The Marmot Population in the Nationalpark Gesäuse

Investigation on the population structure

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Introduction

The first investigation on the alpine marmot *(Marmota marmota)* population in the National Park Gesäuse was done in 2005. It was the aim of a diploma thesis to find out more about their regional distribution, their population size and their age structure (Schmotzer 2007). Schmotzer recorded a population size of 148 animals spread over 26 territories in 2005. This was considered to be a stable population with low extinction risk (Schmotzer 2007). Based on the observations of the hunters in the national park there might have been a population decline in the last few years. There are several possible reasons, which could lead to a reduction of the population. Increased winter mortality, disturbance through visitors, higher predation pressure or decrease of alpine pastures are amongst the causes, which could be responsible for it. Before investigating the reasons of a decline, the observation of the hunters had to be verified through a monitoring. Regularly monitoring of the animals living in a national park is in general an important tool for the management plans and the visitor guidance of the park. The aim of this investigation therefore was to find out whether the population size and age structure changed between 2005 and 2013. Hence a census was done to proof the null hypothesis that there is no significant change in the population size and structure since 2005. The census was done in the already known territories in July and September following the investigation work of Schmotzer in her thesis (Schmotzer 2007).

Background and Method

Study species - *Marmota marmota*

The alpine marmot *(Marmota marmot)* is the second largest rodent living in Austria. It's a typical ice age relict, which once inhabited large parts in middle Europe. Due to the decline of the glacier and the spreading of the wood after the glacial period it was drawn back to higher altitudes and nowadays its dispersion extends over the entire range of the European Alps (Preleuthner 1999). In Austria several occurrences of marmots in the Eastern Alps, go back to (re)introduction in former times (Preleuthner 1999). The first introduction known for Styria took place in the 1930s (Bachofen von Echt & Hoffer 1930).

Marmots usually can be found in altitudes between 900 m and 3000 m, where they find alpine meadows with fresh grass and herbs to feed on and good soil to dig their burrows (Barkhausen 2012). Marmots live in burrows in which they spend, due to hibernation in winter, most time of the year. The territory where the marmot lives is perforated with holes, some of them being real burrows, connected with tunnels, some of them are only escape wholes to hide in when danger. The rodent is a highly social animal and lives in family groups. Every family inhabits a territory with around 2,5 ha and can consist of up to 20 family members (Arnold, 1999). There is a strict hierarchy in the group and every family consists of a dominant male and female, which are the only ones who reproduce. The rest of the family members are their

offspring, which stay with their parents for around 3 years before they leave to find their own territory (Arnold, 1999).

Picture 1: marmot burrow with grazing cow

Picture 2: freshly dug tunnel hole

To overcome the hard and cold winters in the mountains marmots hibernate in their burrows from October till March. This is a quite precarious time for the animals since the surviving is depending on the amount of fat they managed to build up during the short summer period and the family size (Arnold 1990). During summer they show diurnal activity and spend most of their time outside the burrow feeding to gain enough fat store for the winter. Since they are not very heat resistant, marmots stay in their cool burrows during midday on hot days (>25 C°) and have their activity peak in the morning and afternoon hours. On foggy and rainy days they are almost totally inactive (Türk and Arnold 1988).

Common predators of the marmots are the golden eagle (*Aquila chrysaetos*) and red fox (*Vulpes vulpes*). To warn their associates off predators they have their quite famous whistling which is sometimes the only thing that hikers notice from the animal in the mountains.

Picture 3: whistling marmot

Study area

The study area lies in the "National Park Gesäuse" in Austria, which was found in 2002. The national park is situated in the northern part of Styria in the northern limestone alps (Nördliche Kalkalpen). The park lies at an altitude of 1490 m to 2369 m asl and has an area of 11 054 ha. In the national park counts the styrian hunting law in its current version (from 1986). Marmots are preserved from hunting all over the year.

Fieldwork

The fieldwork was conducted two weeks in July (8th-20th of July), and two weeks in September (9th – 21th of September). In July the yearlings are still distinguishable from the adults and this it

the time were the juveniles come out of the burrow for the first time (Arnold 1999). The September observations were important to find out about summer mortality especially for the juveniles and also to have a general comparison between early summer and autumn and a replication of the method.
We checked all registered territories from 2005 (Schmotzer 2005) and did a census if animals were present to have a comparison to Schmotzers work. First the territories were explored, to know the borders and to check for actual signs of presence. If obvious signs like freshly dug burrows/holes, whistling or the animal itself was seen, the territory was monitored. Population count was done by direct observation using binoculars (Nikon Monarch 10x42 DCF WP), a spotting scope (Kowa TSN-663 ED 30x and Kowa TSN-823M 20-60x) and an observation form to note all data (appendix 1). Observation and counting took place from a hidden spot, where you could see the whole territory and the animals did not feel disturbed. This condition was fulfilled when the animal did not increase its attention (frequent screening behavior (Bibikow 1996) through the presence of the observer (Schmotzer 2005). Every 15 min the maximum number of visible animals was noted. We distinguished between juveniles, yearlings and adults. Juveniles can be distinguished easily by the smaller size, the different body proportions, the darker fur color and their behavior. Also yearlings, marmots that survived one winter, can be distinguished by the smaller size compared to adults, at least in the early summer. Since there is hardly any sexual dimorphism, which can be seen only by observation, we did not distinguish between male and female. Observation time varied between one and two hours per territory and almost every territory was observed at least one time in July and one time in September. Observation time per day was depending on the activity patterns of the marmot (see above - study specie) During hot and sunny days observation was done in the morning hours and in the late afternoon hours. On cloudy days, observation was done the whole day. And on rainy and foggy days there was no observation at all. If animals were seen in unknown territories, they were also observed and the territory was added on a map to the already existing ones.

The data from the observation form was evaluated with Microsoft Excel 09 and the statistic program R 3.0.2. The territories with their current positions and changes to 2005 were marked on a map, using GIS (Arc Map 10).

Results

Between July and September 2013 we counted a marmot population of 99 Individuals, spread on 26 territories (table 1, figure 4). The population consisted of 28 juveniles (28%), 28 subadults (28%) and 43 adults (43%) (figure 1). Altogether there was a decline of 33% in the population compared to 2005, with the biggest decline noted in the adult population. The number of adults per group (adult_05, adult_13) got significantly smaller in 2013 ($t = 4.6226$, p-value = 7.779e-05). The number of juveniles almost stayed the same between 2005 and 2013 with only one animal less than in 2005. In 2013 56% more subadults could be observed and 57% less adults compared to 2005 (table 1). In 20 out of 26 territories we found yearlings and/or

juveniles (table 1). The mean group size (Group_05 and Group_13) changed from 5,1 animals (sd 3,88) in 2005 to 3,4 animals (sd 2,51) in 2013, which is a significant difference (t-test, T: 2,41; p=0,0223).

Three of the 26 territories from 2005 (nr. 10 Haglplan, nr. 17 Plotschenboden and nr. 21 Glaneggleiten) seemed to be abandoned, since no actual presence signs (freshly dug burrows, whistling, direct observation) could be found. On the other hand three new territories (nr. 27 untere Koderalm, nr. 28 Josefinensteig and nr. 29 Brunnfeld) with marmots could be recorded, whereas nr. 29 was recorded as abandoned territory in Schmotzers work (Schmotzer 2005). In nr. 24 Glaneggluckn and nr. 25 Obere Stadlfeldalm a shift of the territory borders was noticed (figure 4). In nr. 6 Jägerhofalm/Stadlalm no marmot could be observed even though actual presence signs like freshly dug burrows could be seen. Territory nr. 20 Antonibodn was not visited at all since it was situated quite afield of the other territories.

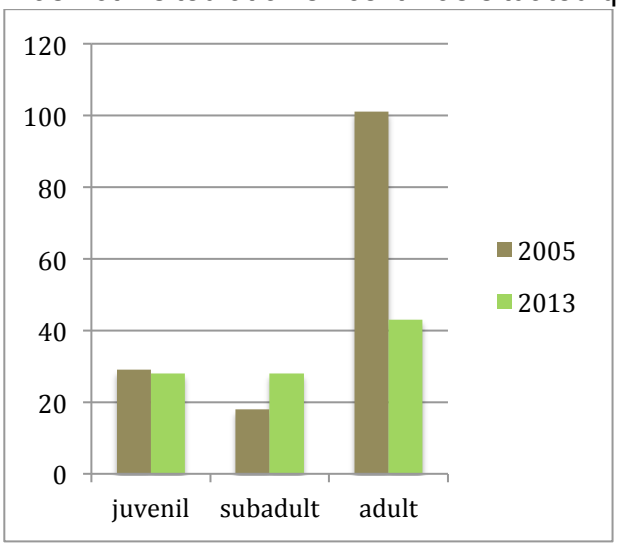

Figure 1: Total number of marmots in 2005 and 2013, divided in 3 age classes.

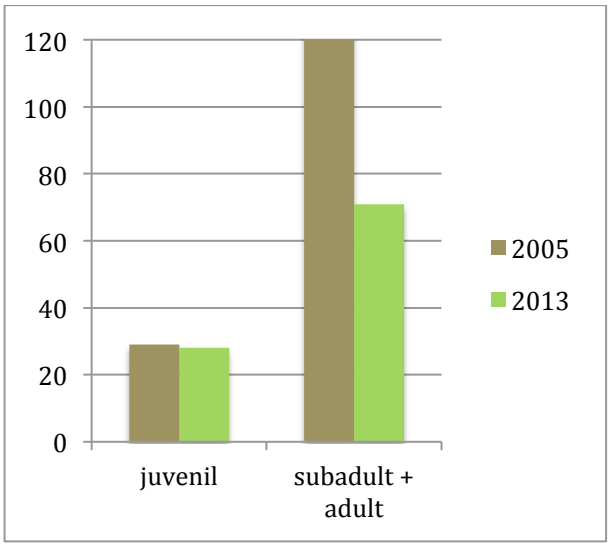

Figure 2: Total number of marmots in 2005 and 2013, divided in 2 age classes.

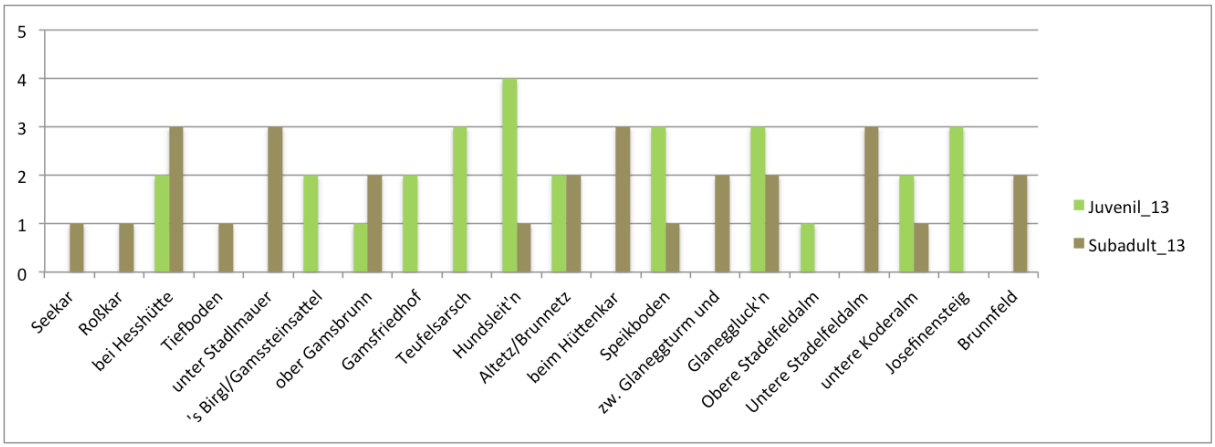

Figure 3: Reproductive outcome 2012 (subadults) and 2013 (juveniles)

Table 1: Marmot territories 2005 and 2013

Nr.	Territory	Juv_05	Subad_05	Adult_05	Group_05	Juv_13	Subad_13	Adult_13	Group_13	Change in %
1	Seekar	3	0	5	8	0	1	1	2	**- 75%**
2	Roßkar	0	0	1	1	0	1	2	3	**+ 200%**
3	bei Hesshütte	0	3	6	9	2	3	3	8	**- 11%**
4	Tiefboden	0	0	3	3	0	1	2	3	**0%**
5	unter Stadlmauer	0	1	3	4	0	3	2	5	**+ 25%**
6	Jagerhoferalm/Stadlalm	0	0	2	2	0	0	0	0	**- 100%**
7	Obere Koderalm	0	0	2	2	0	0	1	1	**- 50%**
8	Abzweigung Richtung Hochtor	0	0	1	1	0	0	2	2	**+ 100%**
9	's Birgl/Gamssteinsattel	3	0	9	12	2	0	2	4	**- 66%**
10	Haglplan	0	0	2	2	0	0	0	0	**- 100%**
11	ober Gamsbrunn	4	2	3	9	1	2	3	6	**- 33%**
12	Gamsfriedhof	0	2	2	4	2	0	2	4	**0%**
13	Teufelsarsch	0	0	10	10	3	0	5	8	**- 20%**
14	Hundsleit'n	0	0	4	4	4	1	1	6	**+ 50%**
15	Altetz/Brunnetz	3	0	9	12	2	2	3	7	**- 41%**
16	Brunnkar	0	0	5	5	0	0	2	2	**- 60%**
17	Plotschenboden	0	0	2	2	0	0	0	0	**- 100%**
18	beim Hüttenkar	0	0	4	4	0	3	1	4	**0%**
19	Speikboden	5	3	5	13	3	1	2	6	**- 54%**
20	Antoniboden	0	0	3	3	0	0	0	0	----------
21	Glaneggleit'n	4	4	2	10	0	0	0	0	**- 100%**
22	zw. Glaneggturm und Stadelfeldschneid	2	0	5	7	0	2	0	2	**-71%**
23	Glanegg-Kessel	0	2	6	8	0	0	1	1	**- 87%**
24	Glaneggluck'n	2	0	2	4	3	2	2	7	**+ 75%**
25	Obere Stadelfeldalm	1	0	3	4	1	0	1	2	**- 50%**
26	Untere Stadelfeldalm	2	1	2	5	0	3	0	3	**- 40%**
27	untere Koderalm	0	0	0	0	2	1	2	5	**new territory**
28	Josefinensteig	0	0	0	0	3	0	2	5	**new territory**
29	Brunnfeld	0	0	0	0	0	2	1	3	**new territory**
	Sum	**29**	**18**	**101**	**148**	**28**	**28**	**43**	**99**	
	Mean group size				**5,1 (sd 3,88)**				**3,4 (sd 2,51)**	

Note: Territory nr. 20 was not visited at all

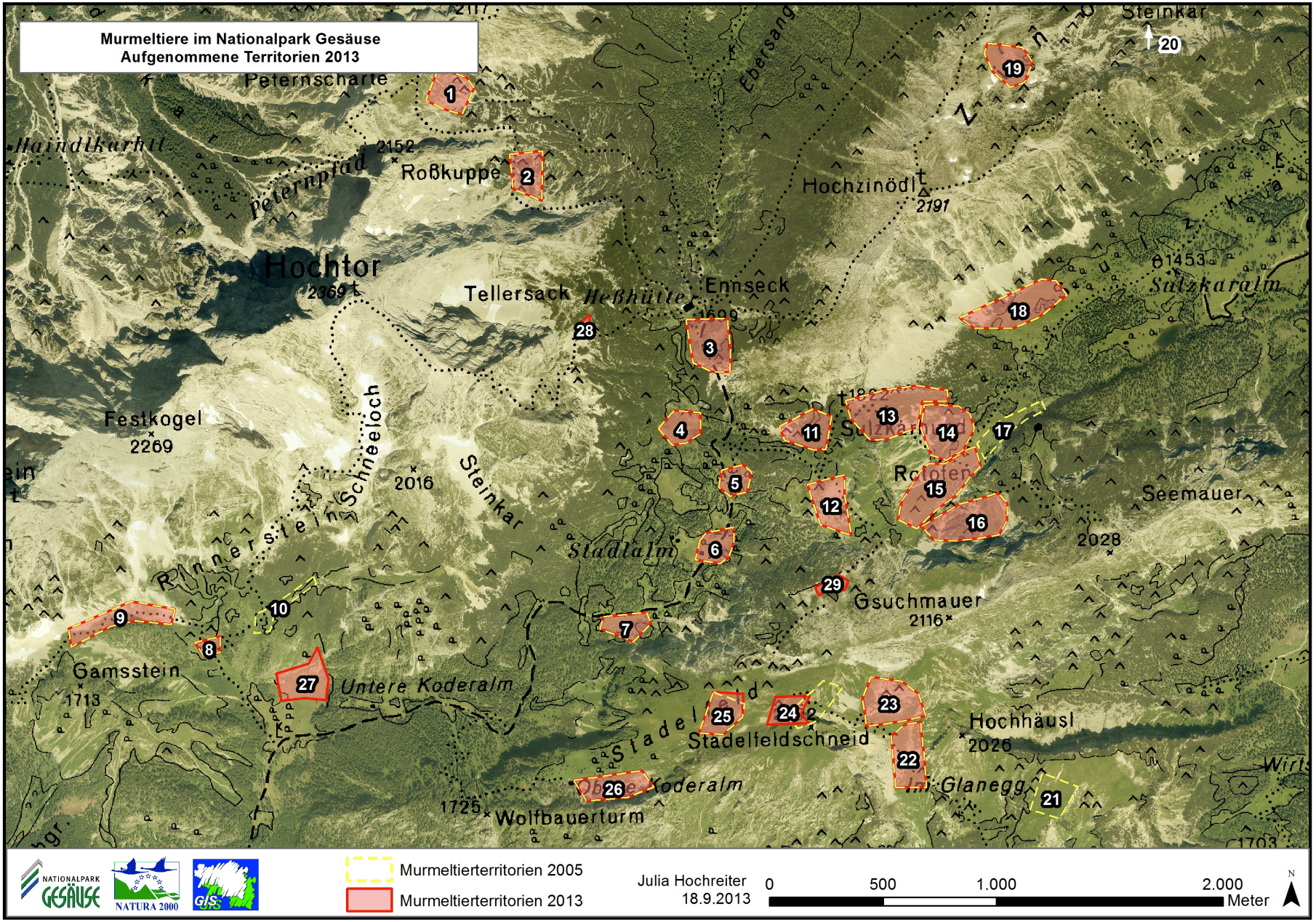

Figure 4: Recorded marmot territories in the national park Gesäuse 2013 and 2005

Discussion:

Even though there was a shift in the territories, the amount of inhabited territories stayed similar to 2005 (table 1), which lets us assume that there are still enough habitats for the marmots to live in.
Nevertheless there is a population decline of 33% and also the mean group size of 2013 is significantly smaller than the one from 2005. The null hypothesis that there is no significant change in the population size and structure can therefore be rejected.

Looking at the age structure of 2013s population it can be seen that most of the decline refers to the adult population. The amount of juveniles is almost similar as in 2005 and we found juveniles and/or yearlings in 20 out of 26 territories (figure 3). Therefore we can assume that the reproductive output in the population is still the same and we can exclude a reduced reproductive success as a reason for the population decline. The number of subadults even rose compared to 2005. But this might also be due to the difficult differentiation of subadult and adult age class, when only observing the animal with binoculars. To overcome this possible mistake, it might be more reliable to put the numbers of adults and subadults together in one group for comparison. This still leads to a decline of 40% with 119 individuals in 2005 compared to 71 individuals in 2013 in this group (figure 2).

Since the reproductive outcome is still the same, one possible reason for the decline could be a higher mortality rate. There is a high mortality risk for marmots in their first summer since the juveniles are quite unexperienced and not aware of possible danger (Neuhaus und Mainini 1998). Red fox and Golden eagle, the two main predators of the marmot are both present in the national park. But there weren't any major changes in wildlife management in the last eight years in the park, so there is no obvious reason why the predation pressure should be stronger nowadays.

Another critical period for the marmot is the wintertime, which has a quite high mortality risk too. During the hibernation the only energy comes from the fat storage the marmot managed to feed on during the summer period (Arnold 1990b). An unusual long and hard winter, which means shorter vegetation period and longer period with snow cover, could lead to a higher mortality rate and therefore a population decline. Data of the last 4 winters (2009-2013) from the meteorological station "Gscheidegg" (1689m) in the national park Gesäuse showed that in winter 2011/2012 there were 225 days of snow cover, compared to the other winters with 146 – 189 days of snow cover (data from national park Gesäuse 2013) (figure 5). This makes a difference of at least one month and therefore could be a reliable reason for the actual population decline. So if we consider the winter of 2011/2012 to be an unusual long winter and the winter 2012/2013 (189 days) to be a "normal" one there is even another fact which argues for this explanation: The actual age structure of the population shows that the number of juveniles and subadults didn't really change compared to 2005, only the number of adults did (table 1). This would account for a high mortality rate in 2011/2012.

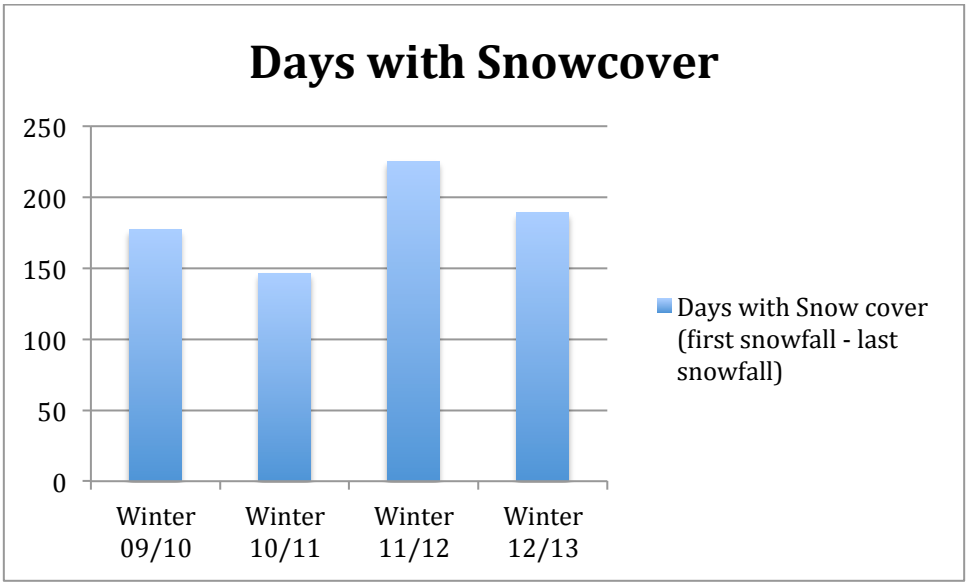

Figure 5: Days with snowcover, calculated with first and last snowfall in winter. (first snowfall: continuous snow cover for at least 3 days.)

Another reason for the smaller population size 2013 compared to 2005 could be a weakness of the method, which was used for counting. Since we only counted the animals that were seen at the same time to avoid double count, the method is probably underestimating the population. Therefore it is quite reasonable that we missed a few individuals. Unfortunately there isn't really an exact description of the method in Schmotzers work of 2005 to make a comparison of the methods. But what can be seen from the work of Schmotzer in 2005 is that she had 40 days of observation, which is a lot more then the 15 days that we had for observations. This reason might also be responsible for the difference in population numbers.

So even though there is a decline in the population number, there is still the same amount of inhabited territories as in 2005. Due to the study of Dorndorfer (1999) in Berchetesgarden a metapopulation needs to have a minimum number of 15 territories to have a 95% chance of survival for the next 100 years. This would mean that with 26 inhabited territories the population in the national park can considered to be stable. Nevertheless it has to be considered that the group size of the territories got significantly smaller. Group size is an important criterion for the winter survival of the marmots. Small groups have a higher mortality risk since the group might not be able to produce enough energy for the social thermoregulation during hibernation (Arnold 1990b). To be aware of the development of the population it would be necessary to have a regular monitoring in the national park.

Monitoring is an important management tool for the national park and even though this result cannot give exact numbers it gives at least a brief view on the actual situation of the marmot population in the national park. To draw a more precise conclusion on the development of the population or the reasons for possible declines, it would be necessary to have population data over several years and also more data about covariables that might influence the population.

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Pictures

Cover Picture: juvenile marmot, Julia Hochreiter, July 2012

Picture 1: marmot burrow with grazing cow, Julia Hochreiter, July 2013

Picture 2: freshly dug hole, Julia Hochreiter, July 2013

Picture 3: whistling marmot, Julia Hochreiter, July 2013

Appendix 1: Recording form

Murmeltierzählung Nationalpark Gesäuse 2013									**Datum:**
Standort:									**Beobachter:** Julia Hochreiter
Zeit (15 min Intervall)	Anzahl adult		Anzahl subadult		Anzahl juvenil		Anzahl gesamt		Anmerkungen Verhalten sonstige Beobachtungen, Besonderheiten	Wetter Schatten/Sonne
	max sichtb.	gesch. Anzahl	max sichtb.	gesch. Anzahl	max sichtb.	gesch. Anzahl	max sichtb.	gesch. Anzahl		

Appendix 2: Field days

Nr.	Territory	July	September
1	Seekar	14	12
2	Roßkar	14	12
3	bei Hesshütte	10 13 14 16 17	10
4	Tiefboden	9 15	11 15
5	unter Stadlmauer	10 15	11 13
6	Jagerhoferalm/Stadlalm	10 15 17	11
7	Obere Koderalm	10	13
8	Abzweigung Richtung Hochtor	17	16
9	's Birgl/Gamssteinsattel		16
10	Haglplan		16
11	ober Gamsbrunn	16	12
12	Gamsfriedhof	12 17	12 10
13	Teufelsarsch	16	14
14	Hundsleit'n	9	14
15	Altetz/Brunnetz	9 16	14
16	Brunnkar	16	14
17	Plotschenboden	16	
18	beim Hüttenkar	9 16	14
19	Speikboden	13	15
20	Antoniboden		
21	Glaneggleit'n	12	
22	zw. Glaneggturm und Stadelfeldschneid	12	
23	Glanegg-Kessel	12	10
24	Glaneggluck'n	12	10
25	Obere Stadelfeldalm	12	10
26	Untere Stadelfeldalm	12	10
27	untere Koderalm	17	16
28	Josefinensteig	13 17	10
29	Brunnfeld		10
	Total	**8 Days**	**7 Days**