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REPORTS

Monitoring of Tatra marmots and Tatra chamois in the Mount Chopok South - North 2023

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Abstract. This survey included monitoring and detection of GPS coordinates of Tatra marmot burrows (*Marmota marmota latirostris* Kratochvíl, 1961) in the area of Chopok South (Low Tatra Mountains, Slovakia) near the ski resort, extending to neighbouring sites in the area between April 15, 2022, and November 15, 2022. This alpine habitat is characterized by dynamic changes related to the migration of Tatra marmots. The survey started in the alpine zone from the eastern saddle Sedielko pod Chopkom and continued west toward the non-functional ski lift Tatrapoma at Zadné Dereše. For the complexity of the monitoring of the ridge part of the alpine zone of the marmot habitat in the vicinity of the Mount Chopok, the northern colony of the trough Retranslačný žľab in the first Dereše basin (prvý Derešský kotol) and the end of the valley Lukovská dolina – the trough Školský žľab were also included in the survey. Wider monitoring was also carried out on the Tatra chamois (*Rupicapra rupicapra tatrica*, Blahout 1972), from the saddle Demänovské (Široké) sedlo, 1,756 m a. s. l. in the east, to the saddle Sedlo Poľany, 1,837 m a. s. l. in the west. The established monitoring system of Tatra National Park (TANAP) was used, including observation and documentation of Tatra chamois occurrence, their migration, and negative impacts.

Key words: Tatra marmot, Tatra chamois, monitoring, Mount Chopok

Tatra marmot (*M. marmota latirostris* Kratochvíl, 1961)

The survey included the area of Chopok South from the Sedielko saddle to the non-functional ski lift Tatrapoma at Zadné Dereše (Low Tatra Mountains, the Carpathian Mountain range of Slovakia, Fig. 1). Monitoring in the upper parts of the alpine zone for a complete picture of the biotope was also extended to two northern locations (trough Retranslačný žľab in the first Dereše basin (prvý Derešský kotol) and the end of the valley Lukovská dolina, the so-called trough Školský žľab). The subject of the monitoring was the status of marmot colonies in the monitored habitat (Fig. 2).

Methodology

Monitoring of marmot colonies in the Chopok area was carried using the same methodology established in 2004 when research commenced. This methodology is based on the geographical coordinates of all burrows found using a GPS device (for more details see Ballo and Sýkora 2005, 2006, 2007).

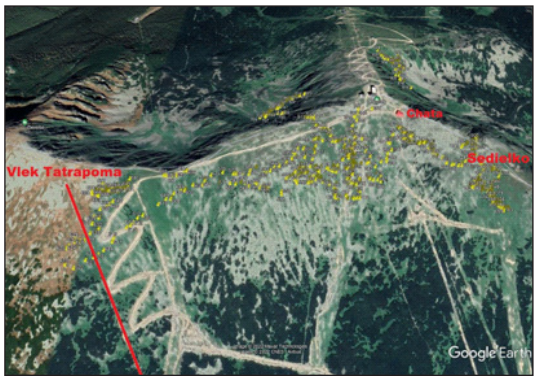

Fig. 1. The area of interest Chopok South, GPS coordinates of the Tatra marmot burrows (yellow points). Sedielko – Sedielko pod Chopkom (Saddle below Chopok), Vlek Tatrapoma – non-functional ski lift Tatrapoma, Chata – hut Kamenná chata.a.s.l.).

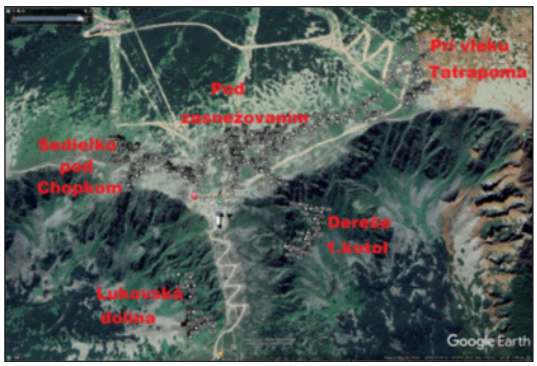

Fig. 2. Locations of the area of interest, marmot colonies in the Chopok area. 940 marmot burrows, GPS-targeted (white). Sedielko pod Chopkom – Saddle below Chopok, Pod zasnežovaním – below snowmaking system, Pri vleku Tatrapoma - non-functional ski lift Tatrapoma, Dereše 1. kotol – first Dereše basin, Lukovská dolina – Lukovská valley.

This is a GPS coordinate processing technique that was established and tested over nine years of research (2004-2012) in the Tatra National Park.

To create a picture of the complexity of the colony, the geographical coordinates of all the burrows found were recorded. From mid-June onwards, maternal burrows inhabited by females and offspring were searched for. Each marmot family discovered in the southern and northern slopes of Mount Chopok were examined. Attention was also paid to ecology, ethology, trophic base, and anthropic influences.

Localization of Tatra marmot colonies

- collection of GPS coordinates of all found burrows
- locating maternity burrows (red dots) where the mother marmot raises her young
- locating the winter burrow (blue points) where the marmots hibernated
- locating secondary escape burrows, auxiliary burrows, and emergency shelters 100 cm or more in length
- processing of detected data (inserting the coordinates into the digital map)
- migrations (used data of the Slovak Hydrometeorological Institute weather station, staff of the hut Kamenná chata and the Mountain Rescue Service)
- search for communication corridors
- anthropic influences (tourism, sports activities)
- predators (eagle, lynx, fox, bear, raven)
- phytocoenology (food, trophic base)
- acoustic manifestations of marmots on predators and anthropogenic influences
- symbiosis and coexistence of two glacial relics living in the common habitat of the Tatra mountains – the Tatra marmot and the Tatra chamois

Monitoring of marmots

Detailed field reconnaissance was carried out between April 15, 2022, and October 15, 2022, (i.e., from the first marmot excavation until hibernation). The first surveys of the habitat were carried beginning in May, using ski mountaineering equipment and climbing handcuffs. The second phase of fieldwork began in early June 2022, when all the snow had melted in the alpine meadows, and marmot burrows - including the northern glacial troughs - were accessible for inspection and recording of coordinates. The collection of coordinates and fieldwork was completed by October 15, 2022, when marmots were preparing for hibernation, by plugging burrows in advance of the first snowfall (see, e.g., Ballo 2008a, 2008b, 2009; Ballo and Sýkora 2005, 2006, 2007). All marmot burrows in the southern slopes were accessible for inspection and coordinates recording between the end of May until the 15th of November 2022. In northern localities (Lukovská valley and the first Dereše basin), where burrows were still beneath snow cover until mid-June, monitoring commenced later in the season and measurements were carried out from the time the marmots were excavated until the beginning of hibernation, when marmots plugged their burrows for winter.

Monitoring began gradually on April 15, 2022, following snowmelt. Due to increasing temperatures, burrows were exposed and visually accessible for monitoring, even in the snow beds. The collection of burrow coordinates was completed on September 17, 2022, when the first snow fell in the alpine zone, persisting until September 27, 2022, during final preparations of the marmots prior to hibernation. Snow showers also occurred on October 2, 2022, and November 5, 2022. The last recorded snowfall in the alpine and subalpine zones fell on November 15, 2022, beginning to form a sub-thermal insulation layer over the marmots' winter burrows, likely persisting until the spring period of 2023.

Types of marmot burrows

A winter burrow is a burrow where marmots hibernate. They occur on high ground, protecting the nest from prolonged precipitation. The plugging of the burrow is about 80 cm long. It is composed of small stones, hermetically filled with dry vegetation and specially selected soil substrate, which insulates the burrow thermally. Snow cover of 1 m to 2.5 m also creates significant thermal insulation. In the second half of May, when the vegetation starts to grow, the marmots emerge from their winter burrow and start to clean it thoroughly. They dig out all the dry lining (dry grass and plant stems) in which they have hibernated, leaving it near the burrow. Weather, wind, and torrential rain often scatter the lining around. The vegetation that begins to grow also provides them with shelter from predators.

The maternal burrow is the dominant burrow, preceded by a large horizontal mound. In the first weeks of life, the young have a sufficient and safe space for their activities (Fig. 3).

Dug emergency shelters are over 100 cm and serve as protection for marmots from predators, dogs, and tourists. Many of them are around the maternity burrow, with which they are connected for the safety of subadult marmots from predators. They are excavated in the grazing territory of marmots. These burrows are spaced 2 - 10 m apart from each other. The marmots in the debris cones and screes use natural emergency shelters among the stones, though these have not been targeted in this research. Together with maternity and winter burrows they form marmot colonies. In one colony 150 to 300 burrows were targeted (for more details see Ballo and Sýkora 2005, 2006, 2007).

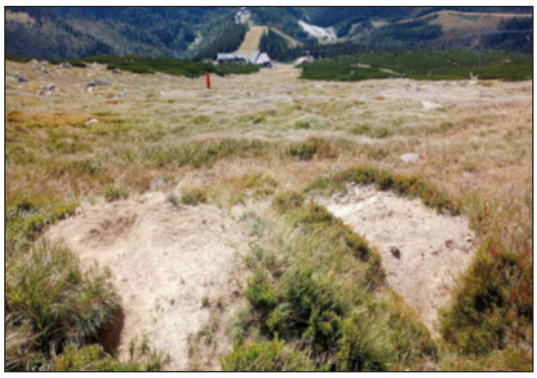

Fig. 3. Maternal burrow at location Sedielko with two mounds of soil.

Assessment of marmot colonies located around Mont Chopok

The Tatra marmot is a rodent inhabiting the highest alpine meadows and debris of the alpine zone of the Low Tatras National Park. This monitoring project, which digitizes the marmot's habitat in detail, is also based on the project for the rescue of the Tatra marmot (Programme for the rescue of the Tatra marmot *Marmota marmota* Linnaeus, 1758, Ondruš *et al.* 2003).

Based on the last detailed monitoring, marmot colonies in the southern slopes and related colonies in the northern slopes of Mont Chopok were digitized (Fig. 4). Colonies consisting of seven marmot families in good condition were found in the surveyed localities. The impact of activities in the study area, namely the cable cars and Chopok South emergency road, were assessed. The impacts on the favourable status of this species were assessed comprehensively in a broader context. Population trends in individual localities were examined. Attention was also paid to ecology, ethology, and trophic base.

GPS was used to locate the burrows of 5 marmot colonies A, B, C, D, E (Fig. 4) saddle Sedielko pod Chopkom A, Predné Dereše B, in the western direction Veľký Dereš (Tatrapoma) C. The overall picture of marmot habitat around the Mount Chopok showed the need for extended unplanned surveys in the north at the end of the Lukovská dolina valley D and in the trough Retranslačný žľab, the first Dereše basin E.

The colonies surveyed in the monitoring sections are, according to the residence traits, built on long-used original sites. Verbal information from long-standing staff of the meteorological station on Chopok, Mountain Rescue Service staff, and cableway staff, confirmed that the targeted colonies have resided there for several decades without long-term changes of habitats. The new knowledge and digital maps of the colonies will aid future translocation or dispersal of marmots or their decline.

GPS measurements only started intensively in mid-June when all snow in the alpine snow beds had already melted. All marmot burrows were accessible for inspection and measurement.

Mapping of marmots continued in the southern slopes below Predné Dereše, heading across the territory next to the artificial snowmaking route below the meteorological station. The complexity of the colony is shown on the digital orthophoto map, with all burrows recorded.

Monitoring focused on the south side, where the marmots are most in contact with tourists, sports activities, and in springtime after emergence, with skiers. Colony "B" Predné Dereše is distributed vertically around the route of the functional snowmaking branch. Here, the snowmaking route further away from the maternal burrows was built as recommended. By observing the residence signs in the largest mapped colony below Predné Dereše, 2 maternity burrows were identified in early summer. In spring, dry vegetation and stones were dug up - remnants of plugs were found in front of the 2 burrows in which the marmots hibernated. They are marked as winter burrows.

Subsequently, the collected coordinates were processed and inserted into the orthophoto map. The knowledge of Tatra Mountain Resort staff and incidental observations of marmot movements from the nearby hut Kamenná chata were also used.

Description of monitored colonies

A. Sedielko pod Chopkom, southern slope

During production of artificial snow equipment in the beginning of summer 2013 in colony B/ below Predný Dereš, vertically next to the cable car, the marmot population was affected so that part of it moved northwards to the first Dereše basin - E. The second major migration of marmots was directed to the colony in the eastern direction below the saddle Sedielko A (Fig. 5a, b; 6).

The marmots found a suitable replacement habitat with a good trophic base. Monitoring during the summer of 2022 revealed that marmots are in good condition in the new location, as evidenced by GPS measurements of burrows. Detailed field reconnaissance over a wide area around Chopok, revealed an increase in the population of this colony, as shown by the large number of fresh mounds. The marmots have found a quieter location at Sedielko, below Chopok. During the summer, most of the warning acoustic calls of marmots were heard from this location. They reacted to tourists on the trail heading to Ďumbier, when they were leading their dog without a leash. There were 2 maternal bur-

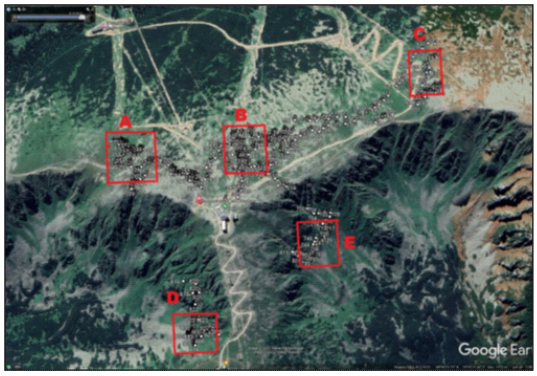

Fig. 4. Locations of marmot colonies (red rectangles). Chopok south A, B, C. Chopok north D, E.

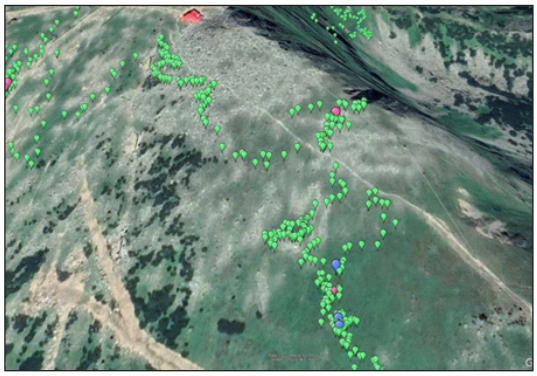

Fig. 5a. Colony Sedielko, above the hut Kamenná chata. Migration corridor westwards to colony "B" and vice versa. Two maternity dens (pink), three winter burrows (violet), emergency burrows (green).

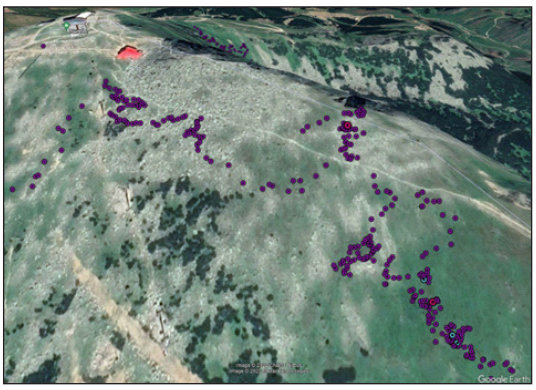

Fig. 5b. Sedielko below Chopok south and migration corridor west, south-west. Two burrows (red), three winter burrows (blue), emergency burrows (violet).

Fig. 6. Marmot migration corridor from Sedielko heading to Predné Dereše and vice versa, in the background there are mounds of marmot burrows.

rows and 3 winter burrows recorded in the colony.

B. Predné Dereše, colony around the artificial snowmaking system

In the Mount Chopok South locality marmot colony, the construction of a snowmaking system was carried out during 2012. From April 15, 2022, just after the end of marmot hibernation, a detailed field reconnaissance was carried out, continuing until the arrival of new snow. It was found that the population of the Tatra marmot in the study area was partially regrouped. Near the snowmaking system, where construction works had been carried out, live marmot burrows had been directly affected in the past. When comparing the 2022 recorded burrows with the earlier findings from 2013, marmot assemblages on the south side of the Mount Chopok and in the vicinity remained in their habitats. Their distribution has increased slightly, as evidenced by the number of new burrow mounds recorded (Fig. 7a).

Three new migration corridors have been created due to construction of the snowmaking system, from Predné Dereše eastwards to A Sedielko, westwards to C Tatrapoma (Fig. 7b), and northwards to Derešský kotol E.

The original colony of marmots was partially disturbed during the construction of the snowmaking system, as well as during construction of the footings of the cable car to Chopok South. The colony is also disturbed by the frequented trail leading from the south side of the Kosodrevina Hotel to the hut Kamenná chata and the upper part of the Mount Chopok.

Notwithstanding the construction of the cable car, the snow making system, and frequent use of the trail by tourists (and often their off-leash dogs) marmots still thrive in the formerly inhabited southern locality. Their viability is due to the suitable trophic base of the southern slopes and paradoxical

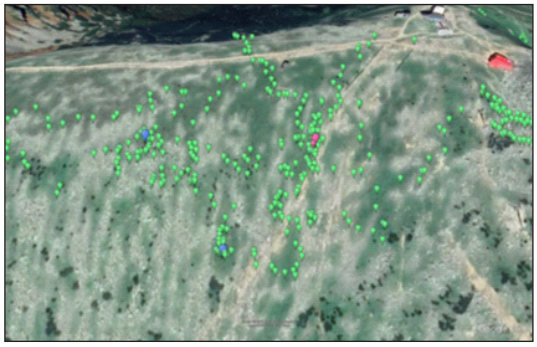

Fig. 7a. Colony "B" in the vicinity of snowmaking, Predné Dereše. Two maternal burrows next to each other (red), two winter burrows (blue), emergency burrows (green).

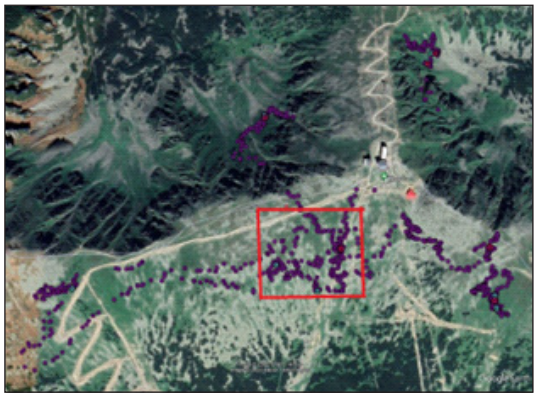

Fig. 7b. Colony "B" (red rectangle) in the vicinity of the Predné Dereše snowmaking area. The migration corridor to the west leads to colony "C". Winter burrows (blue), maternal burrow (red), emergency burrows (violet).

protection from predators due to proximity to hiking trails and cable cars.

In the colony, 2 maternal burrows and 2 winter burrows were recorded.

C. Colony near the end of the non-functional Tatrapoma lift under Veľký Dereš

The western most colony, connected with the marmots of Predné Dereše, is the least abundant (Fig. 8a, b). The maternity burrow, where the mother marmot raises her young, has not been found. One winter burrow (blue point) was recorded at a sufficient distance from the non-functional Tatrapoma H210 lift, heading to Zadné Dereše with an elevation of 550 m. The lift was put into operation in 1981. During the monitoring, repairs were carried out on the lift. Operation started according to natural snow conditions in the season 2022/2023. One winter burrow was recorded, the maternal burrow was not found.

D. Colony in the end of the valley Lukovská dolina, the so-called Školský žľab (School Trough).

The marmot colony and the glacial basin of the valley Lukovská dolina have an eastern exposure, which is advantageous for marmots. In the early morning hours, throughout the vicinity of the marmot habitat, marmots calls are heard in the early morning, especially during mating time (about 10 – 15 days after hibernation), as well as when predators such as the common raven (*Corvus corax*) or red fox (*Vulpes vulpes*) pass by on the hunt. The trophic base starts high above the tarn Lukovské pleso in the green vegetation belts, where burrow mounds have been recorded.

As the sunshine fades during the day behind Mount Chopok at the end of the valley Lukovská dolina, the marmots move to the sunny right side to graze. Above the final station of the double chairlift Konský grúň, 2 webcams recorded marmots disturbed in the morning by skiing all the troughs at the end of the valley, in mid-April following hibernation. The most skied freeride trough is the School Trough, which is the centre of Colony D. Rising temperatures during the afternoon melted snow on the exposed terrain, making it unsuitable for skiing.

No communication links with surrounding colonies and burrows were detected. Two maternal burrows and one winter burrow was recorded (Fig. 9).

E. Colony in the Retranslation Trough, the first Dereše basin

Part of the marmot colony in Predný Dereš moved northwards to the first Dereše basin (into the double trough Retranslačný žľab – E) during the construction of a snowmaking system (Fig. 10a, b). The second, larger migration from Predný Dereš was directed eastwards under Sedielko, below Chopok in

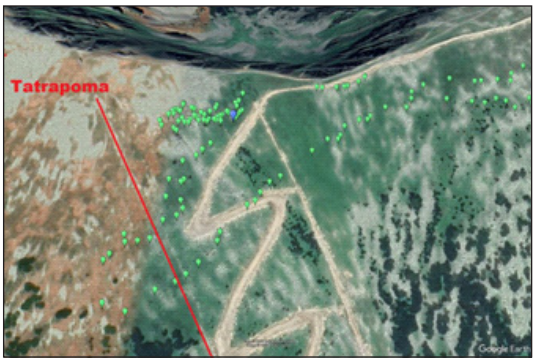

Fig. 8a. Colony near the end of the non-functional Tatrapoma lift below Veľký Dereš and the migration corridor from Predné Dereše. One winter burrow (blue), emergency burrows (green). The maternal burrow was not found.

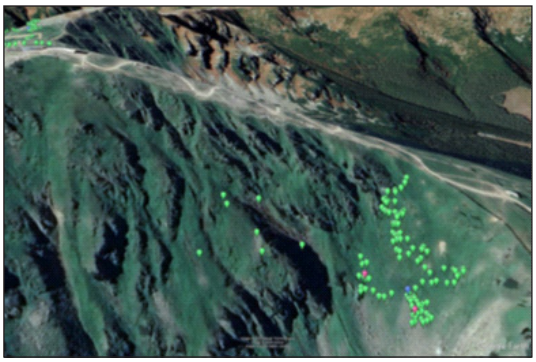

Fig. 9. Colony at the end of the valley Lukovská dolina, the so-called Školský žľab (School Trough). Two maternal burrows (red), one winter burrow (blue), emergency burrows (green).

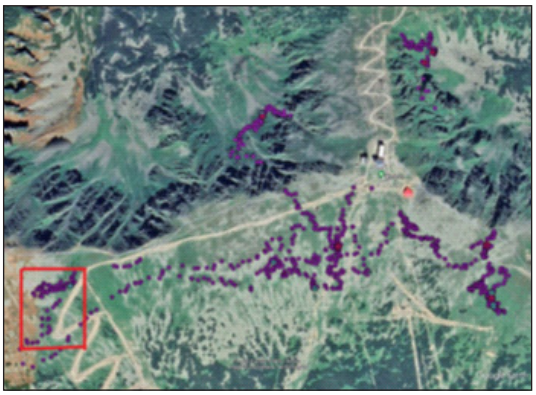

Fig. 8b. Colony (red rectangle) near the end of the non-functional Tatrapoma lift below Veľký Dereš, one winter burrow (blue). The maternal burrow was not found.

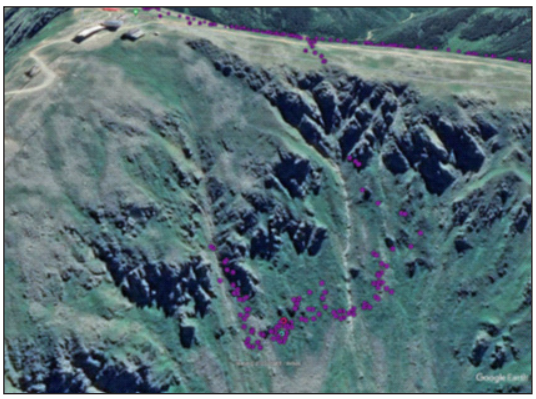

Fig. 10a. Colony in the trough Retranslačný žľab, the first Dereše basin (prvý Derešský kotol). One maternity burrow (red), one winter burrow (blue), emergency burrows (violet).

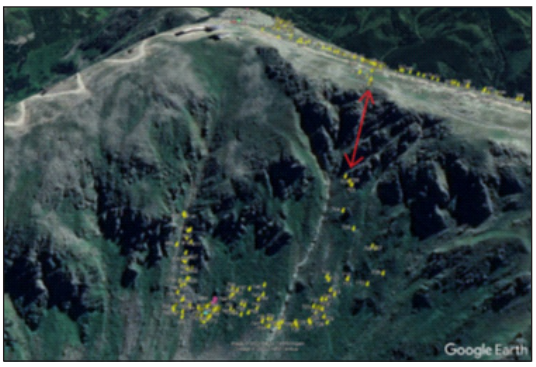

Fig. 10b. Colony (yellow burrows) in the trough Retranslačný žľab, the first Dereše basin (prvý Derešský kotol). Communication corridor towards Predný Dereš and vice versa (red arrow).

the beginning of the summer of 2013. A. The local migration into the first Dereše basin increased the area of distribution of marmots into a locality where marmots had not been for several years in the past.

The work in building the snowmaking system paradoxically helped to expand marmot habitat in an easterly and northerly direction. The north side of the glacial basin is shaded for most of the day and the trophic base is poorer than on the southern exposure. The marmots have calm here in summer and autumn. There is no noise from the cable car from the Mount Chopok or the ridge trail. The marmots are disturbed here in the spring period after hibernation. There is still snow in the northern couloir, and skiing continues into the first third of May. For skiers and snowboarders there is a popular freeride zone starting from the weather station. The marmots mate after emergence and are only able to do so for a few hours. If they are disturbed in the act of mating, there will be no offspring. One winter and one maternity burrow were recorded.

Documentation

Marmot burrows and migration corridors, in addition to GPS coordinates, were documented with a camera and 4K video sequences. Technical camera trapping of the complete marmot colonies of the Chopok south and north habitat was carried out. Anthropic impacts such as hiking, ski mountaineering, paragliding, cycling, drones, and off-leash dog walking were also documented.

The documentation recorded the spread of colonies to the peripheral areas of the study site, the communication links of marmots, as well as the connection of marmots outside the area of interest in an easterly direction to the saddle Demänovské (Široké) sedlo. No communication link was demonstrated in the western direction to the saddle Sedlo Poľany. The ecological characteristics and distribution amplitudes of marmots were comprehensively assessed. Circadian (diurnal) rhythm was influenced by external factors of the harsh alpine environment during the day. The main factors of the cycles are the seasons, changes in environmental temperature and weather, alternation of light intensity, and the age of the animal. The findings of the field reconnaissance of Karč (2006) were used. Special observation was carried out in the northern back of Chopok, under the Funitel cableway and the Chopok North emergency road.

We investigated potential connections between marmots in the Lukovská dolina – Dereše basin. No marmot burrow was discovered and targeted. TMR and cableway staff claimed to have seen marmots in this corridor running east-west and vice versa between colonies D and E. However, no resident tracks were found during a detailed inspection. Marmots require time during the day to dig a safety burrow. The frequented trail, cable car, the constructed wide exit safety track, and many hikers with dogs do not give the marmots time to dig out the burrows. When migrating between glacial gullies (Lukovská dolina – Dereše basin) marmots likely use natural hiding places.

Conversely, on the south side of Chopok, around the cable car and the trail, the situation is different. The marmots live here in original colonies, partly affected by synanthropization, and intensified tourist and sport activities. The soil cover here is more suitable for burrowing than on the northern side of Chopok.

Amplitudes of marmot distribution in the study area

The horizontal amplitude of the colony extension from Sedielko below Chopok to Tatrapoma – Zadný Dereš is 1,582 m (Fig. 11). The vertical amplitude of the extension is 286 m (burrow no. 774, the lowest burrow in the valley Lukovská dolina and burrow no. 387, the highest in the upper part of Chopok).

Climatic and geographical conditions are like those in the Western Tatras, where research with the same methodology has been practiced for 12 years. There is also similarity in the geological composition, which is closely related to the trophic base of marmots.

The observed gap in the habitat used by marmots in the section of the southern slopes of Chopok towards Demänovské (Široké) saddle, where the nearest colony is located, is likely conditioned by successional changes in vegetation. In the past, grazing was practised in the area. During the Wallachian colonisation, deforestation was carried out over large areas even at the highest altitudes. The resulting secondary meadows were used as pastures. Secondary non-forest communities were

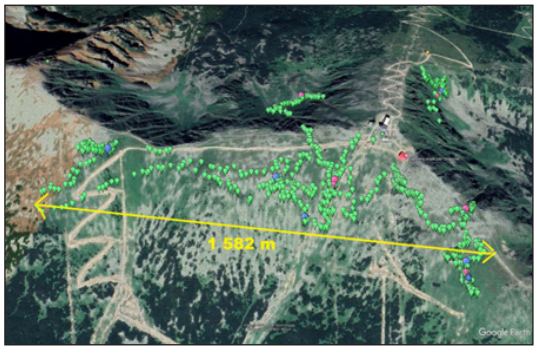

Fig. 11. Horizontal amplitude of the distribution of marmots Chopok South.

formed in these areas. After grazing receded, secondary succession occurred. The composition of plants in the vegetation, which was previously richer, changed. The plant communities gradually became more uniform. Litter and grazing- and browsing-resistant grasses developed, which were not further regulated by grazing. In this habitat unoccupied by marmots, there was a reduction in the species richness of herbaceous plants.

Monitoring

GPS has repeatedly monitored the Tatra marmot around the southern slope of Chopok, where changes and rearrangements of marmot families can be seen. The reason for this was the construction of a snowmaking system in 2013, which directly affected the marmot colony B, the largest group of marmots in Predné Dereše. Monitoring was carried out between May and December 2022. The ethology and anthropic influences in the study site were visually surveyed during individual visits. In the summer period, visits to the marmot habitat were carried out in fine weather, when daily temperatures in the alpine stage were well above 20° C; marmots were therefore only seen grazing in the early morning and before evening. The exceptionally warm summer slowed down the biorhythm of the entire population.

The colony, which partly moved to an alternative habitat below Dereše North E in summer, was monitored visually, with the marmots observed to be in good condition, with frequent acoustic displays.

A total of 945 marmot burrows were targeted by GPS system in the Chopok site, including 7 maternity burrows where mother marmots raise their young, and 8 winter burrows where marmots hibernate.

No population trends were detected during the detailed reconnaissance at the ridge, other than the above identified movements. The other colonies in the wider surroundings (the end of the valley Široká dolina and the Mount Bôry) remained in their original habitats without significant changes. The marmot habitat sites in the vicinity of Chopok form parts of the core area of the marmot habitat in this locality. Monitoring of marmots in the study area was closely linked to the monitoring of chamois.

Biotope

No significant change in habitat character is expected. The modification of the cable car line, the snowmaking system, and the construction of a wide emergency road have resulted in the partial and temporary destruction of suitable habitat (year 2013). In exposed places in Predné Dereše, the subsoil was disturbed by excavation during the construction of the cableway (Fig. 12). As a result, the marmot habitat will be disturbed in the line of excavations in the long term. Natural revitalisation of the damaged habitat tends to be lengthy in the alpine zone, and revitalization is costly.

Threats

The increasing synanthropization of the marmot population is similar to that of chamois, due to violation of visiting regulations, movement outside marked trails, sports activities of all kinds, and nowadays the increasingly widespread presence of domestic dogs in the alpine zone, often without a leash (Fig. 13).

Threats can occur during marmot excavation and in summer by synanthropic foxes that move around the site. The colony's biorhythm is disturbed by ravens flying over. Mothers always give a warning whistle to protect their offspring. Ravens only attack subadults. No attack by ravens has been observed on adult marmots. Another predator, the golden eagle, has only been seen flying over the ridge twice. Its hunting territories have been observed to be in the lateral ranges of the extensive ridge of the Low Tatras National Park. These eagles avoid the area around Chopok, even with the draw of a potential food-source due to prevalence of paragliding, a common tourist and skiing activity. On December 19, 2022, between the Kosodrevina Hotel and Predné Dereše, bear footprints were found heading towards Colony A. The bear in this area was seen several more times by the cableway staff.

However, the marmots are most disturbed by sporting activities and hiking just after digging out in the spring period (after 15 April). Subsequently, mating occurs within 10 - 15 days and lasts only a few hours. If the marmots are disturbed by skiers or snowboarders during this act, mating may not be performed.

Fig. 12. The marmots have returned to proximity to the snowmaking system. Red circle – emergency marmot burrow.

Fig. 13. Czechoslovak wolfhound without a leash during the spring emergence of marmots.

Recommendation

In order to protect the marmots, a warning sign could be installed, banning skiing near the School and Retranslation troughs (colonies D and E) from April 15 onward, when animals emerge from their burrows and begin to mate. If negative impacts persist, changes may occur in the future in terms of reduced vitality, leading to a search for alternative habitat. With the current intensity of use of the ski slope, colonies on the south side of Chopok in colony B, have adapted to the operational regime of the ski resort. Depending on snow conditions, ski slopes are expected to be closed in the last third of April when marmots in the locality emerge following winter hibernation (Fig. 14).

Population status

Numbers of marmots in colonies around Chopok could not be determined during the survey. These rodents immediately disperse to their territory after hibernation. Adults and subadults from one winter nest remain in the colony. Three-year-old individuals from the same nest, which reach maturity in the third year and are capable of mating, seek contact with neighbouring colonies before mating (about 10 – 15 days after excavation). They tend to discover new suitable sites in the vicinity. During these movements they tend to be most vulnerable to predators.

According to the methodology of marmot research in TANAP, we are inclined to compare the number of marmot individuals to the number of chamois in the study area, with approximately 45 individuals and more marmots in the locality between Sedielko below Chopok and Tatrapoma under Veľký Dereš.

On average, in traditional colonies, marmots excavate 5–10% of new emergency burrows during the growing season. Other original burrows in the grazing territory are modified and deepened following heavy rains, as marmots have a strong burrowing instinct. They dig new burrows when the original burrows are heavily damaged. At the end of spring, as the marmots emerge from their winter burrows, they remove the dry vegetation in which they have hibernated. This is a hygienic cleansing of the winter burrow and a preparation for future hibernation.

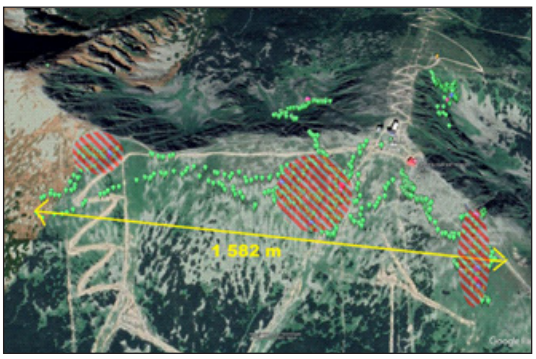

Fig. 14. The most sensitive ski zones (red hatching) in the Chopok south sites after 15 April - the period of marmot emergence and the horizontal amplitude of marmot distribution (yellow).

If the Tatrapoma lift is launched under Veľký Dereš (colony C), marmots in this area will not be disturbed by skiers in the spring as drastically as in the northern couloirs, where there is still enough snow at the beginning of May. There is no snowmaking system around Tatrapoma, and the slope has a southern exposure, so snowmelt occurs 10 days earlier, on average, than in the northern exposures. No significant change in habitat character is expected here. If a snowmaking system was planned to extend into the vicinity of Tatrapoma, suitable habitat would be temporarily destroyed.

The Tatra marmot and the Tatra chamois, two glacial relicts, live in a common habitat in a symbiosis that manifests itself in the joint watching of grazing and resting territory coupled with warning each other against predators, whether from the air or on the ground.

Tatra chamois (*Rupicapra rupicapra tatrica*, Blahout 1972)

In the subalpine to alpine vegetation zone of the Low Tatras National Park, chamois activity was first studied in 1969 – 1976, when the species was restored from TANAP to the Low Tatras Mountains. The habitats of the chamois have features of a glacial character, which corresponds to the representation of alpine flora. Its distribution extends from the top of Štiavnica, 2,025 m above sea level to the western massif of Chabenec, 1,955 m above sea level. The species can also be found on the northern ridge of Bôr, 1,889 m above sea level and in the southern massif of Skalka, 1,980 m above sea level. The northern walls of the main ridge of the Low Tatras are formed by glacial karsts, or rock walls, whereas the southern slopes are of subalpine character with the occurrence of rock formations. The first research on chamois in the Low Tatras was carried out by RNDr. Jozef Radúch. In the works of Radúch (2002a, 2002b) he mentions the basic ecological requirements of this species, and emphasizes the negative factors that threaten it. Radúch and Karč (1981, 1983) and Karč and Radúch (1978) showed detail quantitative representation and distribution of the chamois in the Low Tatras.

Population status

Restored Tatra chamois (*Rupicapra rupicapra tatrica*) live in the Low Tatras National Park. The restitution of the chamois from TANAP was carried out between 1969 and 1976 and totalled 30 individuals. On June 21, 2022, the administration of the Low Tatras National Park carried out an area-wide survey of the abundance of Tatra chamois from the peak of Ďurková, 1,750 m above sea level to the peak of Králička, 1,807 m above sea level. 184 individuals of the chamois were observed.

Biotope

Tatra chamois inhabit a continuous habitat in the alpine and subalpine vegetation zone in the Low Tatras in the central part of the ridge. The range of the population is limited in terms of latitude, occurring from the top of Štiavnica, 2,025 m above

sea level in the east, to the top of Ďurková, 1,750 m above sea level in the west. Their range also includes the peripheral terrain of the upper forest boundary. The habitat of the Tatra chamois lies in a cold area with a fluctuating average annual temperature of + 3° C to - 4° C.

Monitoring

Monitoring of Tatra chamois was carried out in the main ridge in the saddle, Demänovské (Široké) sedlo – Sedlo Poľany, Bôry and vice versa, between May and December, 2022.

Monitoring was carried out over a wider area than the peripheral sites of the marmot habitat in the Chopok area. The boundary was shifted eastwards beyond the marmot colony up to the saddle of Demänovské (Široké) sedlo, 1,756 m a.s.l., westwards up to the saddle of Sedlo Poľany, 1,837 m a.s.l. The Bôry ridge, a known refuge of chamois, especially during the ski season, was also considered (Fig. 15). For chamois, the long-established monitoring system of TANAP was used, with observations, migration recording, documentation, and negative impacts.

The monitoring of chamois in the study area was closely linked with the monitoring of marmots. It was carried out between spring, when new chamois are born, until the end of 2022. During each observation, 2 to 3 herds of chamois were monitored in numbers that varied. Tourism and sporting activities tend to disturb the chamois, so they were always grouped with a different number of individuals.

Monitoring in the above-mentioned localities revealed stable abundance. Previous monitoring in 2011 showed that chamois numbers are slightly increasing. The habitats of the chamois, in the core habitat of the chamois, are traditional. In the month of December, in the winter period, the site of the Bôry ridge, 1,889 m above sea level was visited, though the eastern and western slopes are their main refugee in the alpine and subalpine zones. Chamois have traditional winter and spring habitats here. Gravid chamois gather here in spring and give birth to their young. Similarly, they aggregate to the east on the northern slopes of Konský grúň 1,888 m a. s. l. The population in these localities has been stable since the initial monitoring in 2011, with chamois numbers fluctuating around 45 or more individuals. The population is slightly increasing.

During individual visits to the studied sites, the population status, anthropic influences, and ethology of chamois were investigated. In that section, during marmot monitoring, a close symbiosis of two glacial relicts was recorded at each visit in a common habitat. Cooperation was evident in the presence of predators, including fox, raven, and golden eagle. Warning acoustic displays by marmots alerted both the colony and the chamois to danger. Chamois in turn alerted marmots to the presence of a predator by noisy flight, crossing scree fields to a safe location.

In the study areas, while carrying out marmot monitoring in the ridge of the above sites, between 5 and 45 chamois individuals per day were counted during visits. Their habitats are traditional in the core alpine and subalpine habitat of the Low Tatras. Numbers of chamois are slightly increasing. Numbers are also conditioned by increasing anthropic activity (Fig. 16, 17).

The predicted number from past monitoring in the summer period has been confirmed. Abundance is stable and numbers have increased slightly. The chamois move to the northern slopes in the morning after 9:30 a.m. with the launching of the cable car and the first tourist visits, where the chamois habitats have signs of glacial character in the monitored section. The northern rock walls and ravines correspond to the representation of alpine flora. Its cover is poorer than that of the southern slopes of the hillside with isolated rock formations. The number of individual grazing cycles, their length, and the type of food, depended on the season and disturbance during monitoring.

After the cable car was closed in the afternoon in autumn, and when daytime temperatures dropped below 8° C, the chamois moved to the

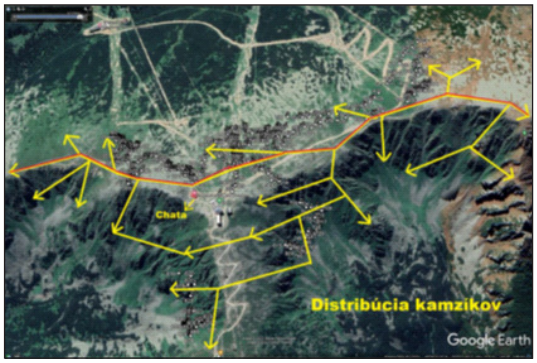

Fig. 15. Distribution of chamois in the Chopok area. During the operation of the cable car, they move to the northern ravines and walls, where the trophic base is poorer than on the southern side.

Fig. 16. Chamois found grazing vegetation around trails and huts where tourists urinate. In the early morning, they search for vegetation here where human urine provides them with a source of salt.

Fig. 17. Tatra chamois near the toilet of the hut Kamenná chata, he considers it as a source of salt. Chamois also lick the salt stones around the paths after human urination.

southern slopes for grazing, where a better trophic base was present. Mother chamois with 1- and 2-year-old chamois young moved to these sites.

Threats

Resituated Tatra chamois from TANAP, brought to Low Tatras National Park in the 1970s, have only a limited area of suitable habitat. The artificially established Low-Tatra population is relatively small and therefore needs to be given increased attention.

During the tourist season, chamois tend to make longer migrations outside the monitored area. This was also observed in the winter season, when ski mountaineering, alpine hiking, dogs without leashes, and low paragliding flights over the ridge of the Low Tatras are practiced along the entire length of the ridge.

Drones

Recently, tourists are more often using drones. Animals may perceive a flying drone as a predator and react accordingly. Drone operations in the alpine zone, which carry out film documentation of protected animals without permission, have a negative impact on protected alpine fauna. This affects not only marmots and chamois, but also predatory birds and songbirds. Flying drones, whose high-frequency sounds are not similar either to a flying helicopter or to a powered or unpowered paraglider, have a very stressful effect on the fauna (Fig. 18). It is a new disturbing phenomenon in the high mountain environment.

Disturbed chamois migrate from their favourite habitats, descending to the bottoms of troughs, rock dens and into wet, damp troughs. They migrate to inaccessible, exposed terrain where food availability is minimal.

A potential threat in the study sites is the gradually increasing impact of synanthropization on the population. The consequence of the threat is the persistent anthropic impacts due to serious violation of visiting regulations by tourists (Fig. 19, 20, 21, 22, 23).

The abundance of the chamois in the central part of the Bôr – Krúpova hoľa has been stable in recent years. One to two-year-old chamois young are seen in the individual herds, and the status of this population has slightly increased. In the upper part of Chopok, the number of tourists has increased several times with the opening of the Funitel cableway. The interventions carried out by the construction activities on Chopok – the cableway, snow-making system, the Chopok North-South rescue road - have disturbed the biorhythm of the chamois fauna. The migration of chamois east-west, north-south and vice versa across the top part of Chopok occurs in adverse weather, as chamois feel safer

Fig. 18. A dead subadult chamois just after a drone flight over the glacial gully of Lukovská dolina.

Fig. 19. A serious violation of the visitor regulations, a flying drone in the second Dereše basin.

Fig. 20. Paragliding operated in the main ridge, low overflights.

Fig. 21. Serious violation of visitor regulations, leading dog without a leash stresses the chamois.

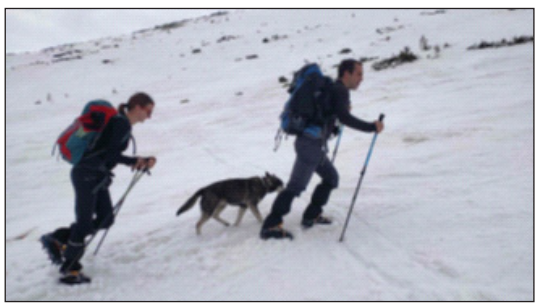

Fig. 22. Spring walks of tourists. Dog without a leash at the time of excavation of marmots above the Kosodrevina Hotel.

Fig. 23. A chamois chased far away in the subalpine biotope, disturbed by a loose dog without a leash.

when there is minimal tourist traffic. During the chamois estrus in late October and November these movements are many times greater. This is when the herds of chamois from nearby areas mix, thanks to the chasing of the rutting chamois caps.

When the disturbance escalates during the day, often due to tourists seeking to photograph the chamois, the herd escapes to the northern troughs of Dereše, Chopok and Konský, where they find temporary peace.

Violation of the visitor regulations, movement outside the marked trails, and nowadays increasingly widespread free leading of dogs without leashes to the alpine level cause the increasing synanthropization of protected animals. In this process, the innate fear of man is gradually decreasing and then disappearing completely in wild animals.

This phenomenon was documented in November during the chamois rut, when the rutting chamois performed their activities a few metres from the Funitel summit station.

Damage to antlers occurs when chamois fall on icy snow, when they are spooked by skiers, off-leash dogs, paragliding, and the illegal use of drones for filming. Chamois falling off cliffs, in rock avalanches, escaping from skiers and snowboarders on icy terrain, and escaping from drones causes damage or complete dislocation of the horns, which will remain with the chamois for the rest of its life (Fig. 24, 25). The antlers are used to determine the animal's age and sexual dimorphism. They serve both as a weapon in fights in the rut and as a defence against predators. An antlerless chamois has subdued its displays of comfort behaviour, scratching its back or flanks especially when changing winter coats.

White chamois

On the main ridge during marmot monitoring between Chopok and the saddle Sedlo Poľany, two female chamois appeared. One was the lighter younger one, the other the darker older one. It is the first time in Slovakia that white-coloured chamois have appeared, it is a genetic anomaly (Fig. 26, 27).

Due to the negative changes mentioned above, in terms of weakening the vitality of the herds, changes may occur. If excessive disturbance in the central area increases in the future, chamois will

Fig. 24. A disabled individual with damaged antlers is having stress crossing the tourist trail.

Fig. 25. Detail of a handicapped chamois.

be forced to find alternative habitats. An open area for quiet refuges is emerging to the west towards Chabenec, Skalka and Ďurková. All human activities in the alpine zone around Chopok significantly interfere with the adjacent core habitat of chamois in the wider surroundings. Refugial habitats may be marginally affected.

Fig. 26. White female chamois with herd near the salt pit in the upper part of Chopok.

Fig. 27. A darker second female chamois in late November during a chamois rut.

Fig. 28. Chamois 8 km away from the chamois biotope on Predná Poludnica 1,480 m above sea level above Liptovský Mikuláš.

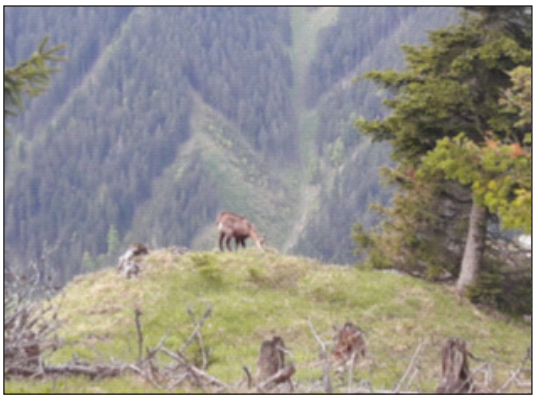

Fig. 29. Chamois above the valley Iľanovská dolina, Končitý vrch 1,390 m a.s.l. 8 km away from the chamois biotope.

Of the anthropic impacts, summer hiking and all alpine summer and winter sport activities are the most significant.

The population of chamois in TANAP represents an endemic subspecies, the Tatra chamois. The establishment of the Low Tatra population occurred between 1969 and 1976. The first 30 individuals were captured on the territory of TANAP and released into the game preserve at the end of the valley Lomnistá dolina. The population interbred with individuals of the subspecies of the alpine chamois (*Rupicapra rupicapra*), introduced in the National Park Slovak Paradise and Veľká Fatra in the second half of the last century from the Jeseníky Mountains (Zemanová *et al.* 2015).

This new population of chamois is already stably seen north up to 8 km from the chamois biotope in the part around Ďumbier, north in the montane step deep in the Iľanovská valley. It has its stable habitats on Predná and Zadná Poludnica above the town Liptovský Mikuláš. In December 2022, for the first time, these chamois were observed wintering in the vicinity of the upper part of Predná Poludnica and on the Končitý vrch hill, 1,390 m above sea level above the village of Iľanovo (Fig. 28, 29).

Cumulative impacts

The decline in population fitness may also be accompanied by ethological changes due to increased visitor movement in the core area (change in biorhythm). A potential threat is the gradual synanthropization of the population.

Frequent encounters with off-leash dogs, and the possible introduction of diseases, can be a health threat, particularly in the core area, but also in the peripheral parts of the population. Migrations can also be caused by the impulse to get to know new habitats, these are the so-called exploratory migrations, when chamois leave their favourite habitats, followed by the search for new habitats, which is open here in the western direction to Ďurková 1,750 m above sea level.

In the habitat of chamois, the presence of humans and their disturbance is like that of marmots. The observed weakening of behavioural mechanisms leads to a reduction in their innate shyness. Loss of vigilance is the most serious negative impact observed, and behaviour towards natural enemies is related to this. During visits, a shortening of escape distance was observed. Based on the reports from the staff of cable cars, restaurants, athletes and tourists who stay in the top part of Chopok, we can say that the population of chamois is becoming more synanthropic every year.

The most anthropic stimuli to chamois movements in the locality were found to be increased disturbance of chamois in their habitats. Monitoring has shown that the population density of chamois in these suitable habitats is so far stable, despite the negative factors.

Conclusion

Assessment of the marmot and chamois population in the vicinity of Chopok

The monitoring of chamois in the study area was closely linked to the monitoring of marmots. It was

carried out during the months of May – December 2022. On each visit, 2 to 3 herds of chamois with a larger number of 6 to 16 individuals were monitored in the morning, as monitoring was conducted early in the morning prior to launch of the cable cars to Chopok. Tourist traffic after 10 am disturbed the chamois and resulted in smaller groupings of 1 – 2 individuals, to a maximum of 4 individuals. In the afternoon, when many tourists and their dogs moved along the ridge trail, the chamois stayed singly in the northern troughs, where they had more peace.

Of the anthropic influences, summer hiking is the most significant, with off-leash dogs frequenting the ridge.

Construction work in 2013 on the southern side of Chopok, construction of the Chopok south and north emergency road, and completion of the construction of Funitel has meant that construction machinery and excavation affected the south exposed marmot families in the locality of Predné Dereše. Part of the marmot population relocated to the north side to the first Dereše basin, where it found suitable replacement habitat. The other part migrated eastwards in front of Sedielko below Chopok.

Chamois avoided the site during construction in 2013 – 2014. Currently, the grazing territory is throughout the targeted marmot habitat with small disruptions and still disturbed ground cover from excavation and earthworks not fully revegetated. After the start of cable car operations, chamois migrated to the north side to the glacial karsts of the Dereše and valley Lukovská dolina and to the west deep into the subalpine vegetation zone towards behind the saddle Sedlo Poľany, where they enjoy relative tranquillity. Violations of the visitor regulations were evidenced by the shortening of the hiking trail on the ridge, and foot traffic off the trail for photography. Free running of dogs in the alpine grade without a leash is becoming more and more widespread. More recently, the flying of drones operated by tourists without permission is also becoming common. Drones taking pictures of the alpine habitat with a camera disturb birds in the alpine environment, along with chamois and marmots.

During the day, when disturbance increases, either from tourists who wanted to photograph the chamois or from those engaged in sporting activities, the chamois migrated deep into the northern troughs of Dereše and Lukovská dolina. In relation to the protected species of marmot and chamois occurring in the site, we note that they remain in a favourable condition despite the implementation of the construction interventions carried out so far. The marmots have been found to be expanding their territory, which is documented in this survey through migration routes. If the proposed measures and visitation regulations are adhered to, populations will be maintained in the near term. The species remain in favourable condition.

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