# Searching for the ghost of the mountains (phase 2)

## Report of a camera trapping study on snow leopard and other mammals in TAVAN BOGD NATIONAL PARK, Altai Mountains, NW Mongolia

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## Introduction and aims of the study

The threatened snow leopard (*Panthera uncia*), along with other larger mammals, have been poorly studied in the remote areas of the Altai Mountains in NW Mongolia. It is known that the snow leopard range encompasses extensive portions of the Bayan Olgii Province, NW Mongolia.

As part of a research programme aimed to assess the status and the conservation of the snow leopard and its sympatric carnivores and ungulates occurring in the Altay-Sayan Ecoregion, the Mongolian Conservation NGO Green Initiative (Mongolia), MUSE - Museo delle Scienze (Italy), and UNIL – University of Lausanne (Switzerland), in partnership with the Mongolian Altai Range Protected Areas Authority, conducted in 2017 a camera trapping survey in the Tavan Bogd National Park (TB NP). The snow leopard was known to occur in this protected area but its distribution within the NP was unknown.

The main aim of the study was to confirm and assess the presence of snow leopard in the target area. The study followed a first phase of the research programme that the mentioned institutions conducted in 2015 in 'Siilkhem B' National Park (see Rovero and Augugliaro 2015), approximately 100 km to the NE along the Altai Mountains range. This report presents the main results from the study. Only qualitative results are reported here, while detailed analyses are on-going by the principal investigators of the research programme.

## Study area and methods

The study was conducted in the 'Tavan Bogd' National Park (48°33'N; 88°37'E) area 6,362 km$^2$ (http://www.infomongolia.com, see also http://whc.unesco.org/en/tentativelists/5955/), located in NW Mongolia, bordering Russia and China (Fig. 1-2). The area reaches the highest elevation in Mongolia with the Khuiten Uul Mountain (4,374 m a.s.l.). The park covers a portion of steep, rocky and dry habitat within the Altai Mountain range, and is mainly covered in grassland with valley bottom sparsely covered by shrubs and scattered larches. In comparison to Siilkhem B NP, where a similar survey was conducted in 2015, Tavan Bogd is a larger and higher elevation area, with large portions of Alpine and glacial habitat. In addition, the southern zone of the park (which were not covered by our survey), is characterized by portions of forested habitat and large lakes.

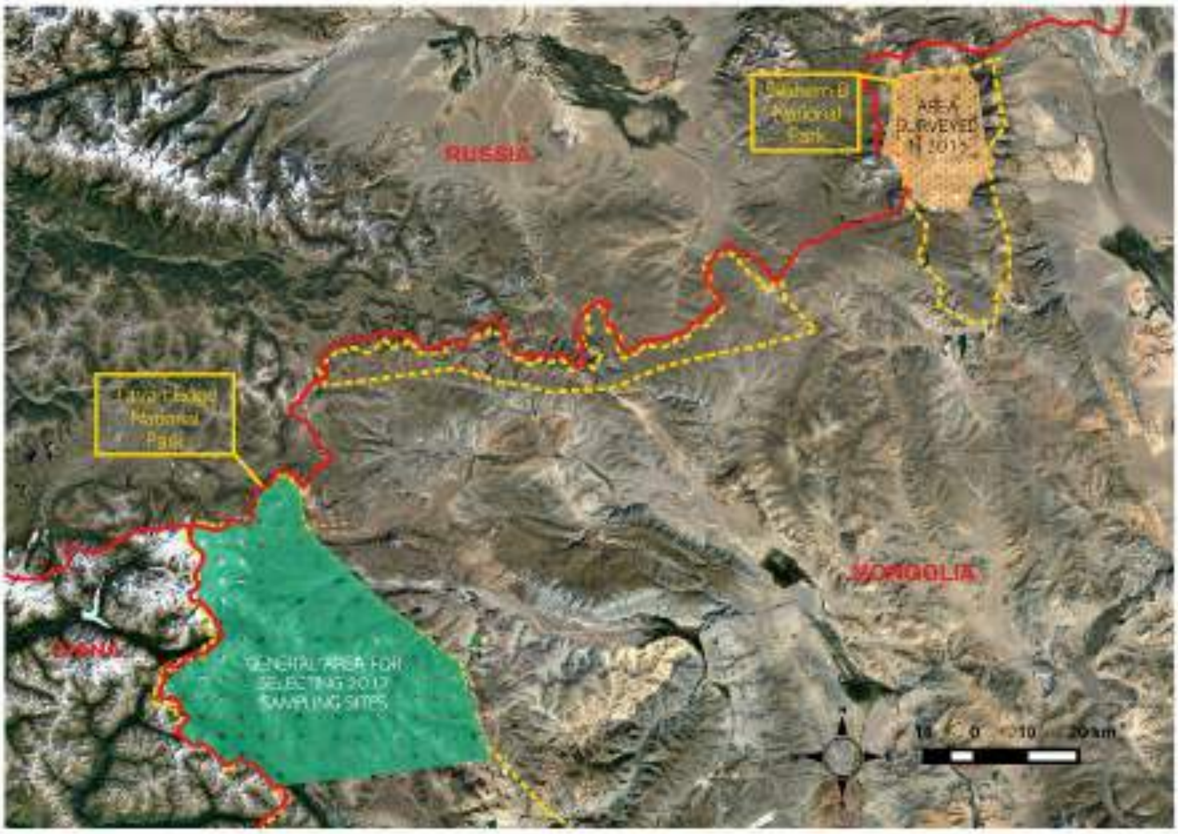


Figure 1. Map of Mongolia with the study area (in green) and the area surveyed in 2015 (in gold) within the general programme in the Bayan-Olgii province.

Figure 2. A view of the study area towards the peaks above 4,000 m a.s.l.

Within Tavan Bogd NP, we sampled the central-to-northern portion for an overall coverage of approximately 1,200 km$^2$ (Minimum Convex Polygon around sampling sites) through the deployment of 60 camera trap stations set at an elevation range of 2,475-3,662 m a.s.l. Each ‘station’ consisted in a single camera trap set at sites of presumed marking or traveling of snow leopard (Figure 3).

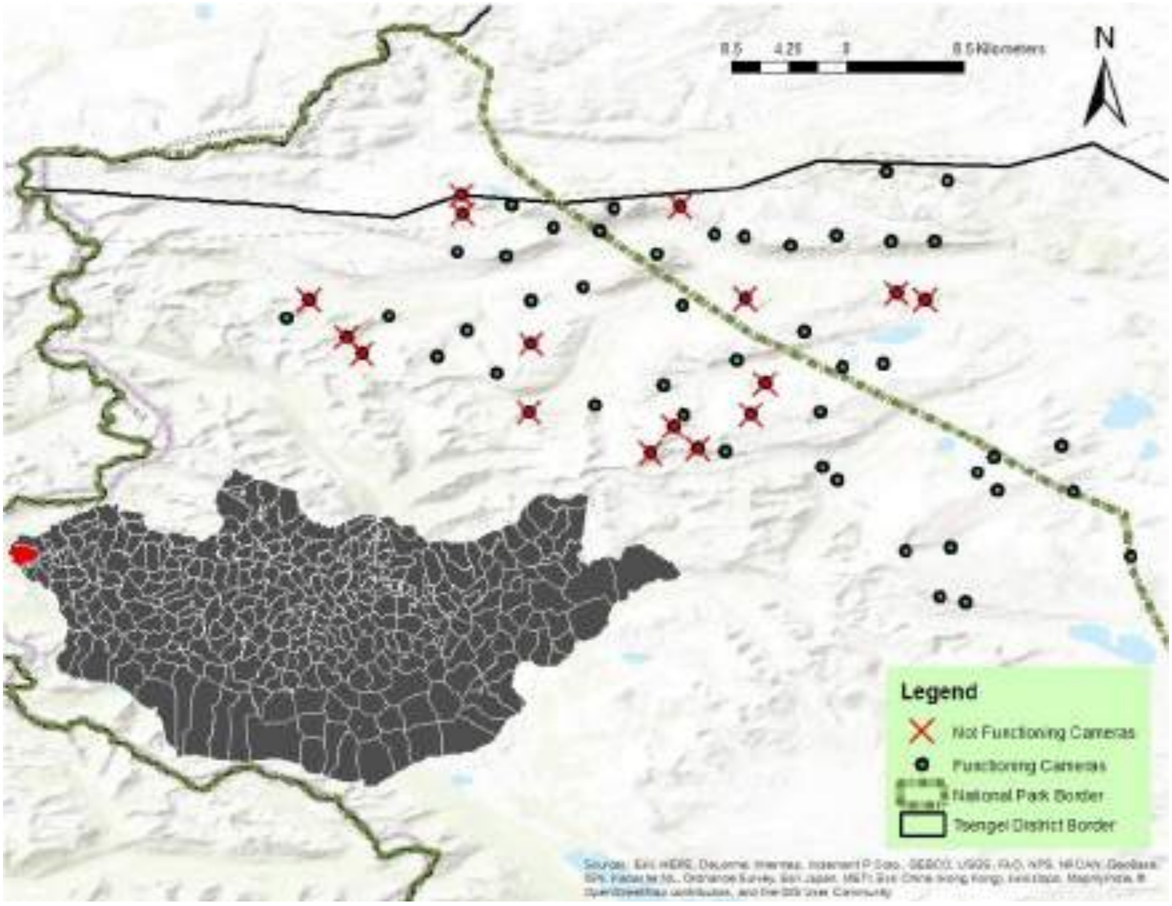


Figure 3. Map of the study area with the 60 camera trap stations set.

Spacing and location of camera trap stations was based on a predetermined design based on home range size of snow leopard, available information on snow leopard presence in the area, and results from the first survey. A general area for sampling deemed suitable to snow leopard presence was initially selected by considering elevation >2200 m a.s.l., slope >30% and ruggedness >0.7. We then designed a regular grid of camera traps spaced at the minimum distance of 3-4 km with a view of covering the largest area possible with available camera traps without leaving major gaps of un-sampled suitable habitat.

Camera traps worked overall from 4th April and 2nd June 2017, for a minimum of 45 days of sampling per camera trap. We used digital camera traps: the majority were Reconyx HC600 and HC500 models (N=52), with no-glow flash, a trigger speed of 0.2 s, and taking only images. The remaining 8 camera traps were UOVision UV572 IR+, with no-glow flash, 1-s trigger speed and possibility to take videos.

We set camera traps on rocks at a distance of approx. 4-5 m from the target trail (Fig. 4). We used alkaline batteries that outperform rechargeable ones in cold temperatures (minimum of -18°C during the study period). Date and time of image was stamped in the images themselves. Camera traps saved images on 8GB SD cards. We used Garmin GPSs to record the location of the camera trap sites, and we also recorded the elevation and the day and time of start and end of sampling.

Figure 4. Setting camera traps

Images were retrieved from SD cards by Green Initiative's team. We screened images for species identification and metadata using dedicated, open-access software (Wild.ID, see https://www.wildlifeinsights.org/WMS/#/shareData). The software produces a database (.csv format) that we used for further analysis.

## Results

Out of the 60 camera traps set 44 worked successfully. One camera trap was stolen, while 15 cameras either did not work or shoot continuously, recording blank images. Problematic cameras were mostly IR+, especially when set on video recording mode, however we obtained relatively high amounts of blank images from most camera traps. Besides the lower quality of IR+ relative to Reconyx, the cold temperatures, and most importantly the strong winds, have probably caused the malfunctioning and false triggering of camera traps. An additional reason might be the setting in 'high sensitivity' mode of the camera traps; this prevents missing triggers by smaller animals, such as the small carnivores, however it increases the incidence of blank images. The rate of failing camera traps was much higher than in the 2015 survey, partially reflecting the sampling in more exposed and higher elevation sites than in 2015 where elevation were lower and relatively more sites were in valley bottoms.

Table 2 summarizes the sampling effort and categories of images obtained. Survey effort is scored as the total number of days cameras operated, from setting to retrieval, or to the last image taken in case of camera malfunctioning.

Table 2. Summary of survey effort and of images obtained (see text for details).

| Sampling effort (camera days) | 2,078 |
|---|---|
| Mean camera days per camera | 47.23 |
| Total number of images obtained | 31,315 |
| Number of identified mammals photos (including livestock) | 15,385 |
| Number of not identified mammals photo (small rodents) | 1,621 |
| Number of bird photos | 1,536 |
| Blank and Set up/Pick up photos | 12,773 |

We obtained 15,385 images of wild and domestic mammals that we could identify to species. We also obtained 1,621 images of small mammals that we could not identify to species and 1,536 images of birds. We filtered images for independent detection 'events', i.e. images of the same species taken within a span of 15 minutes were scored as a single passing event. This avoids multiple scoring of the same individuals detecting within each event. Thus, **we obtained 825 independent events of wild mammal species and 153 independent events of livestock and humans**.

We considered the events as an index of relative abundance for each species, by normalizing events for the sampling effort. We also calculated naïve occupancy as the number of sites positive to species' presence to the total number of sites, which is a complementary index of abundance to the event rate.

We recorded **14 species of medium-to-large wild mammals** (Table 3), as well as people and livestock.

Table 3. Checklist of species detected by camera traps, with the number of detection events screened by 15 minutes, RAI (Relative Abundance Index) and naïve occupancy (the fraction of sites where the species was detected on the total number of sites).

| Latin name | Common name | Events (15 min) | RAI | Naive Occupancy |
|---|---|---|---|---|
| *Marmota baibacina* | Altai marmot | 384 | 18.48 | 0.68 |
| *Urocitellus undulatus* | Long-tailed ground squirrel | 155 | 7.46 | 0.09 |
| *Vulpes vulpes* | Red fox | 67 | 3.22 | 0.48 |
| *Gulo gulo* | Wolverine | 55 | 2.65 | 0.39 |
| *Lepus tolai* | Tolai hare | 45 | 2.17 | 0.27 |
| *Martes foina* | Beech marten | 33 | 1.59 | 0.23 |
| *Capra sibirica* | Siberian ibex | 29 | 1.40 | 0.11 |
| *Canis lupus* | Grey wolf | 16 | 0.77 | 0.18 |
| *Ovis ammon* | Argali sheep | 11 | 0.53 | 0.07 |
| *Otocolobus manul* | Pallas's cat | 11 | 0.53 | 0.16 |
| *Mustela eversmanii* | Steppe polecat | 9 | 0.43 | 0.16 |
| *Ochotona alpina* | Alpine pika | 5 | 0.24 | 0.07 |
| *Ursus arctos* | Brown bear | 3 | 0.14 | 0.07 |
| *Panthera uncia* | **Snow leopard** | 2 | 0.10 | 0.05 |

| ***People and Domestic Animals*** | | | | |
|---|---|---|---|---|
| *Capra hircus / Ovis aries* | Domestic goat / sheep | 102 | 4.91 | 0.18 |
| *Homo sapiens* | Human | 30 | 1.44 | 0.20 |
| *Equus ferus* | Domestic horse | 18 | 0.87 | 0.16 |
| *Canis lupus familiaris* | Domestic dog | 2 | 0.10 | 0.05 |
| *Bos grunniens* | Yak | 1 | 0.05 | 0.02 |

## Species inventory

The chart in Fig. 5 is a species accumulation curve, i.e. the number of species detected with increasing survey effort (and randomized through 1000 iterations). The profile has the expected shape, with initial high steepness as the majority of species are detected followed by a progressive decrease towards a plateau. As the curve still tends to increase at the end of the sampling, there is indication that further survey would held additional species.

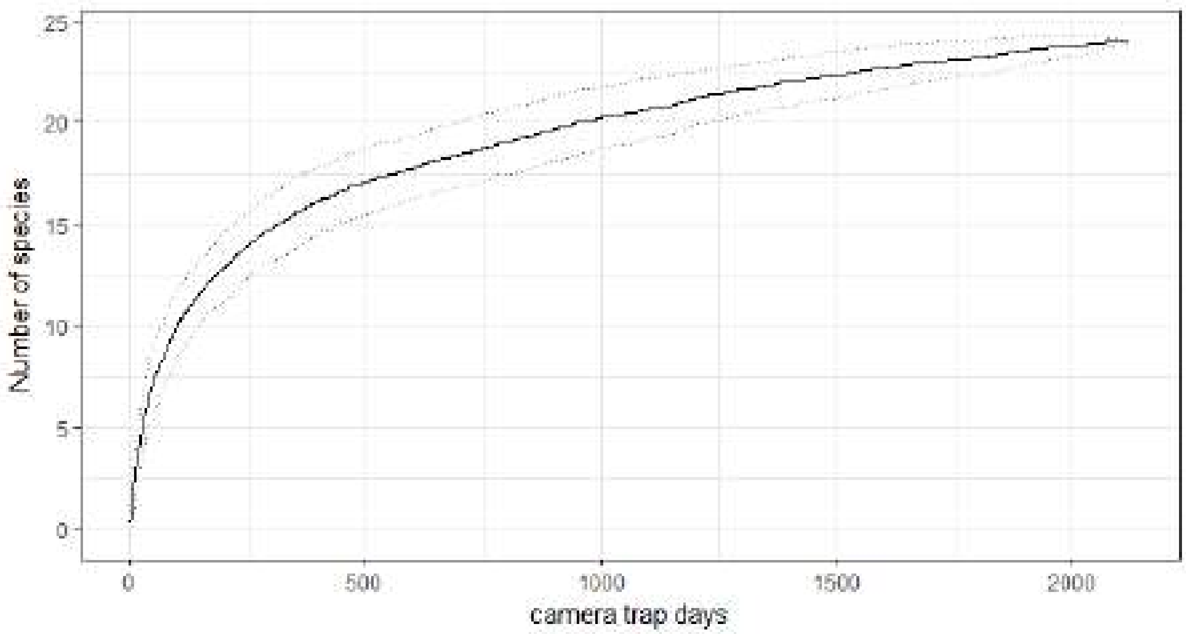


Figure 5. Randomized species accumulation curve (mean as solid line and confidence intervals as dotted lines). The species number increases exponentially during the initial sampling and then its steepness decreases towards an asymptote.

**Snow leopard detections**

Surprisingly, camera traps detected snow leopards only at two sites and with only 2 passing events. The two series of images were of different flanks of the animal hence not enabling us to determine if they belong to one or two individuals. These sites were within a distance of 12 km (Fig. 6-7). In general, and despite the high incidence of failing camera traps, we detected very few snow leopard tracks while surveying to set camera traps, as well as 2 fresh scats.


Figure 6. Map of camera trap sites (black triangles) with sites that detected the snow leopard (red dots).

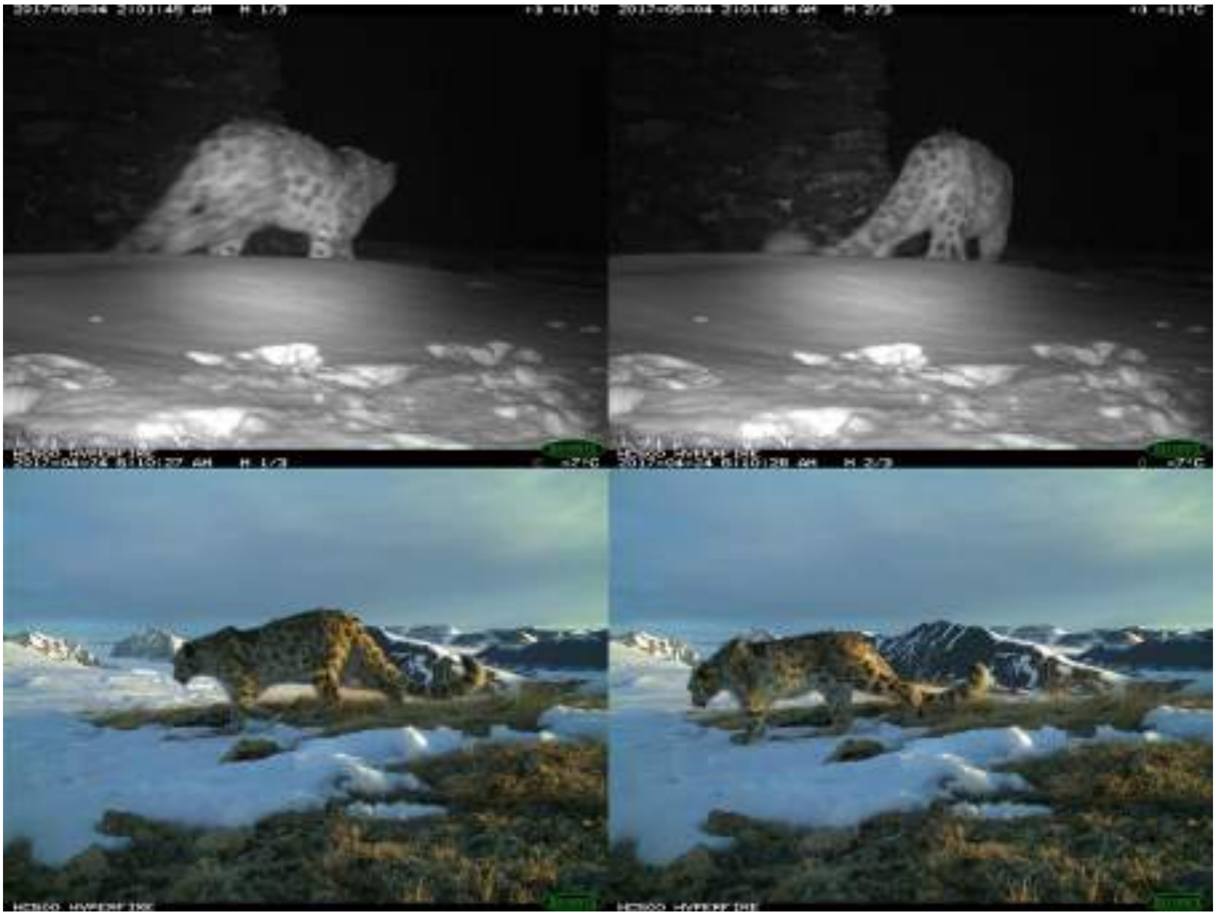

Figure 7. Images from the two sequences of snow leopard captures.

## Other mammals detected

Detections of wild ungulates, which are presumed snow leopard prey, were also few: argali sheep (11 events) and Siberian ibex (29). The latter is likely the main wild prey of snow leopard in the area. This species was found at only 5 of the 44 sampling sites, one of them being also positive to snow leopard presence (Fig. 8-9 and 12).


Figure 8. Map of camera trap sites (black triangles) with sites that detected the argali sheep (red dots).


Figure 9. Map of camera trap sites (black triangles) with sites that detected the Siberian ibex (red dots).

We recorded a remarkable number carnivore species (8): 3 species of mustelids, 2 of felids, 2 of canids and 1 species of bear. Two rodent species (the Altai marmot and the long-tailed ground squirrel) and two lagomorph species (the Tolai hare and the Alpine pika). A selection of photo representing the captured species is shown below (Fig. 10-12).

Figure 10. From the left to the right, from up to down: wolverine, grey wolf, brown bear, Pallas's cat.

Figure 11. From the left to the right, from up to down: steppe polecat, beech marten, red fox, Altai marmot.

Figure 12. From left to right and up to down: Siberian ibex, argali sheep, long-tailed ground squirrel and Tolai hare.

Wolverine was detected with relatively high frequency, with 55 independent events at 17 sites (Fig. 13). It has the second highest RAI and naïve occupancy among the carnivores after the red fox (Table 3). Among the other wild species recorded it is notable the presence of the Pallas's cat (*Otocolobus manul*), a IUCN Near-Threatened species (Fig. 14).

Among the larger carnivores, the wolf was recorded with 16 independent events around the NP border and buffering zones (Fig. 15), while the brown bear was recorded 3 times (Fig. 16). Tracks of wolf as well as wolverine were frequently found throughout the study area. Two wolves were sighted at far distance once, by C. Groff and M. Krofel, during the camera traps deployment. Moreover, we elicited wolf howling in one occasion by simulating the howling. Tracks of brown bear were sighted in the northern part of the study area (in one case of a female with two yearlings), especially during the camera trap retrieval at the end of May. Records of reproductive individuals (and not just transient animals) are interesting for an area lacking arboreal vegetation. Two members of the team had a close encounter (15-20 m) with two adult brown bears. Maps below show the detection sites for wolverine, Pallas's cat, grey wolf and brown bear (see legend for species name).

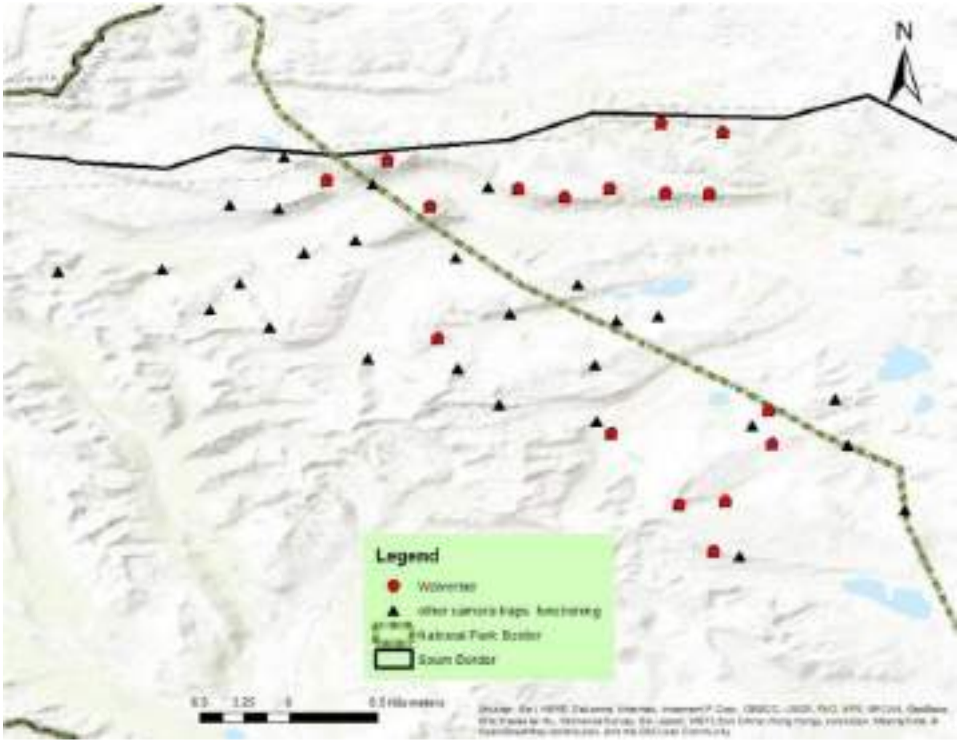


Figure 13. Sites where wolverine were detected.

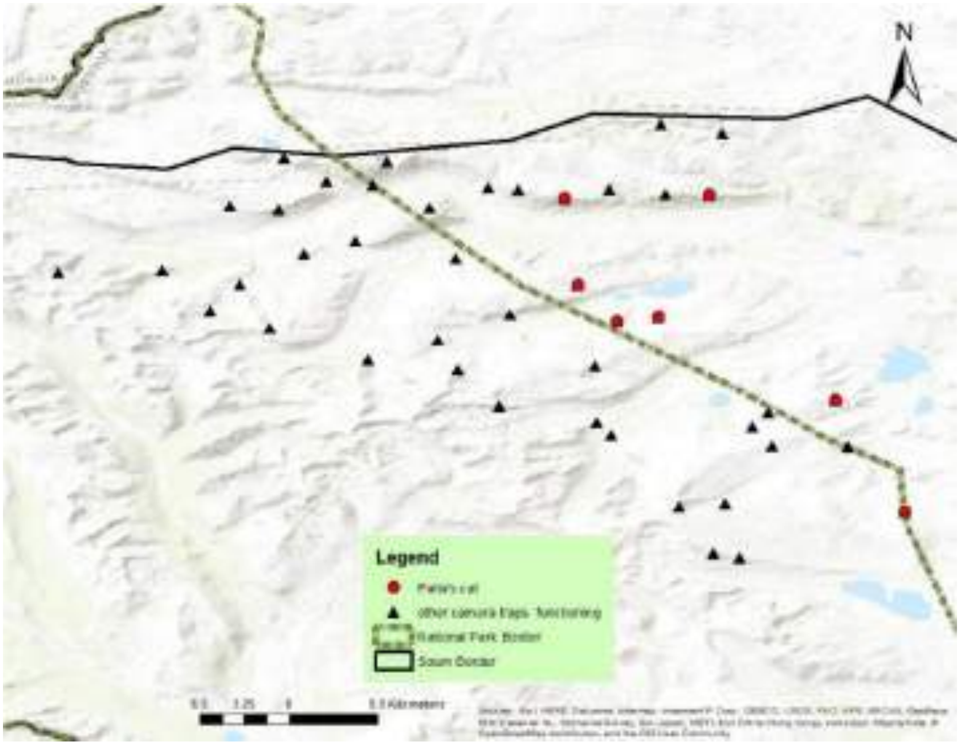


Figure 14. Sites where Pallas's cat was detected.

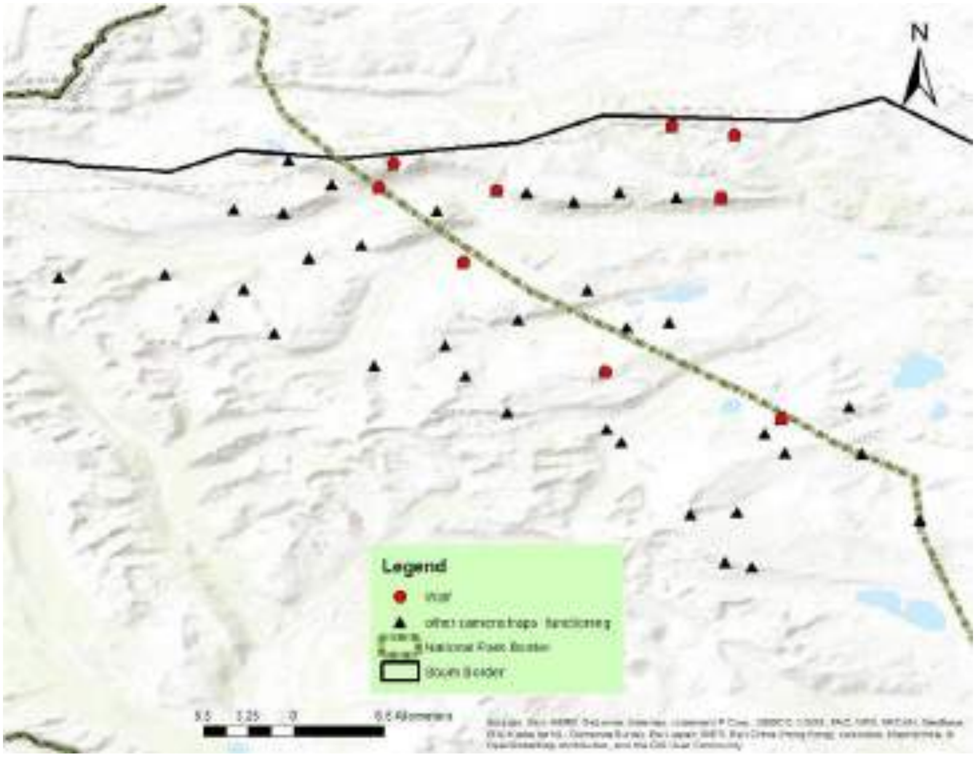


Figure 15. Sites where wolf was detected.

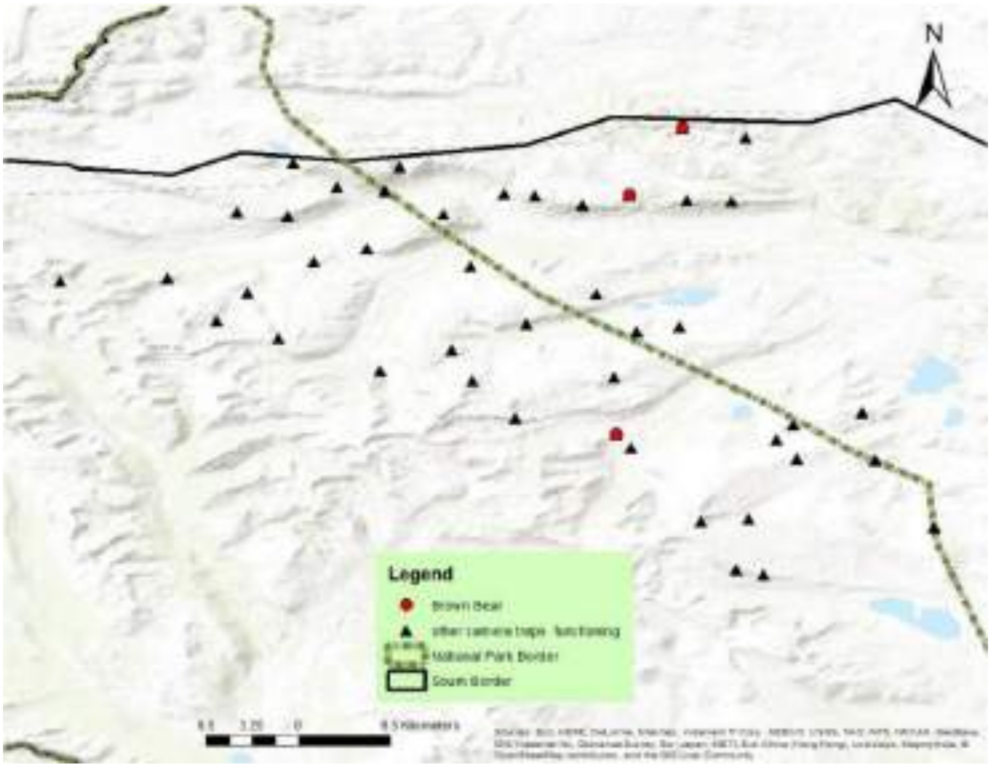


Figure 16. Sites where brown bear was detected.

## Detections of livestock and people

Goats and sheep were recorded through 102 events, representing the second most recorded 'species' after the Altai marmots (*Marmota baibacina*). Livestock also included a few detections of horses and yak, while people were detected with 30 events (Fig. 16). Overall livestock and people were detected at 13 sites, even though herders and herders' houses were present across most of the sampled area with exception of the most interior (western and north-western) areas. Siberian ibex and argali sheep detections spatially overlapped with livestock only at 1 site.

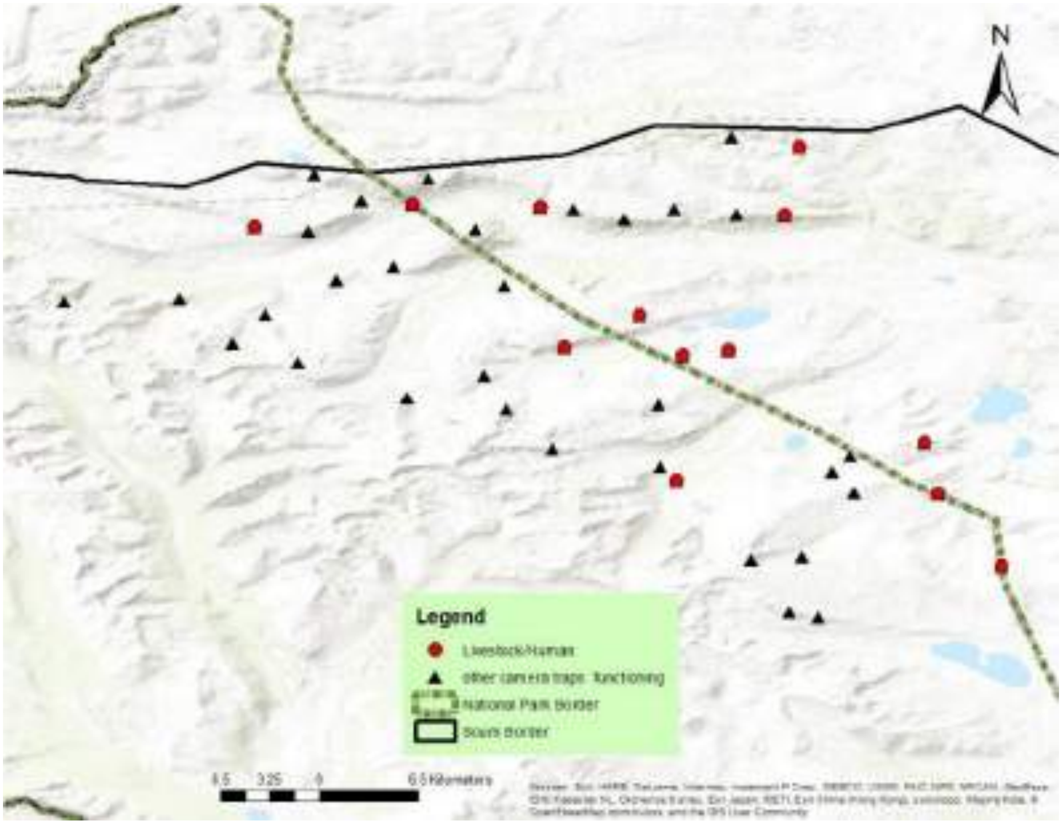


Figure 16. Sites where livestock and humans were detected.

## Conclusions and recommendations

This report presents qualitatively the results of our survey, while quantitative data analyses for scientific publications are on-going. Results show the presence in the study area of a diverse community of medium-to-large mammals with several species of conservation relevance in addition to the snow leopard. In particular, the area seems to hold relatively high presence of wolverine. The presence of argali sheep, Pallas's cat and bear is also notable.

Despite using a systematic sampling that covered a relatively large portion of the northern side of the National Park, **the very small number of snow leopard detections raises the concern that the species may be present in critically low densities in the study area**. Reasons that could explain the low detection rate of snow leopards falls into two categories. The first is the likely low density of the species in the area and the second relates to potential sampling limitations. As for the latter, our sampling was affected by an unexpectedly high rate of camera trap failure, reducing the area effectively sampled. In addition, our survey effort set at 45 days per camera, which was based on results from the previous survey (Rovero et al. *in press*, Oryx), may have been sub-optimal in an area with critically low density of animals. A third reason could be that snow leopard optimal habitat (with adequate density of wild prey) may extend further west into the interior part of the mountain chain stretching along the border with China relatively to the area we sampled. Unfortunately, those western areas were not accessible in the sampling period due to deep snow. Therefore, it is likely that prolonged sampling (up to 90 days) into a wider area may have yielded a greater number of snow leopard captures.

Despite these limitations, we are confident that our results still point to a **critically low density of snow leopard in the area, which is likely due to a combination of lowered prey density due to hunting and the direct and indirect effects of livestock grazing** (see Rovero et al. in press). The low detection rate of wild ungulates (Siberian ibex and argali sheep) is indeed surprising especially when considering that we sampled at relatively higher elevation and targeting more ridges than in Siilkhem B NP. Indeed we detected the Siberian ibex at a smaller number of sites in Tavan Bogd than in Siilkhem B (naïve occupancy 0.11 versus 0.18; we did not detect argali sheep in the latter area). Unfortunately, we gathered clear evidence that **hunting** is widespread inside the National Park as well as in buffering areas, as especially indicated by furs displayed in herders' houses (Fig. 17). We also observed that the two species of wild ungulates were very shy of people, running away at distances >300 m, which is a clear indication that they are under hunting pressure.

Figure 17. Furs of fox and wolverine inside a herder house in the area buffering the National Park (left) and a brown bear paw in a herder house inside the National Park (right).

We also found a steel-jaw trap in a herder house roof within the protected area, declared to be used for wolves but obviously trapping any other animals of appropriate size (Fig. 18).

Figure 18. A steel-jaw trap found in Tavan Bogd National Park.

This is unfortunate as the law of Mongolia on special protected area (article 12) specifies that in the National Conservation Parks is prohibited "to hunt, catch, scare or drive out animals, damage or demolish their nets, dens or holes with the purpose other than activities regulating the census of animals, their number, age, gender and herd composition according to approved schedule and methodology".

Besides hunting, **livestock grazing** is also a potential threat to wildlife. We detected less presence of livestock than at Siilkhem, however herders' houses and livestock occur all around the buffering area and within the eastern and northern part of the park that we sampled, while only at its interior in the period of sampling livestock was absent due to snow cover.

Livestock likely impacts the occurrence and abundance of ibex and argali as it creates competition for foraging grounds with exclusion of the wild species. How livestock impacts the presence of the snow leopard remains difficult to assess. Rovero et al. (in press) found from the 2015 study that while the negative effect of livestock on Siberian ibex was clear, livestock may not have an effect on snow leopard even though the cascading effects such as retaliatory killings, decreased wild prey base and raising human-carnivore conflicts will threaten enduring protection of snow leopard.

In addition, while the low number of snow leopard reduce the potential conflicts with shepherds, the retaliatory killing to wolf can indirectly threaten the snow leopard (Rovero et al. in press). Traditional livestock keeping is allowed in the limited use zones of National Parks (article 17 of the Mongolian law on special protected area; 1994). However, in the last two decades the number of livestock - mainly represented by goats due to the increased global demand of cashmere - has increased steadily across the country. Hence, the current protection regime may not be suitable for Tavan Bogd National Park, where strict protection is advocated or, alternatively, livestock numbers allowed in the park should be reduced.

In conclusion, we have conducted the first systematic camera trapping study of the larger mammal community in Tavan Bogd National Park, which represents the western-most and highest area of the Mongolian Altai Mountains, and provided novel information on snow leopard and other mammals. We revealed a context whereby the **long-term viability of snow leopard population needs sound and timely attention to increase protection and make livestock keeping compatible with wildlife conservation**. We recommend future efforts consider sampling additional populations in the same region to achieve a more robust data set to estimate the abundance and assess the conservation status of snow leopard.

The field team that set camera traps in April 2017 at one of the hosting herders' houses.

### References to 2015 survey

Rovero F, Augugliaro A (2015). Searching for the ghost of the mountains. Report of a camera trapping study of the snow leopard and other mammals in the Altai Mountains of NW Mongolia. Unpublished report, available at www.muse.it/it/Esplora/Progetti-Speciali/Pagine/Mongolia-Snow-Leopard-2015.aspx

Rovero F, Augugliaro A, Havmøller RW, Groff C, Zimmermann F, Oberosler V, Tenan S (in press). Co-occurrence of snow leopard *Panthera uncia*, Siberian ibex *Capra sibirica* and livestock: potential relationships and effects. *Oryx*.