking spatial data, as well as visits with an emphasis on ground-based inventory in July and August when pups could be seen and counted. Day-trips will be augmented by overnight and multi-day trips at select sites, especially in periods of warm weather when marmots spend significant periods of the day underground. The Foundation plans to expand the use of wildlife cameras to as many colonies as possible. Priority for camera deployment will be colonies that are difficult to access.
- (ii) *Mortality recovery*
The Foundation will attempt to recover transmitters and collect evidence from mortality sites in order to infer cause and timing. The Foundation will install wildlife cameras at Haley Lake and other colonies with a significant predator presence to better monitor predator activity and use of habitat.
- (iii) *Investigation of new monitoring techniques*
The Foundation will continue to investigate using direction-finding software-defined radio to automate collecting data about marmot movements. We will also continue to explore the use of passive RFID readers in the field for detecting tagged marmots at feeders or hibernacula, as was trialled by the VIU team on Mt Washington in 2022. Furthermore, we will continue to investigate the use of acoustic recorders and telemetry base-stations to improve monitoring efficiency and effectiveness. These technologies have been used successfully with other species, but have not been extensively tested on a project with similar goals and terrain. Acoustic recording devices may improve detection of marmots in unsuitable habitats. Base-stations may be able to record telemetered marmot movements both within and between colonies. Both technologies need additional testing before widespread deployment. We will also continue to explore the applications of Unmanned Aerial Vehicles (UAV) for surveying inaccessible sites, particularly during emergence surveys. The Foundation will also continue to test the inclusion of temperature loggers on implanted telemetry transmitters to assist with gathering more detailed biological data.

10.3 Proposed Actions for the Captive Breeding Program

- (i) *Wild captures*
The Foundation consulted with Studbook Keeper John Carnio for the Captive Breeding program to determine whether new additions to the program would be helpful from a genetic or pairings perspective. In 2024, MRF staff may attempt to capture a small number of wild marmots from the few remaining sites (specifically Big Ugly, P Mountain and Steamboat Mtn) that do not have current genetic representation in the captive population. This action is based upon our basic captive management principles and recommendations from the Studbook keeper. This will act to safeguard the genetic legacy of these sites and will further enhance the overall genetic robustness of the captive population. This action has been endorsed by the Recovery Team and is contingent upon inventory results at these colonies (including survivorship and reproduction).
- (ii) *Genetic Studbook*
In partnership with Dr. Gorrell, Dr. Janes, and Vancouver Island University, the Foundation will begin to develop and implement a studbook based on individual genetic profiles for marmots in captivity. This is envisioned as a multi-year project that in the long term will

provide better tools to conserve genetic variation in the captive and wild populations.

10.4 Biosecurity Measures

DNA analysis indicates that Vancouver Island Marmots have low genetic diversity, potentially as a result of population bottlenecks, island isolation, or a combination thereof. This low genetic diversity puts the marmot population at greater risk to novel pathogens. To reduce the risk of accidentally introducing a novel pathogen, the Foundation will continue to take biosecurity measures. In the field this will include:

- Sanitizing footwear and changing clothing between locations.
- Wearing masks and gloves when handling marmots, gear that will come into contact with marmots, or working in close proximity to marmot habitat features, such as active burrows or look out rocks; and
- COVID-19 vaccinations to reduce spillover opportunities.

In the Tony Barrett Mount Washington Marmot Recovery Centre, additional biosecurity measures will be taken, including:

- Dedicated footwear and overalls inside marmot areas.
- Limiting visitor and non-necessary staff access; and
- Sanitizing footbaths before entering marmot areas.

The Foundation will continuously review and update biosecurity measures in response to emerging threats and best practices.

10.5 Population, Habitat, and Viability Modelling

In partnership with Vancouver Island University and Dr. Gillis and Dr. Gorrell, the Foundation will begin a multi-year project to model Vancouver Island marmot habitat, and the populations of the two metapopulations. This builds on a 2015 IUCN Population Viability Model (Jackson et al, 2015), but expands the scope of the modelling to both metapopulations, incorporates another 10 years of data, and provides the resources to more thoroughly investigate key sensitivities the drive marmot population trends.

11. FUTURE DIRECTIONS

The Foundation acknowledges that some activities that would greatly benefit the recovery effort have not been possible due to funding constraints, the scope of an activity, or the need for external expertise and/or resources. These activities include, but are not limited to:

- Continued exploration of non-lethal predator deterrent methods, including predator-deterrent lights but also additional technologies or methodologies that have not been explored and/or tested in previous years.
- Research into marmot dispersal and habitat needs for marmots when outside core colony areas. The Foundation has begun testing base stations and direction-finding software defined radio, but significant additional opportunity exists to explore marmot dispersal and landscape use.
- Collection and mapping of information about the marmot's extent of historic occupation, especially in the northern and western portions of the marmot's historic range.
- Research into the extent and characteristics of climate change induced habitat change that has occurred in marmot meadows to date.
- Exploration of supplementary or alternative geolocation technologies for re-capture of Vancouver Island Marmot location data.

Items that have been identified in the past that are now in the early stages of active development include:

- Further incorporation of advances in our understanding of marmot genetics into the Foundation's management of the captive and wild populations.
- The development of population models that incorporate data collected since 2015 and the Strathcona metapopulation.

The Foundation encourages partnership and collaboration in working to address these challenges.

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