PAC 6580 filed under Haley Lake

PROGRESS NOTE
Vancouver Island Marmot Recovery Project

Chief Scientist report

prepared for the Recovery Team meeting of 24 October, 2000

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News from the field:

- **41 marmots counted in the wild** (9 pups and 5 yearlings and 27 adults)
- 5 animals taken into captivity (4 pups and 1 adult), **leaving 36 in the wild**
- Extinction of marmots from clearcuts (we removed the last three solitary adults)
- Last K44A animal ("Hobo" adult male) sent to Toronto (due to pre-existing injury).
- 2 of 4 pups from Washington sent to Calgary (leaving 2 in the wild)
- 2 of 5 pups from Green summit sent to Toronto (leaving 3 in the wild)
- 2 animals transplanted to Heather and P Mtns (to facilitate "rescue-effects").
- **5 colonies remain in southern population** (28 animals)
- One litter on Green summit (litter of 5, total =12)
- Extinction of Haley bowl (oldest known colony) and Haley-Butler-Gemini complex
- **More than expected on Washington** (litter of 4, total = 13)

Narrative

Marmot populations in 2000 are the lowest ever recorded (see science section).

Continued monitoring is identified as a high priority in the Recovery Plan and in the Marmot Workshop proceedings (#D1). Count effort and coverage was high despite poor June weather (>3 counts per site...the crew worked hard). Survival from last year was 100% except for two sites. Apparently we lost 5 adults at K44A and 3 at Haley, causing complete extinction at the latter and leaving a solitary male at the former. Timing of last observations of these animals suggest predation and not winter mortality. P Mtn surprised us with a pair this spring. Tagging occurred at P Mtn., Heather and Big Ugly for the first time. Three of the four yearlings on Green Mountain were implanted with transmitters and left in situ; the plan is to transplant one or more of these animals next spring.

The crew augmented the P Mtn. pair by importing Alfy from Butler Peak west roads clearcut. Marilyn from the clearcut Sherk Lake was moved to Heather Mtn (the site now has two adult females but we were unable to find an "expendable" male anywhere else). Instead of being transplanted, the last male at K44a clearcut was taken into captivity because it had an injured and infected foot (this animal subsequently made a full recovery).

Both radio-telemetered animals on Mount Washington survived the winter (although both transmitters failed). The transplanted animals were implanted with transmitters, as were yearlings on Green Mountain. The latter animals made sizable movements in late summer, including visits to the former K44A colony and the former NW ridge colony. These observations reinforce existing data (Bryant 1996, 1998) that yearlings make extensive explorations prior to dispersal.

Probably the most significant result from the 2000 field season is that Mount Washington now contains approximately 1/3rd of the known population. In the south, loss of the last of 10 colonies in clearcuts formed during the 1980s and 1990s is also notable. The southern metapopulation has collapsed to the point that it must by now be suffering Allee (underpopulation) effects. It is doubtful that presently un-mated animals will find mates, and I suggest that the possibility that populations might recover without human intervention to be essentially zero.

This situation also has important ramifications for future research. In short, possible sample sizes obtained from wild marmots would be insufficient to test all but a few hypotheses.

News from zoos

- **40 animals in captivity** (28 adults, 4 pups born in the wild and 8 pups born in captivity)
- **Five arrivals** this summer (4 pups and male all doing fine)
- **Two litters** at Calgary from established pairs (Gudron/ China from Franklin had 5 pups, while Ivan/Boedecia from F19 had 3 pups).
- **No losses** in captivity from last year (100% survival)
- Mountainview Farms facility becomes operational (9 animals from zoos)
- Toronto Zoo (13 animals)... after 5 animals moved to MtnView
- Calgary Zoo (18 animals)... after 4 animals moved to MtnView

Narrative

No marmots died in captivity this year (100% survival). Indeed, some injured or sick individuals that we were concerned about appear to have made full recoveries. I conclude that husbandry protocols work. In particular, no animals have been lost during hibernation since adoption of a target ambient temperature of 6-8° C.

Two Calgary litters (from China and Boedecia) are consistent with what we know of demographic performance in the wild (China was at least 5 years-old and Boedecia was known-age 6 year-old). This is especially true considering the age of males (respectively these were Gudron, known-age 5, and Ivan at least 4). It is notable that these two pairs were formed in the wild and not in captivity. I have no doubt that pairs can form in captivity (Okanagan Game Farm experience: a single pup female captured in 1981 mated with a presumed-age adult male captured in 1980. They produced pups twice: in '85 and '86, litters of 4 and 4, age/sex-structured F/M data are therefore 4/7 and 5/8 years-old).

Three pairs of >3 year-old animals did not breed at Toronto Zoo (i.e., ToughGal/Chase, Shona/Arminius and Stumpy/Washington; F/M ages are 8/4, 3/4 and 3/4 respectively). In the wild mean age of first reproduction is 3.8 = most females first breed at 4 or 5 years-old). So, statistically speaking, it isn't surprising that 2/3 females didn't breed. See reproductive monitoring in the science section.

Gordon Blankstein's facility in Langley is now operational and received its first marmots in June. This individual has already spent well over $300,000 on the project, excluding staff expenses. I'm hugely impressed, and we would do well to remember that the project would be suffering from lack of marmot accommodation had it not been for Mr. Blankstein.

Mount Washington: What can I say? The architectural plans and the approvals were in place. The contractor was available and cash-flow models existed. The money wasn't quite there. It looks like we will complete the concrete foundation this fall and continue construction in the spring. Given Mr. Blankstein's contribution, my opinion is that the delay in construction does not pose a significant problem although it will be important to complete at least some new marmot accommodation next year.

Science:

- Interpolated population data (first complete picture of recent population dynamics)
- Updated landscape measurements (refined model will permit connectivity mapping)
- Jason Lewis project (40% correct identification of historically occupied habitats using a basic GIS-based habitat suitability model)
- Luise Kruckenhauser DNA project (now installed at Uvic as a post-doc)
- Mycoplasma (broadly distributed, 11/14 samples from zoos and 3/10 samples from wild)
- Hibernation rhythms (hibernation at 6-8° C produces expected hibernation rhythms)
- Dave Ryckman reproductive monitoring (multiple cycling in females, 4 week window of high testosterone production in two males)
- Publications
- Unsolicited proposals
- Data requests

Population trends, landscape conditions and dispersal

In my opinion, this year saw major improvements in our ability to understand recent population dynamics and conceptualize the problems currently facing marmots. Missing values analysis had the effect of allowing a shift in perspective, from that of a sampling exercise (variable effort across years) to that of a population exercise (i.e., I filled in the blanks in our 1972-2000 sampling regime given defensible assumptions about occupancy and trends; recommendation #D1, #E1). Second, satellite imagery provided by Jason Lewis allowed me to update and correct the existing GIS coverage of the Nanaimo Lakes metapopulation (recommendation #C7).

The resulting "interpolated population history" permits exploration of recent population trends in a spatial and temporal context. It is clear, to take one example, that forestry altered local marmot density from ~5 animals per km^2 to over 20 animals per km^2 in the Butler-Gemini-Haley-Green "core" area. These results were presented at the 2000 mammal meeting in New Hampshire in May...I propose to include it on the web as a "slide show"; results can be previewed at:

www.marmots.org/team/team1

Note that we can't test some types of hypotheses using the interpolated population data. However they do allow some new insights, notably about the nature and importance of dispersal (recommendations #E1, E2).

From mark-recapture at the intensively studied colonies (Green, Haley, Vaughan, Sherk, Franklin, Pat Lake and K44A) we know that within any given year, about 10% of the non-pups are animals that immigrated there during that year. The ratio of immigrants to residents is doubled in clearcuts (χ^2 test of independence = 6.2 with 1 df, $P = 0.012$). The data are:

	Natural	Clearcut
resident-years	178	154
immigrant-years	11	24
proportion of immigrants	0.06	0.13

Given that immigrants become residents if they stay at least one year, it becomes possible to ask "what proportion of animal-years are contributed by animals that were not born on-site?" The data are as follows; effect of habitat is again highly significant (χ^2= 12.4 with 1 df, $P < 0.001$).

	Natural	Clearcut
born on site	164	128
born off-site	25	50
proportion born off-site	0.13	0.28

The next logical question is "what proportion of pups are produced by immigrants"? and here's where it gets really interesting. Immigrant females produced 17 of 90 pups (18.9%) born in natural meadows. In clearcuts they produced a startling 31 of 48 (53%) pups. The situation is compounded by immigrating males, and there are several examples of immigrating males being followed by immigrants (Liberace's and Stephen's 4 litters at F19). In short, rescue effects are the norm for Vancouver Island marmots. A second telling observation is that the mark-recapture reveal no cases of full-sib or parent-offspring mating. Hardly surprising. Marmots, like most mammals presumably have behavioral traits that discourage close inbreeding.

We know that most natural colonies are small (one or two families in historical times) and that immigration is critical to ensuring gene-flow and rescue effects. When you combine that idea with the interpolated population history you start asking questions like "how many dispersers would it take to keep the whole system working?" Consider the fifteen or twenty colonies that probably existed in 1976.

The metapopulation probably contained about 125 adults and 45 pups, all in natural meadows. Most colonies had one or two families. Reproduction would be in alternate years for most families; annual per adult birth rate would be about 0.4 (Bryant 1998). About half of the pups would die in their first year and another few would die as yearlings, leaving perhaps 25 surviving

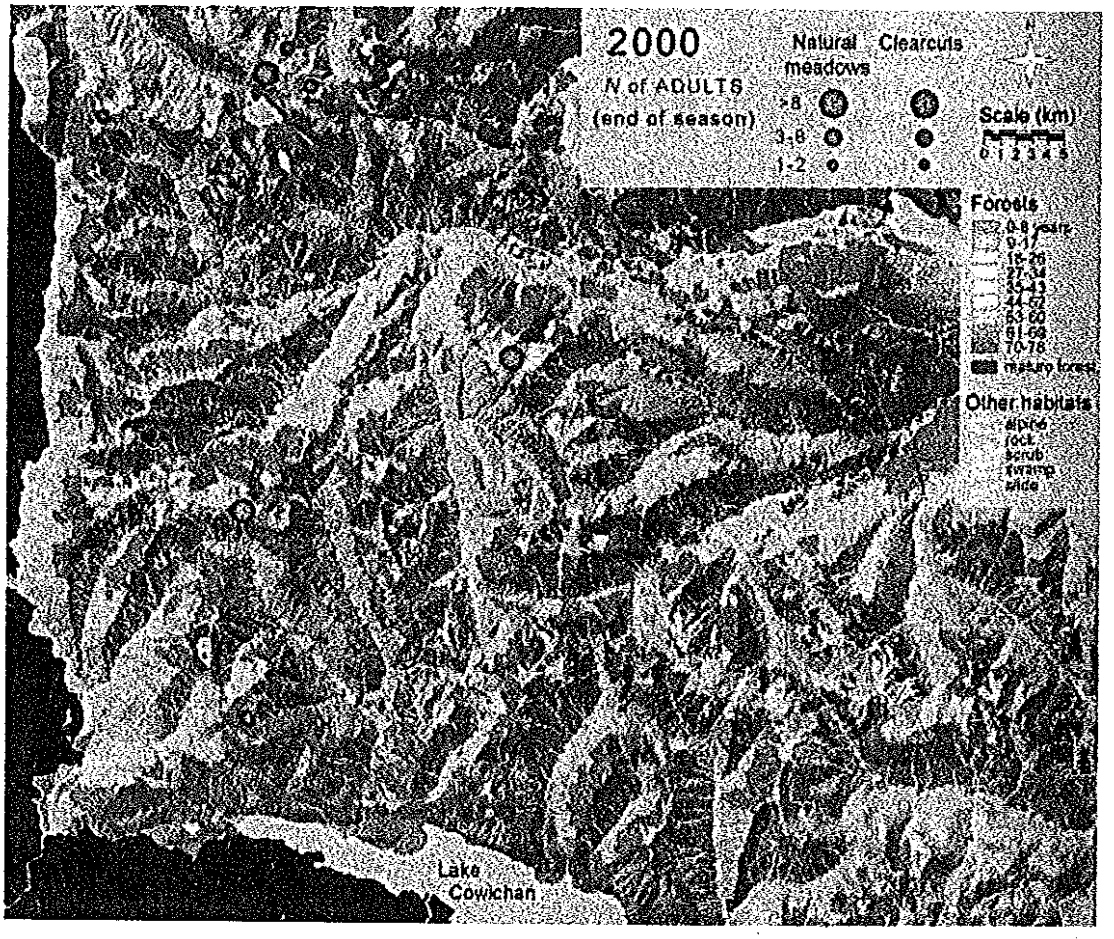
wo-year-olds with the option of staying put or dispersing. We know that a substantial portion of wo-year olds stay at their natal colony, so perhaps 10 of them leave per year. A similar estimate would result from thinking about the proportion of immigrant-years to adult-years calculated earlier (about 6% of the 125 adults).

I think these are important results because they illustrate just how few dispersal movements pparently maintained the system. Or how few changes could be made without disrupting the ystem. Seen in this light, the early colonization history of clearcuts is more easily grasped. pecifically, if we look at clearcuts colonized during the 1981-1986 period it becomes apparent at most animals seen in clearcuts could not be explained by reproduction on site. The data are:

Year	resident-years	immigrant-years
1981	0	3
1982	2	4
1983	1	23
1984	4	3
1985	6	6
1986	7	3
Totals	20	42

If you consider annual production of ~10 dispersers in the 1976 metapopulation it makes more se. Consider the data. The 23 apparent immigrants in 1983 are particularly interesting because highest reproduction ever observed happened in 1981 (30 pups at the Green-Gemini-Butler- ey area). This is consistent the idea that two-year olds are the primary dispersers. More ortantly, the scale and location of colonization effects is consistent with the scale of production lispersers in nearby natural meadows. Genetic studies will probably provide confirmation, but I gest we already have a good idea of where the animals originated.

Finally, here is what the metapopulation looks like as of today. (the complete set of maps is available on-line in the "private" area at



Habitat suitability model for reintroduction planning

I applied for and received a "software grant" from ESRI (makers of Arc/Info GIS software) this spring...the Foundation now is a licensed owner of PC Arc/Info and ArcView. This permitted Jason Lewis to construct a habitat suitability model as part of his Master's work through University of Calgary (recommendation #B4). The Foundation covered Jason's costs this year. (Note that despite being identified as a high priority by last year's workshop participants, ESRF rejected this study for the 2nd time).

Jason's initial model (using slope, aspect, elevation, snowmelt, proximity to cliffs, herbaceous spectral signature from Landsat imagery) correctly identified 40% of persistent natural colonies (it missed 60% of the actual colonies) in the Nanaimo Lakes metapopulation. Two thirds of the sites selected by the model were not persistent natural colonies.

Jason reports: "although these results look poor when written, they seem very promising when printed on an map. These are only initial results: better results will come when the model is "tweaked" by incorporating new variables such as isolation. From our photo-reconnaissance flight in the northern Strathcona area, my initial feeling is that the model works quite well, despite the quite different geography/topography. To further grade potential sites, I will analyze photos taken from a helicopter to rate each site as to how well it provides forage, denning areas, loafing rocks and other variables. This will be done for potential sites photographed in the Strathcona study area as well as for sites photographed in the Nanaimo Lakes area. The latter will be used to determine

how well these added variables improve the model's ability to identify known colony locations." Jason intends to defend this winter.

L. Kruckenhauser DNA research

I applied for and secured an $11,000 grant from Global Forests to sponsor Luise Kruckenhauser's genetic work (recommendation #A3). Dr. Kruckenhauser is now installed in John Nelson's lab at University of Victoria (officially as a post-doc) with >110 hair samples. The Foundation is covering other costs (about $10,000). The objective is to evaluate connectivity between colonies; side-benefits will be development of local expertise (we're training a local technician) and creation of a long-term DNA library.

DNA extractions are complete and results from 55 samples are intriguing. Five polymorphic alleles were identified. Most interestingly, 3 of these are "private alleles" found only among Mt. Washington animals. This raises very interested questions about the desirability of managing the captive population as a single panmictic unit. I'm delighted that Dr. Nelson has taken a personal interest and look forward to his participation in manuscript preparation. Results should be available by Christmas (Luise leaves Canada on 15 December).

Mycoplasma research

A total of 24 animals have been tested for Mycoplasma spp. following the death and autopsy of a female pup in Calgary in 1999. This individual had been captured from the wild 23 days prior to her death. Post mortem examination of this marmot indicated changes suggestive of a pneumonia caused by a bacteria called Mycoplasma. Further tests confirmed the presence of Mycoplasma in this dead female and also in the upper respiratory tracts of 9 of 10 healthy marmots surviving at the Calgary Zoo and the Toronto Zoo (specifically, the Big Ugly 2 year old and 4 Sherk yearlings, Franklin 2 year-old and 4 K44a yearlings. Only one K44a yearling tested "clean"). Finally, 3 of 10 samples collected in the wild also tested positive. The data are:

Green (3), negative
Washington (4), 1 positive
Butler clearcut (1), negative
P Mountain (1), positive
Heather Mtn (1), positive

The organism is fragile and absence from some of the wild samples could be caused by sampling difficulties. Malcolm writes: "We do not know the full role of Mycoplasma in Vancouver Island marmots. Because marmots are physiologically stressed during the winter hibernation (which is also a time of high mortality) it is possible that Mycoplasma may have its most serious effects during this period. Work to determine the prevalence, the source (i.e. whether it originated with the Vancouver Island marmots or from another animal source) and the clinical implications of this bacteria are currently underway. Captive management procedures have been developed or modified in order to reduce the potential impact of this bacteria." (recommendation #A2)

This work is paid by the Foundation. Testing of additional samples continues.

Hibernation rhythms

See my previous report (March). The short version is that hibernation at 6-8° C at Toronto Zoo produced expected spontaneous arousal patterns (unfortunately, temperature data from Calgary were unusable due to lack of a control). The Toronto dataset is now complete (weight-loss, hibernaculum temperature and arousals confirmed by closed-circuit TV). One of my winter

projects will be to revisit my prior analyses performed this spring and co-author a paper with John Carnio for publication. It is a good dataset and it will be only the 2nd species for which these kinds of data are available.

As for this winter, Min-max thermometers and additional Hobo dataloggers have been ordered so that we can systematically measure these variables in 2000-2001 at all facilities (recommendation #A4).

Reproductive monitoring

David Ryckman produced an excellent interim report of his work on animals at Toronto Zoo (funded by an ESRF grant) and I consider his work to be potentially of great importance. Results include 1) confirmation of multiple cycling (ovulation) in females within a single reproductive season based on peaks of progesterone and estradiol measured from feces, 2) a month or six week window in which this occurs. A similar pattern was observed for male testosterone production. Two males (Washington and Caruso) showed no significant increase in testosterone throughout the sampling period, and two others (Chase and Arminius) showed highly elevated levels from 21 March through 21 April; in both cases observed mounting behaviour occurred during these periods.

A notable result is that little overlap existed between the apparent timing of ovulation in some individual females and high testosterone levels in the males with which they were housed (e.g., Chase had already been removed when Tough Tal apparently ovulated again in May). In my opinion such results underscore the importance of maintaining natural hibernation rhythms to ensure that males and females are "ready" at the same time. This may be particularly important for Mount Washington animals, which may exhibit a later reproductive "window" than animals from the south.

Publications and conferences

Blumstein, D.T., J.C. Daniel and A.A. Bryant. In press. Antipredator behavior of Vancouver Island marmots: using congeners to evaluate abilities of a critically endangered mammal. *Animal Behavior.*

American Society of Mammalogists meetings (June 18-21 2000, Durham NH). "Forestry and historical population dynamics in the endangered Vancouver Island marmot"

Unsolicited proposals

Only one was received this year (T. Karel's proposal to study hoary marmots in Kluane) and this was not funded. Diane Casinar's tentative proposal to pursue behavioural work as a master's thesis was retracted after she obtained a scholarship from the Jersey Trust.

Data requests and collaborative efforts

Apart from general requests (e.g., how many marmots are there) I was involved in only a few extraneous issues this year.

- Dr. Ken Mahdral (U of Florida) asked for and received life-table results for a new book on population biology.

- I reviewed the status of the Montague Island marmot (*M. caligata* sub-species) for the Alaska Fish and Wildlife Service.

- I'm working with Jim Kennagy (U of Washington), Patty Happi (Olympic National Park) Bob Brett (Whistler Mountain) and B.C. Parks to develop a marmot population monitoring program (this is very new...more soon).

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From: 6-6-2-537-56

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Marmot Proposal

<u>Wildlife Observations</u>

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vol-order
TACarson

PAC 6576 filed
under Haley Lake

Sept. 14, 1977

<u>Aves</u>

15+ White Crowned Sparrows
20+ American Robins
1 Varied Thrush
6 Common Raven
3 Pygmy Owls (hooting at noon)
20+ Golden Crowned Kinglet
1 Marsh Hawk
1 Golden Eagle.
1 Goshawk
} marmots generally silent except when predators fly by
~8 Pine Siskins
1 Red-Breasted Nuthatch
3 Blue Grouse
1 Yellow Rumped Warblers
~12 Bank Swallows

<u>Mammals</u>

Vancouver Island Marmots 6 seen ~ 10 heard in Colony 1
<u>Marmota vancouverensis</u>
(No others seen in Colonies elsewhere
(one heard on west facing slope west of Haley Lake)

Roosevelt elk, tracks & scats seen.
<u>Cervus canadensis</u> <u>roosevelti</u>

Black bear tracks seen <u>Ursus americanus</u>

Red squirrels <u>Tamiasciurus</u> <u>hudsonicus</u>

HALEY LAKE ER

MOD: FAUNA-TERRESTRIAL

SUB-MOD: AVIAN SPECIES LIST