DISTRIBUTION AND HABITAT CHARACTERISTICS OF YELLOW-BELLIED MARMOTS (*Marmota flaviventris*) ON BIG CREEK IN THE FRANK CHURCH RIVER-OF-NO-RETURN WILDERNESS, IDAHO

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Abstract

Wildlife populations change over time in response to alterations in their environment. More recently these changes have been accelerated in many species due to anthropogenic influence. I evaluated the persistence of a metapopulation of yellow-bellied marmots and examined habitat selection of marmots in an area with little anthropogenic disturbance, within the Frank Church River-of-No-Return Wilderness. During the summer of 2004 I located 12, and sampled 10, yellow-bellied marmot colonies within the Big Creek drainage, near the Middle Fork of the Salmon River, Idaho. Marmots were still present in the same areas as in 1978, and had expanded to two new locations. The marmots did not appear to choose habitat based on canopy cover or the percent composition of graminoid, forb, shrub, bare soil, or rock. Marmots did appear to prefer establishing colonies in locations with a higher percentage of stable talus and a lower percentage of rocky outcrops than was available across the landscape, while rock size did not appear to be important in habitat selection. Marmots chose areas with gentle slopes, facing south or southeast. Wherever humans had recently altered the landscape, marmots were present. In areas without human activity, marmots preferred landcover dominated by ponderosa pine or shrubs. I used a Geographic Information System to predict new areas subpopulations may inhabit following expansion during favorable years. Although other marmot species in North America and Europe are in decline, my examination of the marmot population on Big Creek suggests that this population is in a stable condition. Yellow-bellied marmots are not currently at risk however, understanding habitat selection and population expansion in a natural system for this species may prove valuable in understanding these factors for less common species in areas with anthropogenic disturbance and serve as a baseline for conservation design.

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Introduction

Six marmot species occur in North America; all but one occupy higher elevation sites of the West. Woodchucks (*Marmota monax*), hoary marmots *(M. caligata*), Alaskan marmots (*M. broweri*), and yellow-bellied marmots (*M. flaviventris*) have stable and healthy populations in most sites they have historically occupied (IUCN 2004). Olympic marmots (*M. olympus*) are not officially recognized as threatened in the Olympic Mountains, Washington (IUCN 2004), to which they are endemic, but their numbers are declining markedly (NPS n.d., S.C. Griffin, pers.com.) and Vancouver Island marmots (*M. vancouverensis*) are listed as endangered in their home on Vancouver Island, British Columbia (Blumstein, Daniel, & Bryant 2001, IUCN 2004). Most of the species that inhabit North America are closely related, excluding *M. monax* and *M. broweri*, which are more closely related to Eurasian species (Steppan et al. 1999).

Marmots are adapted to survive harsh climates of varying extremes (Arnold 1992). All marmots are true hibernators (Kilgore 1972) and are one of the largest-bodied groups of true hibernators on the planet (Armitage & Blumstein 2000). Marmots were more widespread during colder climate periods of the past; their range has been receding since the end of the last ice age (Armitage 2000). Warming climate trends (S.C. Griffin, pers.com.) and changes due to human activity may be among the factors leading to a decrease in numbers of *M. olympus*. Logging practices involving the creation of clearcuts are recognized as the most important factor leading to the decline in *M. vancouverensis*, in addition to possible effects from climate change (CWS 2004). One method to gain insight on declining populations of *M. olympus* and *M. vancouverensis* might be to study closely related marmot species occupying similar latitudes, such as the yellow-bellied marmots.

It may be valuable to study *M. flaviventris* for other reasons as well. Yellow-bellied marmots exhibit a classic metapopulation structure (Van Vuren & Armitage 1994) where stochastic events have the ability to cause periodic local extinctions, which for persistence, must be followed by recolonization from nearby sites (Meffe & Carroll 1997, Hanski 1998). In attempting to gauge impacts of anthropogenic fragmentation of wild areas, we may find it useful to examine smaller-bodied species persisting in metapopulations in naturally fragmented landscapes.

Life History

Marmot population structure most often consists of colonies, in which one male has a harem of 2-3 females, some yearlings, and young of the year (Armitage 1962, Armitage & Downhower 1974), though this is not the only option. It is also common for individuals or single male and female pairs with their young to occupy burrow systems outside of colonies, referred to as satellite sites or isolates (Armitage & Downhower 1974, Svendsen 1974).

Depending upon where the colonies of *M. flaviventris* are located in latitude and in elevation, the time spent in hibernation varies. Some marmot species will spend up to 8 months of the year hibernating (Arnold 1992). Duration of hibernating is dependent on a number of factors, mainly food availability from snow melt in the spring (Van Vuren & Armitage 1991) and vegetation senescence in late summer or fall, but may be delayed if a minimum weight gain is not reached by the end of summer (Armitage, Downhower, & Svendsen 1976).

Marmots choose their diet based on a number of factors including relative abundance, phenology, rejection or low ingestion of plant species with defensive compounds, nutritional quality, and energy requirements (Frase & Armitage 1989). Unless there is prolonged drought, water content is not deemed an important factor in food selection in most areas (Frase & Armitage 1989), but in dry areas of California water content in forbs may be important in habitat selection (Stallman & Holmes 2002). Kilgore and Armitage (1978) reported yellow-bellied marmot colonies ingesting only one to two percent of the available net primary production during gestation. Therefore, marmot population density is probably not determined by food availability (Kilgore & Armitage 1978).

Predation does not seem to hold the most significant role in population regulation of this species year round (Armitage & Downhower 1974), but summer mortality is almost solely due to predation (Van Vuren 2000). Yellow-bellied marmots are preyed upon by a number of species. Coyotes (*Canis latrans*), badgers (*Taxidea taxus*), American martens (*Martes armericana*), black bears (*Ursus americanus*), and golden eagles (*Aquila chrysaetos*) and other raptors have been among those determined to prey on *M. flaviventris* (Van Vuren 2000, Armitage 2004). Although it appears that parasites and pathogens are harbored by yellow-bellied marmots, they do not commonly lead to a direct mortality (Armitage & Downhower 1974). Most mortality occurs during hibernation, most likely due to inadequate weights at the time of its onset (Armitage & Downhower 1974).

Although yellow-bellied marmots are rarely observed digging new burrow systems (Armitage 2003a), it must occur at some point in order for populations to expand their range or recolonize areas of more distant local extirpation. Marmots appear to prefer settling near other marmots, but dispersers do colonize or recolonize empty sites when there are no other choices available. Colonization of new areas by dispersers requires a surplus of juveniles in the source population (Armitage 2003a), so favorable climatic and demographic parameters must be met. Following wet years (see Armitage 1994), years of thick snow pack (Svendsen 1974), and less severe winters (Armitage & Downhower 1974, Svendsen 1974, Van Vuren & Armitage 1991), overwinter survival is greatest, allowing marmot populations the ability to expand.

The objectives of my study were (1) to accurately describe marmot colonies along the Big Creek drainage and compare their density and distribution to those factors in 1978, as reported by Lombardi (1979); (2) to evaluate microhabitat features in marmot colonies; and (3) to evaluate macrohabitat features in colonies in a Geographic Information System (GIS) and develop a model to identify potential areas of range expansion following favorable years.

Hypotheses and Predictions

My hypotheses and predictions were as follows:

H1: Distribution of marmots has not significantly changed since 1978.

P1: Marmots are still present in the areas reported by Lombardi.

P2: Few if any new colonies will be found.

H2: Distance to water, vegetation cover and height, and presence of rocks are important factors influencing habitat selection by marmots.

P1: Marmot colonies will have greater forb cover than surrounding areas.

P2: Vegetation height within marmot colonies will be lower than surrounding areas.

P3: Marmot colonies will contain rocky outcrops and will be less than or equal to 100 meters from perennial water sources.

H3: Recent fires have created potential dispersal corridors between persisting marmot populations.

P1: Fires have reduced canopy cover and created new meadow openings between currently occupied habitats.

Study Area

I chose to study yellow-bellied marmots in the Frank Church River-of-No-Return Wilderness (FCRNRW) of central Idaho, based out of Taylor Ranch Field Station on Big Creek, near the Middle Fork of the Salmon River. Taylor Ranch served as a prime headquarters from which to observe how marmots "naturally" select habitat because it is located 32 miles from the nearest road, and despite history of human occupation by Native Americans and early settlers, anthropogenic impact has remained minimal. The Big Creek drainage has been included in the Idaho Primitive Area since 1931 and within the FCRNRW since 1980 (Carrey & Conley 1992).

My study area encompassed the area two miles from the trailhead at the Forest Service campground near the town of Big Creek (Edwardsburg) to where Big Creek empties into the Middle Fork of the Salmon River, 40 miles downstream, and five miles of Crooked Creek, a tributary of Big Creek. Elevations in the study area range from approximately 1000 to 2500 meters.

Field Methods

During the summer of 2004, I collected data on yellow-bellied marmots in the Big Creek drainage. I traveled the study area, stopping every half mile, listened for alarm calls, scanned the slopes with binoculars, and climbed 50 to 100 meters from the trail to search for scat and burrows. I spent additional time observing areas with marmot activity reported by Lombardi (1979). If during this period I found marmot sign or directly observed them, I returned at a later date to observe the area for ≥2.5 hours from a location 75 to 200 meters away, determined by terrain. If marmots where observed again, this confirmed their residence. I used the scan-sampling technique and recorded how many individuals were visible, recorded their location on a hand-drawn map, and recorded activity, along with notes on presence of other mammals.

I returned to colonies with confirmed residences to collect information on vegetation within and adjacent to the colonies to determine what habitat features the marmots selected at a greater proportion than was available to them. I determined colony boundaries by mapping all burrows with a Global Positioning System (GPS), pacing the farthest east-west and north-south distances from the burrows on the edges of the colonies, and calling the intersecting point of the paced lines the colony center point. I set the colony boundaries, radiating 100 meters out in all directions from the center point. I identified a "buffer zone" as the area adjacent to the colony, extending from the colony boundary out another 100 meters. Due to time and topographical restraints I was not able to accurately observe the animals and discover the areas they used exclusively and the areas they did not use, so I made a rough approximation of the area in which they spent most of their time based on my observations. I believe the resulting area I considered used by colonies (3.14 hectares) is accurate for my purposes based on comparisons found in the literature: Downhower (1968) considered yellow-bellied marmots moving over 100 meters to be dispersers, Armitage (2000) reported home range size varying with biomass, and Allainé et al. (1994) reported Alpine marmot (*M. marmota*) family groups using between 1.97 and 3.03 hectares.

I sampled ten transects within each colony and ten transects in the buffer zone outside of each colony, with four quadrats on each transect, using the Daubenmire method described by Coulloudon et al. (1999). From the colony center point, I took a random compass direction and paced a random number of steps within the colony boundary to lay the first frame and collect vegetation information. From the first quadrat, I sample three more, four paces apart. I continued on the compass line to the colony boundary, and paced another random number of steps within the buffer, sampling four quadrats in the same manner as above. At each quadrat I measured the maximum height of understory vegetation, and estimated the percent cover of graminoid, forb, shrub, bare ground, and rock, and recorded the most common plant species. I recorded the dominant rock type in each quadrat in four categories: "*stable talus*", "*loose talus*", "*rocky outcrops or rock embedded in the soil*", and "*rock sitting on top of the soil.*" The dominant rock size was also recorded and classified as "*small*" (up to one half foot in any direction), "*medium*" (one half foot to three feet), and "*large*" (over three feet). For four transects, I obtained canopy cover measurements with a densiometer within the colony and within the buffer zones. I also recorded densiometer readings from each colony center point and along the trail every half mile.

Analyses

I used a number of different statistical methods to analyze the field data at the fine scale. I used paired *t*-tests (Zar 1999) to compare the matched data inside each colony and buffer zone in addition to within all colonies and all buffer zones for the percent composition of the vegetative classes, the percent ground cover of rocks and bare ground, and the maximum vegetation height, and to compare the canopy cover within colonies and their buffers for each transect. I also used *t*-tests to compare the average canopy cover along the trail to the average canopy cover at the colony center points. I used a Multivariate Analysis of Variance (MANOVA; Zar 1999) to search further for differences in the representation of forbs, grasses, and rocks, as well as the maximum vegetation height. I used the Wilcoxon signed-rank test (Zar 1999) to assess levels of independence for rock type and rock size.

I used a GIS to analyze habitat selection and make predictions at the coarse scale. I used a GIS (ArcView 8.3) to identify the proportion of aspects (Table 1), slopes (five classes: 0-13.8, 13.8-27.6, 27.6-41.5, 41.5-55.3, and 55.3-69.1 degrees; aspects and slopes derived from USGS Digital Elevation Model downloaded from "Inside Idaho" URL: www.insideidaho.org), and landcover types as identified by the Idaho GAP Analysis Project (downloaded from http://www.wildlife.uidaho.edu/idgap/idgap_landcover.asp) within the colonies and within the study area. I performed a Chi-square test with a Bonferonni correction for multiple comparisons using "Resource Selection for Windows" (Leban 1999) to compare the proportions. If marmot colonies were located in areas that demonstrated repeatedly higher or lower proportions of classes within those habitat categories compared to the proportion of their availability across the study area, I concluded that the marmots preferred or avoided those habitat features. I also asked whether the colonies were within 100 meters of open water. I used the information obtained through this process to predict possible areas that marmots may inhabit during a succession of favorable years.

Table 1. Classes of equal interval degrees and their corresponding compass directions used in analyzing aspects selected by *Marmota flaviventris* colonies along the Big Creek drainage within the Frank Church River-of-No-Return Wilderness, Idaho, in 2004.

Compass Direction	Degrees
Flat	-1
North	337.5-22.5
Northeast	22.5-67.5
East	67.5-112.5
Southeast	112.5-157.5
South	157.5-202.5
Southwest	202.5-247.5
West	247.5-292.5
Northwest	292.5-337.5

Results

I discovered 12 colonies within the study area (Appendix I; see Appendix II for coordinates of colonies and isolated sightings of marmots). Due to time constraints, I sampled 10 colonies on the ground, but all 12 were included in the coarse analyses with a GIS.

Upon gross examination, the marmot population on Big Creek does not seem to have changed significantly in the past 25 years, although individual colonies have changed in size (Table 2). I believe that historically there was in fact a large colony at Smith Creek (Wilbur Wiles, Big Creek resident, pers.com.), but Lombardi (1979) did not report this colony. It is possible that some of the other 1978 estimates could lack accuracy as well.

Table 2. Population estimates for 1978 and 2004 for *Marmota flaviventris* colonies along the Big Creek drainage, within the Frank Church River-of-No-Return Wilderness, Idaho.

Colony Name	2004 Population estimates (adults and yearlings)	2004 estimated number of young	1978 Population estimates (adults and yearlings; Lombardi 1979)
18	15-20	0	0
Beaver Creek	5-7	0	0
Big Creek Ranger Station	7-11	5	17
Taylor Ranch	13-16	0	27
Soft Boil	5-7	0	Individual sighting
Smith Creek	9-13	0	Individual sighting
S01	2-3	0	*
T01	3-6	0	*
F01	1-3	0	*
V01	5-6	0	*
U01	1-2	0	*

*Lombardi (1979) reported 11 marmots along Crooked Creek as one continuous colony. I chose to classify the population with 5 smaller colonies along Crooked Creek.

Statistically, there were few differences among the ground cover elements considered at the fine-scale. Comparing colonies to buffer zones individually and grossly resulted in no significant differences in the categories encompassing the percent of vegetative classes (graminoid, forb, shrub), percent bare ground, percent rock, maximum height of vegetation, or canopy cover using paired *t*-tests (df=9; Table 3). Although a level of significant difference was detected among colonies (Wilks' Lambda, $P<0.0001$), no trends were observed between colonies and adjacent areas in maximum vegetation height, and percent composition of graminoid and forb classes.

I did not discover any trends when examining the most common species within colonies and their buffer zones. Within colonies the most common dominant species were *Bromus tectorum* (dominant in 9.5% of the quadrats), *Agropyron spicatum* (6.75%), *Sysimbrium* spp. (5%), and *Spyrarea betulufolia* (4.25%). Within the buffer zones the most common species were *Agropyron spicatum* (12.25%), *Bromus tectorum* (9%), *Pysocarpus malvaceous* (6.75%), and *Epilobium* spp. (6.75%).

Table 3. Results from comparing mean ground cover values at the fine scale (paired *t*-test, 2-tailed) inside and in areas adjacent to 10 colonies of *Marmota flaviventris* along the Big Creek drainage within the Frank Church River-of-No-Return Wilderness, Idaho during the summer of 2004.

	Colony		**Buffer**			
Habitat variable	$\bar{x}$	**SE**	$\bar{x}$	**SE**	***t***	***P*-value**
Graminoid (%)	22.84	6.56	27.46	5.61	0.53	>0.5
Forb (%)	18.01	4.44	21.60	2.63	0.56	>0.5
Shrub (%)	10.84	2.38	12.36	2.03	0.55	>0.5
Bare soil (%)	3.23	1.33	3.66	0.91	0.66	>0.5
Rock (%)	57.15	10.04	48.69	5.25	0.55	>0.5
Maximum height of vegetation	32.90	6.96	38.25	6.03	0.61	>0.5

My examination of the categorical rock data produced some interesting points. The Wilcoxon signed-rank test (2-tailed, *P*=0.02) detected significant differences in rock type. More *stable talus* was observed inside the colonies than in the buffer zones (n=8), less *rocky outcrops* were found inside the colonies (n=10), but no differences in the amount of *loose talus* (n=8) and *loose rock* (n=9) were detected within the colonies and their buffers. The Wilcoxon signed-rank test identified no differences in rock size (*small* (n=10), *medium* (n=10), and *large* (n=8)).

Among the factors considered at the coarse-scale, I detected several differences. All colonies were located within 100 meters of a perennial water source. The Chi-square test identified significant differences in the proportions of the five slope classes, the eight aspect classes, and the 19 landcover types within the study area. Marmots selected slopes in the first category, less than 13.82 degrees (*P*<0.0001), and avoided slopes greater than 41.47 degrees (*P*<0.0001). Marmots selected south (*P*< 0.0001) and southeastern

(*P*<0.05) facing slopes and avoided north (*P*<0.0001) and northeastern (*P*<0.0001) facing slopes. Refer to Table 4 to view the results from the Chi-square test for landcover types.

Table 4. Proportions of landcover types as designated by the Idaho GAP Analysis Project (downloaded from http://www.wildlife.uidaho.edu/idgap/idgap_landcover.asp) that were present within *Marmota flaviventris* colonies located in 2004 along the Big Creek drainage within the Frank Church River-of-No-Return Wilderness, Idaho.

Landcover Type				Marmot Choice
Code	**Type**	**X^2**	**P^2**	**A=avoid, S=select, N=neutral**
10XX	*Urban or Developed Land*			
1002	Low Intensity Urban	3663.12	< 0.0001	S
1101	Disturbed, High	2794.405	< 0.0001	S
1102	Disturbed, Low	324.547	< 0.0001	S
30XX	*Non-Forested Lands*			
3110	Perennial Grass Slope	34.986	< 0.05	A
3200	*Mesic Shrublands*			
3202	Warm Mesic Shrubs	2282.615	< 0.0001	S
33XX	*Xeric Shrublands*			
3301	Curleaf Mountain Mahogany	88.253	< 0.0001	S
3307	Basin & Wyoming Big Sagebrush	1.069	<0.05	N
42XX	*Needleleaf Forest*			
4203	Lodgepole Pine	21.314	<0.05	A
4206	Ponderosa Pine	114.187	< 0.0001	S
4212	Douglas Fir	68.004	< 0.0001	A
4217	Subalpine Fir	0	<0.05	N
4220	Mixed Subalpine Forest	3.237	<0.05	A
4222	Mixed Xeric Forest	68.172	< 0.0001	A
4223	Douglas Fir/Lodgepole Pine	18.258	<0.05	A
43XX	*Mixed Needleleaf/Broadleaf Forest*			
4301	Mixed Needleleaf/Broadleaf Forest	1.813	<0.05	A
5000	*Water*	205.608	< 0.0001	S
60XX	*Riparian and Wetland Areas*			
6101	Needleleaf Dominated Riparian	8.417	<0.05	A
6102	Broadleaf Dominated Riparian	10.86	<0.05	A
62XX	*Non-forested Riparian*			
6202	Shrub Dominated Riparian	4.294	<0.05	A

Predictions

I have developed a number of habitat models for *M. flaviventris* within the Big Creek drainage and beyond. I created separate models for slope (Appendix III), aspect

(Appendix IV), and landcover (Appendix V), and combined the maps to create models for potentially suitable marmot habitat based on the factors I examined in this study. I produced one map exhibiting preferred habitat (Appendix VI) and one identifying all habitat except those habitat types avoided (Appendix VII).

As with all human abstractions of natural systems, these models have inherent limitations. The sample of marmot colonies that I based my predictions upon is of relatively small size. Also, my examination of factors at the fine-scale may be somewhat inaccurate because I made approximations of colony boundaries, instead of exclusively determining the areas used by marmots through direct observation or telemetry. I recognize that extrapolation from my study site to other areas within the FCRNRW may induce error, especially in respect to landcover because there were a number of landcover types identified by the Idaho GAP Analysis Project that were not present within the study area, but were present in other areas of the FCRNRW. In order to minimize the effect of this on the larger area, I created another model using only slope and aspect (Appendix IIX). Lastly, I did not use water characteristics in developing my models, because I believe there may have been a sampling bias, in that all of my sampling occurred within a relatively close area to the creek.

Ecology notes

I found limited evidence of predation on marmots. There was no obvious evidence of badger activity at the colonies. I observed one attempted predation by a golden eagle at colony "V01" on Crooked Creek. Troy Hinck (pers.com.) reported marmot hair in black bear scat collected near Pioneer Creek, a tributary northwest of the

"Taylor Ranch" colony. I observed a red fox (*Vulpes vulpes*) wander through the Smith Creek colony and this elicited loud and repeated chirps from the marmots present.

I observed a number of potential competitors within marmot colonies. Pikas (*Ochotona princeps*), red squirrels (*Tamiasciurus hudsonicus*), golden mantled ground squirrels (*Spermophilus lateralis*), and chipmunks (*Tamias* spp.) were regularly observed within colony boundaries at several sites. Columbian ground squirrels (*Spermophilus columbianus*) were not present within any marmot colonies, but at the Big Creek Ranger Station colonies of the two species were directly adjacent to one another.

Discussion

Marmot colonies were widely distributed throughout the study area, with more colonies located in the upper half of the drainage, than the lower portion. This may be due to the elevation. Yellow-bellied marmots are not often reported at elevations less than 2000 meters (Armitage 2003b).

Because my study did not show any significant differences in comparing colonies and their buffer zones in regards to vegetation or canopy cover, but significant differences were detected in rock type, I believe that suitable burrow sites are the most important determinant of habitat selection by yellow-bellied marmots within the Big Creek drainage. Hibernation and predation are the most important factors determining marmot survival (Armitage & Downhower 1974, Van Vuren 2000) and although vegetation is important for weight gain, appropriate location of burrows should have the greatest effects on survival.

I do not believe that the severe year 2000 and other fires have or will have a significant impact on the marmot population for the following reasons: (1) if marmots were to have benefited from the disturbance I believe there would have been a significant difference in the location of colonies and in colony size since the large 2000 fire; (2) according to my analyses, the marmots do not select areas according to canopy cover or percent composition of vegetation, so the change in vegetation structure from fires would have little effect; and (3) if marmots did preferentially establish new colonies in areas due to altered vegetation from the fire, the colonies could likely be temporary or act as sinks if the vegetation were to return to its previous physiognomy. Therefore, I chose not to incorporate information on recent fires into my habitat model.

Marmots along the Big Creek drainage are not adversely impacted by human disturbance. Because marmots occupy every location within the study area where people have recently altered the land, the examination of landcover indicates marmots are in fact profiting from anthropogenic activities. As far as management for this species is concerned, low-impact anthropogenic activity should have no detrimental effects on the populations, as long as mortality from humans does not occur.

The intraspecific interactions with marmots and various species along the Big Creek drainage produced a few interesting observations. Yellow-bellied marmots and most other Glires species adapted to similar habitat are able to coexist within the study area, possibly excluding Columbian ground squirrels. During the summer of 2004, predation at colonies did not appear to be a significant factor.

Further research on Big Creek

Upon completion of this study, I believe there is still much that could be done to learn more about this population, as well as yellow-bellied marmots as a whole. It may be valuable for researchers to continue monitoring this population to observe long-term demographic trends. Also, it could be valuable to examine why marmots are present in some areas, but absent in others, identified in the models with similar habitat characteristics. Are there other factors not examined that are more important in determining the distribution of marmots within the drainage? Is the presence of competitors or predators influencing their distribution? It seems unlikely that competitors are limiting marmot populations because I observed most potential competitors within colony boundaries and it seems unlikely that the larger marmots would secede to the smaller and only Glires species not observed inhabiting the same areas, Columbian ground squirrels.

I imagine there is another factor I did not examine helping to determine habitat selection in the marmots of Big Creek. Perhaps dispersion, predation, and elevation could account for their absence in the lower portions of the drainage especially.

Lastly, I feel that further examination of marmots on Big Creek could aid in our understanding of this species as a whole by comparing factors here to those studied extensively in Colorado and California. Little work has been conducted on yellow-bellied marmots at this latitude, and intraspecific differences as well as interspecific differences within the marmot genus at varying latitudes may aid in conservation efforts across the globe.

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