Eastern tur (Capra cylindricornis) monitoring in Lagodekhi protected areas

Final Report

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Executive Summary

In the summer of 2016, NACRES was contracted by CNF under a consultancy service agreement to assess the Eastern tur population in Lagodekhi protected areas (LPA). The primary goal was to estimate the current tur population using direct observation technique. A comprehensive literature review was conducted and our new estimate was considered in the context of more than 70 years of observation. We also examined varied determinants of tur habitat use and population size. This report also includes a second progress monitoring report.

The NACRES team closely worked with and involved park rangers and volunteers in field activities. Fieldwork preparations included the creation of maps, tur counting protocols and other survey documents. Prior to surveys, we trained the rangers in camera trapping and direct observation techniques.

The study area spanned 244.51 km^2 and covered almost the whole of potential tur range in Lagodekhi Protected Areas (LPA). Field teams were organized to conduct three different tur counts across various seasons.

Because tur range in LPA tends to change according to seasons, we created two separate range maps for the summer season and late-spring season with sizes 159 km^2 and 144 km^2, respectively.

We estimate the minimum total tur population in LPA to be at approximately 600 individuals. This is a minimum population size, because we assume that a portion of the tur population remained inside the forest and therefore escaped our visual counting. While it is difficult to compare our estimate with those of previous latest studies, it is still probably safe to conclude that the Lagodekhi tur population has seen a positive trend starting from the early 2000s.

Poaching is the most important human threat to the tur population. Livestock (sheep and goats) grazing tends to limit tur range in the summer and restricts their use of habitat in the north-west of LPA. With poor veterinary care, livestock may bring various diseases that can be passed onto wild ungulate populations. The rising number of visitors is an additional disturbance to tur and other wildlife, as visitors can restrict habitat use by wildlife.

While providing a good assessment of overall threat levels in LPA, focusing only on tur as an indicator species fails to yield the whole picture. For example, contrary to the tur, the red deer – another key mega-herbivore in LPA – may be declining due to unknown reasons. By monitoring both tur and red deer, it will be possible to assess threats to wildlife more comprehensively and it will also help understand the complex relationship between different ungulates and their dynamics. All of this can have important implications for the effective management of LPA.

Contents

1 Introduction

Lagodekhi protected areas (LPA) are among the several Georgian protected areas supported by the Caucasus Nature Fund (CNF). Since 2011 CNF has provided the LPA with co-financing to help cover operational expenses such as salary supplements, vehicles and fuel, field allowances, equipment, etc. Additionally, CNF supports infrastructure development and maintenance in LPA. In spring 2016, CNF commissioned a desk study to provide better insights into the linkages between biodiversity values, pressures and threats, and conservation measures taken in LPA (Garstecki and Rajebashvili, 2016). The study identified the eastern tur (*Capra cylindricornis*) as the biodiversity value indicator for LPA.

In the summer of 2016, NACRES was contracted under a consultancy service agreement to carry out the following activities:

(i) Conduct an analysis on available information regarding the eastern tur population's numbers and abundance, seasonal habitat use, population trend developments, etc.; Prepare a map of the core area inhabited by tur through consultations with park managers, rangers, etc.;
(ii) Train a selected group of rangers and students to conduct tur monitoring in accordance with an agreed-upon methodology. Finalize the composition of the field monitoring teams (per team: supervisor, junior expert/student, ranger) based on individual and overall assessments of the participants.
(iii) Conduct tur monitoring in accordance with the agreed methodology and analyze the suitability for using additional techniques in support of direct observations;
(iv) Analyze anthropogenic and a variety of other impacts on tur in LPA; Analyze management interventions in order to reduce pressure on the tur population; Provide recommendations to modify and improve management as appropriate.

2 Analysis of available information

The earliest report on the Lagodekhi tur population belongs to Dinnik N. I. (1914), who mentions that tur skull samples were gathered in Lagodekhi for the Academy of Science's museum. Thus, it is probable that the tur population was well established by the beginning of 20th century. According to Markov (1938), the ungulate populations flourished in Lagodekhi because strict controls and protections were established when the place become a hunting reserve and subsequently leased to Principe di San Donato E. Demidov in 1903.

During the 20th century researchers studied many aspects of the tur population, such as vertical migration patterns, diets, parasites, courtship behaviors, birth dates/places and, to some degree, habitat use. Tur population numbers are also widely discussed in more recent literature. Additionally, the Division of Reserves and Hunting Areas has many accounts by a state authority who managed all the reserves in Georgia during the soviet era.

2.1 The dynamics of the Lagodekhi tur population during 1934 - 1994

The first comprehensive assessment of large mammal species in Lagodekhi was carried out after the establishment of Lagodekhi as a strict nature reserve in 1929 (Markov, 1938). In 1934, E. Markov (1938) saw only 15 tur in Lagodekhi and assumed that there were no more than 200-300 individuals. He mentioned that tur numbers were extremely low compared to the neighboring Zakatala reserve. One reason why tur population numbers were low was because hunting reserve lease contracts were terminated after the Soviet government established itself in Georgia. Thus, due to reduced protection, locals extensively exploited natural resources. Moreover, using alpine meadows under the pasture in addition to hunting and logging shrank the number of large mammals in Lagodekhi (Markov, 1938). However, the tur population increased significantly in 1945 when hunting, logging and grazing were restricted and protection was improved (Enukidze, 1965).

The Lagodekhi reserve administration counted tur every year and published the results in the annual journal, *Chronicles of Nature – Lagodekhi Reserve*. Analysis of official data reveals interesting aspects of tur population dynamics in the period ranging from 1947 to 1994. As seen in the graph below (see figure #1), the tur population began to rise sharply in 1952 and reached approximately 6,900 individuals in 1961. Such an unusually high tur count was explained by increases in human disturbance external to the protected area. It was suggested that significant pressures, such as illegal hunting on the pastures and the use of explosives in geological exploration throughout the tur range, forced the animals to take shelter in the reserve (Petriashvili, 1969). Additionally, an estimate of more than 6000 is mentioned in the book *Animals of Georgia* (Janashvili, 1963). Later, however, Janashvili A. (1977) acknowledged that the figure was significantly overestimated.

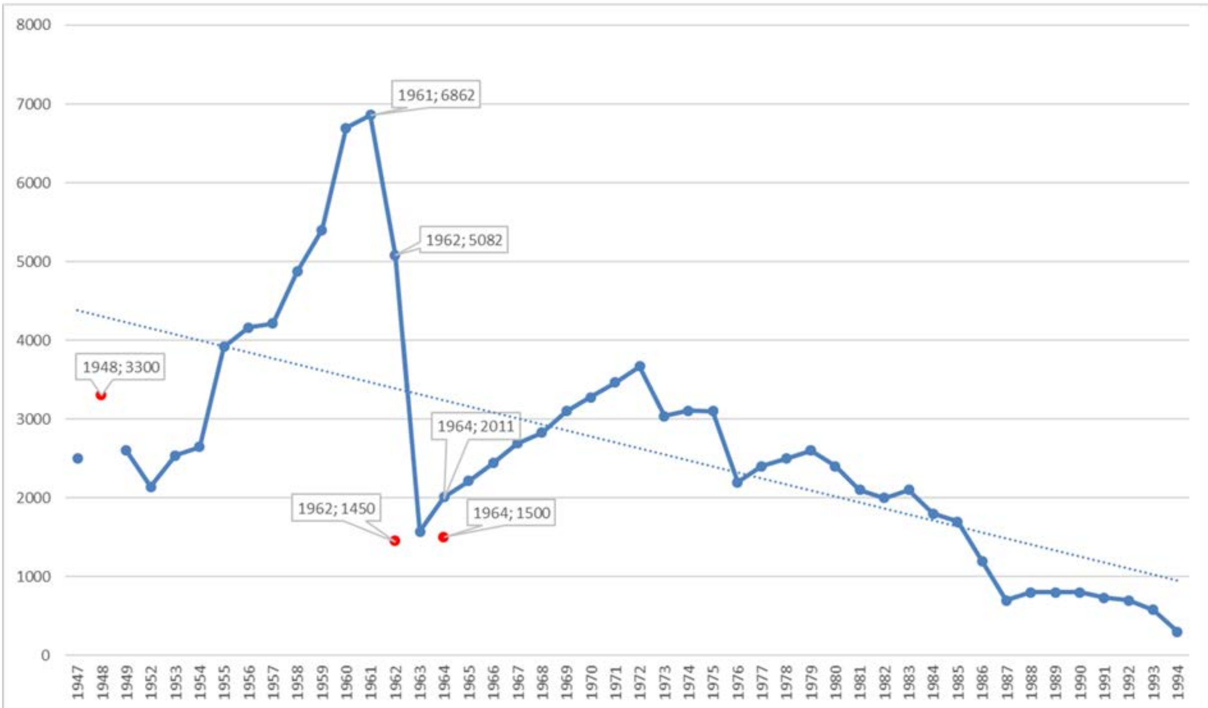

Figure #1 Tur population trend in Lagodekhi during the 20th century. The blue line and blue dots are tur census results published in *Chronicles of Nature – Lagodekhi Reserve* (summarized and provided by Giorgi Sulamanidze); Red dots are relatively independent count results carried out by Enukidze and Chlaidze (1961 and 1965, respectively).

According to official data, the population saw a dramatic, more than a four-fold, decrease only two years after the peak in 1961. This sharp decline was again explained by increased disturbance, but this time within the reserve—authorities temporarily permitted livestock grazing and allowed geological explorations within the reserve (Petriashvili, 1969).

There exists another independent study that yielded a different estimate of the tur population in 1962. This two-year study estimated the population to have only 1,450 individuals (Chlaidze, 1967), versus the official count of 5,082 as seen in the graph above. Comparatively, independent census results were typically very different from the official data published in the *Chronicles of Nature* (Figure #1).

It is important to note that there was a steady decline in tur numbers from 1972 onward. One reason for this decline is linked to the growing numbers of red deer in the 1980s (Eriashvili, unpublished data). Indeed, red deer increased significantly in response to controls on the wolf population in Lagodekhi (Gurielidze, 2004). Based on Z. Gurielidze's data (2004), we compared red deer and tur population trends and found that red deer numbers negatively correlate to tur counts (Figure #2).

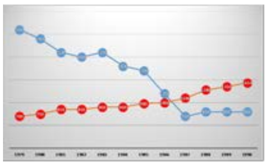

Figure #2 The blue line represents the tur population trend in Lagodekhi (*Chronicles of Nature – Lagodekhi Reserve*, summarized by Giorgi Sulamanidze). The red line represents red deer counts in Lagodekhi (Gurielidze, 2004).

However, while studying all ungulate populations in Lagodekhi, Gurielidze (2004) only noted a negative impact on chamois. He did not mention the effects of red deer on the tur population, only emphasizing the fact that red deer expanded their range into the chamois habitats. Other authors, however, believe that rising deer numbers were a prime factor in affecting tur numbers (Chikovani *et al*. 1990, Eriashvili, unpublished data). The negative effects of increased deer numbers on both the chamois and Alpine ibex populations have been shown in the Swiss alps, where a migratory red deer population negatively influenced mountain ungulate numbers and their habitat use (Anderwald et al. 2015).

While interspecific competition with the growing red deer population may have played an important role, it is more likely that a combination of different factors led to the declining tur population. Notably, illegal sheep grazing and poaching was not rare in Lagodekhi (Eriashvili, 1989, Gurielidze Z. personal communication) and could have directly affected the tur population. While hunting – both legal and illegal – affected all ungulate species in Georgia, tur were more heavily hunted for decades. This is partly because the red deer's inclusion in the Red Data Book of Georgia (Kacharava et al. 1982) granted red deer more protection than the tur; the latter continued to be hunted including in the reserves.

Even foreign VIP visitors were brought to Lagodekhi to shoot tur (Gurielidze Z. personal communication), whose horns were valuable trophies. Although tur hunting would eventually be suspended, shooting a tur was still considered a less severe crime than killing a red deer, for which one could go to jail. Hence, selective hunting in conjunction with other factors, such as intense illegal sheep grazing and probable interspecific interactions, are likely causes for the decline of tur in Lagodekhi.

In the 1990s, Georgian political instability and practically no control in the protected areas resulted in a sharp decline of all ungulate numbers (Badridze, et al. 2000). NACRES researchers conducted ungulate surveys in Lagodekhi during 1999 and visually counted only 76 tur throughout the protected area (Gurielidze, et al 2000). The next assessment was carried out in 2004, when the tur population was estimated to be at 240 individuals, with a density of 4.4 individuals per 1 km^2 (NACRES, 2004).

The most recent assessment of the Lagodekhi tur population was carried out by Ilia State University in 2013 and 2014 as part of the national monitoring program financed by the government. The team employed an aerial count method using a helicopter to cover LPA and its adjacent areas. The flight transects covered the main tur habitats, especially in the subalpine and alpine habitats of LPA. Additionally, the transects covered an area ranging from the neighboring southern slopes of the Greater Caucasus range to its north-west regions. The census took place in December, the tur rut season**.**

Population estimates were 492 individuals in 2013 and 279 individuals in 2014. It is important to note that the confidence interval for the 2013 estimate was large (the 95% confidence interval being 135 – 1,794) while that of the 2014 estimate was considerably smaller. The two estimates above have limited use for drawing any conclusion on LPA tur population trends. Unfortunately, the Ilia State University report does not provide any details of group numbers and locations that could help us compare their results with our own observational data.

In conclusion, the fluctuating tur population over the past seventy years has largely been a response to the changing levels of protection and management of the Lagodekhi protected area, especially considering the fact that the population is not closed (the cross-border movement of tur into the neighbouring Dagestan is a recognized but poorly understood fact). On the other hand, interspecific interactions between the ungulate populations in this predator-rich environment should not be overlooked. Further detailed studies are necessary to understand the underlying reasons for changes in different large herbivore populations of the Lagodekhi protected areas.

2.2 Habitat use

Subalpine and alpine areas are considered the primary habitats of the Eastern tur (Chlaidze, 1967, Weinberg, 2008). Depending on the season, the local conditions and the scope of human disturbances, one could also consider subnival and even nival habitats, as well as forests (Markov, 1934; Vereshagin 1959; Ekvtimishvili, 1952; Enukidze 1965; Claidze 1967; Magomedov et al. 2001; Weinberg, 2002; Gavashelishvili, 2004; Weinberg, 2008). It has been suggested that the majority of tur population (around 60%) in Lagodekhi prefer forests as their primary habitat during the winter and spring (Ekvtimishvili, 1952).

The vertical distribution of the tur appears to vary greatly in different countries and locations throughout the Greater Caucasus. This species is typically found within the altitudinal range from

1,000m to 4,000 m on (Chlaidze, 1967; Weinberg, 2002;). In Dagestan, the species prefers higher elevations, usually between 2,500-3,500 m.a.s.l. (Magomedov et al. 2001). In Azerbaijan, it is found from 800m to 3,500m (Kuliev, 2012). According to earlier studies in Lagodekhi, the tur inhabits areas from 900 m to 3500 m (Enukidze 1965), but prefers alpine habitats between 2,500 m and 2,700 m (Enukidze 1965). During the summer, fewer individuals stay in the forest (Ekvtimishvili, 1952).

Some authors believe that there are forest-dwelling tur populations in Lagodekhi as well as in Azerbaijan that are completely isolated from the populations living at higher altitudes (Markov, 1938; Vereshagin, 1959; Kuliev, 2012; P. Weinberg, 2008). In Lagodekhi, locals call them “forest tur” and believe they live separately from “mountain tur”. Some researchers suggest that high levels of human disturbance forced these animals to live in the forest (Markov, 1938; Vereshagin, 1959; Chlaidze 1967). However, some individuals have remained in the forest even after protection was improved in all Lagodekhi. Additionally, some authors did not confirm the existence of two separate tur populations in Lagodekhi (Ekvtimishvili, 1952; Enukidze, 1965).

The typical tur habitat abounds in steep slopes, and this feature is usually a defining factor of tur distribution throughout the Great Caucasus (Magomedov et al. 2001; Gavashelishvili, 2004; Gavashelishvili, 2009). In Dagestan, areas with a mean slope inclination of 36^0 are the most preferred (Magomedov et al. 2001). For the most part, tur use slopes with an inclination of 30^0 and above, depending on the season (Weinberg 2002).

There is little information on the daily movement and distance covered by tur. It is known that females typically cover smaller distances as compared to males, both vertically and horizontally (Chlaidze, 1975, Magomedov *et al.* 2001, Weinberg 2002). Chlaidze (1975) suggests that daily tur movement depends on pasture availability and real-time threats. For the Western tur (*C. caucasica*), the average daily distance travelled was estimated to be between 400-600 m, but can be as long as 2,000 m (Chlaidze, 1975). In Dagestan, male individuals may move 400-500 m vertically but can reach up to 1500 m (Magomedov et al. 2001). In North Osetia, they usually cover 1,500 m horizontally and 1,000 m vertically, while females move less than 500 m horizontally and 300 m vertically (Weinberg 2002). All these data come from direct observations which did not involve any tagging of concrete individuals. Since it is extremely difficult to ensure individual identification, the above information cannot be considered reliable.

3 Study area

The Lagodekhi Protected Area complex (LPA) is comprised of Lagodekhi Nature Reserve (IUCN category I) and Lagodekhi Managed Reserve (IUCN category IV). LPA is situated on the southern slopes of the Great Caucasus range’s Lagodekhi administrative district, located in north-east Georgia (see Appendix #1 – Study area map). LPA is also as an important Emerald site that harbours important habitats and species protected under the Bern Convention.

The northern boundary of the protected area lies along the top of the main watershed of the Great Caucasus range, which is also the state border line with the Republic of Daghestan of the Russian Federation. The eastern border is marked by the river Matsimistskali (Matsimchai), the state border line with Azerbaijan. Both the Zaqatala state reserve in Azerbaijan and the Tlyaratinsky state-managed reserve (IUCN category IV) in Russia border the Lagodekhi protected areas. These three protected areas create a large system of conservation territory.

LPA covers 244.51 km^2, of which 197.49 km^2 is the Lagodekhi Strict Nature Reserve and 47.02 km^2 is the Lagodekhi Managed Reserve. The managed reserve includes forest habitats in the lower zones of LPA which forms a transitional buffer zone between the Strict Nature Reserve and adjacent villages. The managed reserve also encompasses alpine pastures in the north-western parts of LPA that are used for livestock grazing (Lagodekhi pasture MP, 2015). It additionally includes a linear zone which consists of popular tourist trails that go through the nature reserve (MENRP, 2015). The LPA's elevation ranges from 450 to 3,500 m.a.s.l and covers mountain forests as well as subalpine, alpine and subnival habitats. (see Appendix #2—Main habitats of LPA).

The fauna of LPA is very diverse. There are 38 mammal species, at least 133 bird species, 12 reptile species, 7 amphibian species and 4 fish species spread across LPA rivers. There are three species of Caucasian endemic birds, including Caucasian black grouse (*Tetrao mlokosiewiczi*), Caucasian snow cock (*Tetraogallus caucasicus*) and Caucasian chiffchaff (*Phylloscopus lorenzii*). Among Caucasian endemic mammals, the east Caucasian tur is the most prominent species. Other important large mammals include red deer, chamois, roe deer, brown bear, lynx, wolf, etc. (MENRP, 2015).

4 Methodology

The monitoring protocol proposed for the priority indicator (the eastern tur) is summarized in the desk study by Garstecki and Rajebashvili (2016). It follows the simple direct-observation and counting approach proposed and tested by Veinberg (2012) in Azerbaijan. Considering the complex and dynamic social structure of the tur, with males and females occupying different portions of the habitat according to different seasons, annual monitoring has to be conducted in two periods: (i) the post-parturition season, from June through July, and (ii) the rutting season, from November through December. While the referenced protocol was developed for and tested in Azerbaijan, Garstecki and Rajebashvili (2016) suggested that the protocol is fully applicable for LPA.

The tur-monitoring field form proposed by Veinberg's protocol was translated, revised and upgraded (see Appendix #3—Tur census form). We added images in addition to tur age and sex identifications, making the form easier for park rangers and other observation teams to record observation data in a standardized manner. We used images from the following literature: „Monitoring Programme for Mountain Ungulates in Azerbaijan“ (Veynberg 2012) and "Dagestan Tur – aspects of population and trophic ecology of the species" (Magomedov et al. 2001).

Direct observations can lead to significant underestimation of a mountain ungulate population (Wingard et al. 2010). We believe this is particularly true for Lagodekhi, where a significant portion of the tur population live in the forest (Ekvtimishvli 1952, Eunkidze 1965, Chlaidze 1967). According to Ekvtimishvli (1952), about 40% of the Lagodekhi tur population live in the forest year-round. Direct observation of tur in the forested area of Lagodekhi is impossible due to the dense canopy. The methodology is only applicable in open areas of high-elevation. Hence, any census that relies solely on direct counts can yield only an index – such as relative abundance – rather than a real population count.

We decided to use camera traps as an additional tool to compensate for the above drawback of the proposed field method (direct observations). We placed camera traps throughout the forested section of the tur range to record tur groups that remained within the forest during the direct observations. The idea was to exclude the possibility of counting the same individuals twice. We intended to avoid double-counting by identifying tur individuals in camera trap photos that were taken on the same exact date and time as when direct observations took place. This way we could count individuals that remained in the forest, but also ones that escaped our direct observations.

The following parameters were used to derive the tur range in Lagodekhi: elevation, inclination, habitat type and human disturbance. Camera trap data, GPS locations of tur signs and direct observation data were used to determine the range of inclination and minimal elevation used by tur in LPA. A 30 m-resolution digital elevation model (DEM) was used to outline the preferred slopes. The forest GIS layer was derived from 2017 Google Satellite imagery maps. ArcMap 10.2 was used to outline the tur range in LPA.

To estimate the total population in Lagodekhi, we outlined an effective sampling area and calculated tur density. The effective sampling area is the area in which the counted tur groups were present during the sampling period. We chose to use the Convex Polygon Method (CPM) and Mean Maximum Distance Moved (MMDM) approach to calculate the effective sampling area. This approach is applied to calculate animal density in the camera trap studies (O'brian 2011). Because telemetry data were unavailable– which would have given an accurate MMDM for the Lagodekhi tur population– we had to rely on the literature. We calculated tur density by simply dividing the effective sampling area by the total tur group number counted in that area. The density was then calculated and extrapolated over the similar territories within the tur range in Lagodekhi.

5 Tur monitoring presentation and training at LPA administration

A one-day workshop/training was organized at LPA in August 2016. It was attended by the most experienced rangers who would potentially take part in tur monitoring activities. We introduced the tur population monitoring project, its goals and objectives, and discussed the details of the census approach and its methodology. We also presented a draft census form, prepared in advance, to receive comments from the participants (photo #1).

The NACRES team and LPA rangers worked together on the tur distribution map (photo #2). Some of the rangers made valuable contributions, such as suggesting that the Kabali gorge be added as one of the important tur areas in LPA. We also discussed possible tur observation points and selected preliminary points throughout the LPA.

Photo #1 *Workshop participants discuss project activities* ***Photo #2.*** *Working on tur range map*

Another session was dedicated to the joint planning of field surveys. Because the main objective was to study the range of the tur population and its habitat use in LPA, we had to select sites for camera traps. We presented a draft map of the distribution of camera traps in LPA and received comments from the rangers and various members of the administration. The decision was to organise three field groups consisting of two rangers and one NACRES member. Practical training in using the GPS and camera traps took place in the field while we worked together with LPA rangers. Some of the rangers already had sufficient knowledge and experience on how to select suitable camera trap sites and then mount them on a tree. They also provided very valuable information on tur movement in the alpine areas and shared with us their knowledge and skills on how to search the area for tur individuals. We explained the principles of direct counting and conducted joint test counts with the rangers.

6 Tur population census surveys

6.1 Setting camera traps

LPA administration's camera trapping data from 2014-2016 suggested that 1,100 m was the minimum elevation at which tur were spotted. Assuming that tur rarely use areas below that elevation, we decided to place our cameras at and above 1,000 m. Although there are reports of tur individuals using even lower elevations, such as 800 - 900 m (Enukidze, 1965; Kuliev, 2012), we believe those were exceptions rather than within the tur distribution norm. Initially, we intended to use grid cells (2 X 2 km) to achieve an even distribution of camera traps in Lagodekhi. This approach would give us full coverage of the study area. But due to the limited number of camera traps available for the study (19 units were provided by LPA and 3 were available from NACRES), we had to choose camera trap sites based on local knowledge and the NACRES team's previous experience.

Fieldwork was carried out in the beginning of August. Twenty-two camera traps were set on trails actively used by large mammals in the forest habitats found within the vertical range between 1,000 and 2,400 m.a.s.l. We placed camera traps both in primary tur habitats, such as forested cliffs, and in areas with a relatively mild terrain (see Appendix #4—Camera trap sites).

Cameras were regularly checked by the rangers through the end of September 2017. During each check, batteries were replaced and data were extracted from the cameras. Unfortunately, most of the cameras were quite old and failed to operate properly – there was too much false triggering and many had a very short operation time. Because the rangers had to camouflage the cameras with moss, leaves or grass to make them invisible to poachers, some of those "camouflage objects" shifted to partially or fully cover the camera view. Camera traps remained operational from August 2016 to September 2017. Three cameras were stolen.

GPS locations of tur footprints and scats were also taken while in the field setting and checking camera traps. This information was later used as additional data for updating the tur range map.

6.2 Tur population census via direct counts

Tur counts were conducted in three sets—November, May/June and July—to reveal the most appropriate time of the year for long-term monitoring.

During the summer of 2016, the NACRES team selected observation points and carried out test counts. The observation points were selected using two main criteria: (1) to have a wider, clear view of tur habitats and (2) to exclude as much as possible any double counting of individuals. During the actual counts, the field team made certain adjustments, omitting observation points and adding new ones as appropriate. We had to change observation points that did not give an effective view of tur habitats. Some areas needed to add new observation points to effectively count tur in the study area. Eventually, tur counts were carried out from 13 observation points (see Appendix #5—Tur observation points).

In the field, the tur monitoring team broke up into two or sometimes three groups. Each group conducted counts from one observation point twice a day: early morning and late afternoon. Each group was equipped with two-way radio handsets to keep in constant contact and to avoid double counting—by regularly share real-time information on tur movement. Each observer worked independently in the team to count individuals. Later, all the team members came together to share and compare data. All the key aspects, such as the number of individuals, sex ratio and age of the observed individuals/groups, had to be agreed upon among group members before filling out a field data form. Whenever possible, tur group photos of one field group were taken and shown to other field groups to compare data. The best available counting distance was 300-1,200 meters. The animals were very shy and their flight distance was approximately 300-400 m. Disturbed tur groups either sought shelter in the forest or ran along the slopes.

6.2.1 Tur count: November, 2016

According to Weinberg's protocol, main tur counts should be conducted during tur mating season (November - December). During this season, tur gather in relatively large groups and it is easier to count adult individuals. According to the protocol, tur counts can be started in November when the snow cover is relatively low and when tur begin to aggregate in larger groups.

Snow already started to appear in Lagodekhi mountains by the end of October 2016. Therefore, the NACRES team started fieldwork in the beginning of November. According to weather forecast, this was the most promising period for direct counts. First-base was made at Meteo Station (1940 m. above sea level). There was already abundant snow cover on the elevation at 2900 m and above. Field groups used snowshoes and trekking poles to reach observation points as far up as 2500 m.a.s.l. However, it became clear that observation points on elevations higher up were not reachable.

Photos 3 & 4. *Team members observing tur groups*

In November, observations were carried out from 10:00 until dusk, 17:30 (Please see photos #3 and #4). During good weather conditions, observations were made twice during the day, in the morning and in the late afternoon. The best observation conditions were in the morning from 10:00 to 12:00; the light during this time allowed for clear visibility of tur groups and of most individuals who were on the pastures. From 12:00 to 15:00, evaporation distorted images and affected data collection. In addition, tur were less active and their detectability was lower at this time. In the afternoon, tur became active again (from 15:00 to 17:30) and visibility was much better.

The field team spent 3 subsequent observation days at the Meteo Station. Data were collected from 5 observation points. Observation points in the western part of LPA were not reachable from the Meteo station, so the field team went down to Lagodekhi's town. According to the plan, the next station was to be made on Kudigori ridge – the central ridge of Lagodekhi reserve. At this point in the field work, heavy snowfall started to fall and the weather worsened dramatically. The snow continued for several days and even covered Lagodekhi's town. The field team tried to reach other observation points on Kudigori ridge. However, the group could not even go above 1500 m.a.s.l as horses fell down and were immobilized. Steep slopes did not allow us to set up a camp at a high elevation, thus forcing the field team to return to Lagodekhi. From the LPA administrative building, observation points were way too far to make day trips to the locations. Hence, NACRES stopped the tur counting fieldwork in November.

This experience should be carefully considered when planning tur monitoring activities during the late autumn season and into the winter time. Poor weather conditions can influence count duration as well as row data. Although it is possible to shorten the duration of tur counting, this would entail more experienced and more fit people to do the counts simultaneously. It would be optimal to have information on daily tur movement, as this would enable us to properly plan the observation process accordingly. Due to the abundance of snow, the majority of the tur population could remain in the forest, due to which less individuals would be observed during the winter (Enukidze, 1965) In addition, sufficient equipment for extreme weather conditions should be provided (good snowshoes, suitable sleeping bags, tents etc.).

6.2.2 Tur count: May-June, 2017

At the end of May, we started our second tur-counting fieldwork in LPA. To compensate for the incomplete census in November, we intended to start collecting data before the sheep flocks would reach the alpine meadows of Kabali's summer pastures. However, some of the sheep flocks were already on the summer pastures. Although snow cover restricted movement in higher altitudes (2900 m. and above), we were able to reach nearly all of the observation points.

Tur counting was conducted over 10 days at three main sections of the protected area: (1) Old Meteo Station, (2) New Shelter in Kudigori and (3) upper part of the Kabali gorge. In clear weather conditions, observations were made twice during the day—in the morning and the afternoon. The morning, 06:00 - 07:30, provides the best conditions for observation; during this time, most individuals were still on the pastures and the light allows for clear visibility of tur groups. During the day, tur were less active and had low detectability. In the afternoon, however, they became active again (from 15:30 until 20:30).

6.2.3 Tur count - July, 2017

In July, all places were accessible in LPA. The field team collected data over the span of 8 days from all three main sections of the protected areas (Old Meteo Station area, Kudigori and upper part of the Kabali gorge). However, data from Kabali were not sufficient due to foggy and rainy weather. We believe that the tur took shelter in the forest habitat due to high aggregates of sheep in Kabali.

In clear weather, observations were made twice during the day—in the morning and in the afternoon. The morning, 05:30 - 07:00, provided the best observation conditions—the light allows for clear visibility of the tur groups. In the afternoon, observations were carried out from 16:30 until 21:00.

7 Tur census results and discussion

7.1 Range

The tur range in Lagodekhi changes with seasons and is comprised of forest, subalpine, alpine and subnival habitats. We did not observe tur in subnival habitats during our surveys. (Although we often observed large mature males in these areas in previous studies carried out during the summer). We outlined tur ranges for two separate periods of the year —summer and late spring, based on camera trap data, direct observations and tur signs locations.

With varying success, our camera traps collected data with a total of 4,456 traps/day—more than 9,000 photos and 4,000 videos were taken. Up to 4,000 photos captured different wild animals and images, with tur being the most numerous at 2,128 photos (see table #1). As many as 5,496 images were a result of false triggering.

Table #1 *Camera trap data collected from August 2016 to October 2017*

Species	**Number of images**
Eastern tur	2,128
Chamois	23
Bezoar goat	3
Red deer	966
Roe deer	413
Wild boar	1
Wolf	7
Brown bear	34
Lynx	8
Medium and small mammals, birds and unrecognized animals	366
Total	**3,949**

Tur were captured on 13 separate camera traps, out of the 22 placed throughout the forest habitat. The fact that in the images tur outnumber all other ungulates combined, is a probable indication that this species is the most abundant large herbivore in the reserve.

During the winter, it appears that tur use the middle forest zone more intensively – camera traps placed within the altitudinal range of 1000-1450 m captured the highest number of tur images. This confirms the observations made earlier by many researchers (Ekvtimishvili, 1952; Enukidze 1965; Chlaidze 1967; Weinberg, 2002). One camera captured tur mating behaviour in the forest habitat at an elevation of 1,057 m. The images show mature males chasing females in the forest, displaying mating behaviour (photos #5, #6, #7).

Photos #5, #6 and #7 Tur courtship behavior in LPA

With respect to slope steepness, our tur location data were within the range 32^0 - 52^0. We used this range as one of the variables for our range mapping process. As far as tur vertical distribution is concerned, we found that the tur range was vertically limited by snow cover and human disturbance. During autumn and spring, the upper limitation due to snow cover was approximately 2,900 m. During this period, tur groups remained primarily in steep and rocky areas that do not retain snow cover as well as in sheltered, but sunny, spots with green vegetation. In May, we observed how mature males travelled off, leaving their snowless spots for higher elevations to the north. However, they soon came back after realizing that those areas remained deeply covered by snow.

The range of tur during the summer appears to be limited to the north-west, since subalpine and alpine areas of the protected area are occupied by sheep flocks. It appears that tur prefer to stay in the forest to avoid contact with humans and/or livestock. However, it is still possible that tur was coming out of the forest to graze on the pastures—mostly during the night and the very-early morning before the sheep arrived. Further studies, preferably with telemetry techniques, are needed to test this hypothesis.

Tur distribution at lower altitudes of LPA is restricted by mild terrain and human disturbance. According to our data, tur did not use areas below 1,000 m (no signs recorded). Therefore, this altitude was used as the lower boundary of the tur range in Lagodekhi.

Thus, we created separate range maps for the summer season and for late-spring seasons with sizes 159 km^2 and 144 km^2, respectively (see Appendix #6 and #7—Tur range summer and autumn/late spring). Unfortunately, we did not have sufficient data to outline the autumn and winter tur range in Lagodekhi. It is however highly likely that the autumn tur range coincides with that for late spring.

7.2 The structure of the Lagodekhi tur population

7.2.1 Sex ratio

Within the combined observation data, the sex ratio was almost equal, with the total females only slightly more than total number of males – the male to female ratio being 1:1.1. In November and during May through June we observed fewer males than females and the sex ratios were 1:1.2 and 1:1.3 respectively. Interestingly, twice as many males as females were observed in July – the sex ratio in the July data was 1.9:1; this is mainly at the expense of young males 2-5 years of age. It should be emphasized that the above sex ratios are calculated from the direct observation data conducted in the non-forested tur habitat only. Hence it may not reflect the real overall sex ratio within the LPA tur population because this parameter may be different in the forest habitat.

7.2.2 The size and sex/age composition of observed tur groups

During direct observations, all types of groups were observed—female groups, females with kids and juveniles, young males, adult males, and mixed male-female groups of varying age classes (total number of groups, N=83). Adult individuals were the easiest to identify by their distinct body, horn shape and coloration. Some adult males (≥ 6 years of age) were quite dark-brown and almost black during the observation period (Photos #8 and #9).

We observed the largest group, comprised of 35 adult males, in Gongichai (upstream Matsimi river, bordering Zakatala reserve in Azerbaijan) during May-June. The largest mixed group (34 individuals) was observed near the new shelter (upstream Shromiskhevi river) in the same period. It included 2 big males, 23 females and 9 juveniles. The largest adult female group was comprised of 22 individuals, and the average size of female groups was 7. The mean size of all male groups was 11 (see Appendix #8 – Tur group sizes according to sex).

Mixed groups were more frequently observed in November (n=12) than in any other counting session (n=6 in May-June and n=4 in July). Mixed female and male groups were not stable – they often separated and joined together again; large males did not seem to actively follow the females; there were occasional fights, such as pushing and shoving matches to establish dominance. Clearly, that was only the beginning of the breeding season.

Photos #8 and #9. *Adult male groups in alpine (left) and subalpine (right) habitats*

7.3 Population number and density

The observations were carried out in November, May-June and July (see Appendix #9— Tur group locations according to census sessions) and the total observation time consisted of 41 hours. In November, observations were carried out only around the old Meteo Station because other observation points located in the north-western part of LPA were inaccessible due to severe weather conditions. Therefore, November surveys alone did not provide us with sufficient data to calculate the tur population number. The second round of tur counts were conducted in late May to early June. We were able to carry out visual counts in almost all of the main gorges in Lagodekhi. Ninoskhevi gorge and other small gorges in LPA were not surveyed, since we concluded that already-obtained data was enough to extrapolate on similar tur areas. In July, we conducted the third count and collected data from all observation points as we did in May-June (see Appendix #9—Tur group locations by census surveys).

The total number of tur counted in July was much smaller than in previous surveys. During the summer, it appears that animals were more evenly distributed throughout the available habitats. They may have even moved across the border into Dagestan (Russian Federation) or Zakatala (Azerbaijan). Whereas, in May-June tur movement was restricted by deep snow in the mountains and human disturbance in the lower areas and the population was probably closed. Therefore, we used data from the May-June survey to calculate the tur population number.

During the May-June survey, we visually observed 27 separate groups with a total number of 357 individuals. Juveniles less than 1 year of age were excluded. The maximum number of individuals observed in one day was 63, with an average of 20 individuals per observation day. The distribution of the groups was not even. We observed more groups in the south-eastern part of Lagodekhi (near the Azerbaijan border) and less in Kabali – the northwest section of LPA (Appendix #9).

Unfortunately, camera trap data in conjunction with direct observations did not support proper estimation of tur numbers, because none of the tur camera trap photos coincided in time with our observation period. Thus, it is unknown how many (if any) individuals were in the forest during our observations.

Because our surveys resulted in two separate data sets according to two different sections of the tur range (Kabali and Old reserve—see map in Appendix #7), we estimated tur densities/numbers for each section separately. We outlined the effective sampling area for each data set to calculate tur densities. First, we outlined a territory by the simple Convex Polygon Method (CPM), i.e. by connecting peripheral group locations into a polygon. In order to produce the effective sampling area, we had to add the Mean Maximum Distance Moved (MMDM) as a buffer around the convex polygon (see map in Appendix #10). Because MMDM for Lagodekhi tur was unknown, we instead used an average maximum distance of 1,000 m that we calculated from the best available literature on tur movement (Chlaidze, 1977; Weinberg 2002). Finally, we corrected the effective sampling area according to the tur's late-spring season range map by excluding all areas where tur was not present during observations, such as areas above 2,900 m. and pastures occupied by sheep flocks. Dividing the total number of recorded individuals by the total area provided us with tur density calculations for each effective sampling area. The results are summarised in the table below:

Sections	Effective study area	Total No of recorded individuals	Density per km^2
Kabali	4.78 km^2	31	6.5 individuals
Old reserve	36.51 km^2	324	8.9 individuals

Each of the two densities above was separately extrapolated over similar areas outside the two effective study areas. Total tur counts were calculated as follows: 140 individuals in Kabali 140 individuals and 476 individuals in Old reserve 476. Thus, the minimum total tur population in LPA is **616 individuals**. This is a minimum population size, because we assume that a portion of the tur population remained inside the forest and therefore not detected during our census.

While the minimum number above is certainly an underestimation, it is still more than twice the size as the conclusion drawn by Ilia State University during their last assessment–their 2014 aerial tur count was estimated to be at 279 individuals. It is unlikely that the population doubled in only two and half years since their study. Additionally, aerial counts are more prone to underestimating the tur population in LPA than direct observations. While we should use caution in comparing our results with those obtained earlier by different teams, especially teams that applied different census techniques, the comparison is still useful in indicating the overall positive trend of the tur population. The value in doing a comparative analysis is revealed by the graph below, which shows official census data *vs*. independent assessment results (see Figure #3). Keeping in mind the direct association between tur population and effective PA management, the positive trend in tur population numbers should primarily be attributed to improved protection and anti-poaching measures implemented by the LPA administration over the last few years.

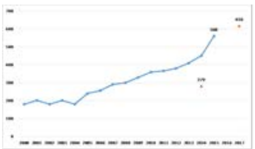

Figure #3 Tur population dynamic since 2000. Blue dots refer to official data from LPA and orange dots refer to independent tur counts in LPA.

8 Other key species in Lagodekhi

8.1 Chamois (Rupicapra rupicapra)

In 1980, there were 350 chamois counted in Lagodekhi reserve (Gurielidze 2004). Since then, the population began to decline and plummeted to 60 individuals in 1990 (Gurielidze 2004). In 2014, Ilia state university carried out an aerial count of the chamois population in LPA, in addition to areas north-west of Lagodekhi up to mountains near Akhalsopeli village. According to their census results, only 23 individuals live in LPA and its adjacent areas (Ilia state university, 2014).

We could not observe chamois in LPA during the tur census. However, 3 of our cameras spotted chamois in the central and north-western regions of LPA (photos #10 and #11). Chamois crossed camera trap areas 16 times, giving us a total of 22 chamois pictures. Based on our camera trap data, it seems that tur is less likely to be detected on cameras when those cameras have chamois pictures and *vise versa*. The same idea is expressed by Enukidze (1965) based on visual observations in Lagodekhi. He mentioned that the team observed less tur in the places where more chamois lived. According to Al. Arabuli (2000) chamois and tur use different habitats in the Lagodekhi PAs.

On a map, we placed points at chamois sighting locations obtained via camera traps and visual observations since 2012 (see Appendix #11— Chamois locations in Lagodekhi protected areas since 2012). Some locations were obtained by the NACRES team and some were provided by the LPA administration. Data are more concentrated in the central and north-western regions of LPA.

Considering that the species has a more secretive lifestyle in Lagodekhi, a separate study should be carried out to obtain robust data on the status and distribution of chamois in the study area.

Photo #10 and #11. Camera trap photos with chamois

8.2 Red deer

Our camera traps took many pictures of red deer (up to 1,000 photos), which perhaps indicates that the deer population is not dramatically low in Lagodekhi forest. However, we could not visually observe red deer in the subalpine zones. Before and during 2004, red deer were frequently visible from old Meteo station on the opposite slope. Red deer population counts were 350 individuals in 2015 (Gurielidze, 2015) and Z. Gurielidze believes that this population has a negative trend.

We are now brought to the question: if the tur population rises, why might the red deer population decline? The declining deer population cannot be explained exclusively by human factors. Chikovani and others (1990) believed that red deer negatively affect tur. The same conclusion was made in the Swiss Alps, where the red deer population negatively affected the ibex population (Anderwald et al. 2015). In both cases, their conclusions were based on analysing carnivore-free environments (or environments that were almost carnivore free). Existence of large carnivores, especially wolves, can have major impact on deer numbers and distribution. Ungulate distribution in Lagodekhi can, therefore, be a result of complex interspecific relations, of the scope of carnivores in the environment and of human disturbance (intensive tourism). Robust monitoring of red deer populations, together with tur monitoring, will give better indications on how to answer the question above.

8.3 Bezoar goat

One of the camera traps also spotted a bezoar goat in Lagodekhi— this is a very rare case. According to Vereshchagin (1959), bezoar goats appear once in 20 or 30 years in the regions of Lagodekhi and other southern slopes of Greater Caucasus. However, bezoar goats never stayed permanently in these regions. It can be hypothesised that tur occupy the habitats of the bezoar goat, which consists of cliffs in middle forest zone and prevent bezoar goats from establishing a permanent population there.

9 Threats to the Tur population in Lagodekhi PA

9.1 Poaching

We believe that illegal hunting is a major threat to the tur population in Lagodekhi, as well as on the whole Greater Caucasus. Many scientists indicate in their articles the devastating effects of intensive tur hunting (Markov, 1934; Markov, 1938; Vereshchagin, 1959; Arabuli, 1985, Claidze, 1967; Chlaidze, 1975; Janashvili, 1977; Kokhodze, 1991), particularly in Lagodekhi (Chlaidze, 1967, Eriashvili, 1989, NACRES 2004).

Poaching in Lagodekhi happens primarily in late autumn and during the winter. During this period, border police checkpoints are removed, fewer tourists hike in the mountains and many rangers are busy with firewood provisions to local population. Tur, especially large mature males (trophy individuals), are more visible. During this period, all of these factors create a favourable environment for poachers. During the summer, border police checkpoints and a high number of visitors impede illegal tur hunting.

Tur hunting is a solely recreational activity; it is unlikely that anybody will hunt tur due to lack of food or for additional income. Tur hunting is a risky activity and therefore associated with bravery. In some places, tur hunting was considered an initiation process for young hunters. According to the LPA director, most of the poachers come from Lagodekhi town and nearby villages. They are physically fit, know all of the trails well and often manage to escape from rangers.

The effect of poaching is not confined to the simple reduction in numbers. It also affects tur habitat use and movement patterns. For example, we observed tur running towards the forest after gunshots. Subsequently, for a few days afterwards, the animals were less frequently coming out into open habitats.

It should also be mentioned that LPA is distinct from other PAs because of its unprecedented efforts against poaching. An impressive number of 23 violations were revealed in 2016, and four of them qualified as criminal acts.

However, the local court is too loyal to poachers, and penalties are often so insignificant that poachers are encouraged to continue violating the protection regime. In one case, for example, LPA rangers caught poachers violating the PA regulations for a second time, but the local court did not consider a harsher sentence. The violators were only subject to the minimum of fines.

9.2 Grazing

The upper subalpine/alpine part of the Managed Reserve (ca. 2,500 ha) is used as a summer pasture mainly for sheep. These pastures range from the current tree line (ca. 1,800 m.a.s.l) to the alpine zone (ca. 2,950 m.a.s.l).

According to our observations, as well as information provided by local shepherds and rangers, there is no evidence of tur on the pastures during the summer. At the end of May, tur groups were still observed in upper part of Kabali gorge, as this is the period when sheep flocks begin to occupy the pastures. However, when the sheep flocks arrived fully to the summer pastures in July, tur became less visible.

Pasture assessments conducted by NACRES in 2014 found that most of the farms were overstocked (NACRES, 2015). Considerable amounts of pressure affect not only the ecosystem but also wild ungulate populations; livestock farming involves many activities that put pressure on the animals. There are additional factors that may be detrimental to biodiversity, such as diseases, livestock movement, potential forest fires and the presence of humans and sheep dogs.

Implementing the pasture management plan that was developed by NACRES in 2015, the LPA administration is leasing pastures. The plan implies that pasture management measures be implemented very carefully and step-by-step to gain support of the local sheep farmers in introduce new grazing schemes and practices. Those pasture management measures will benefit the tur population as well as biodiversity in general (NACRES, 2015). In the future, veterinary studies should be conducted to assess the potential risks of disease transfer from sheep to tur and other wildlife.

9.3 Disturbance

The number of visitors to LPA increase each year. According to statistical data, Lagodekhi received about 50,000 visitors in 2016 (APA visitor statistics 2016). The vast majority of visitors spend only one day in LPA, while some groups stay longer and hike in the PA. For the most part, visitors use four main trails in LPA. Three popular trails are found in the lower forest (Machis Tsikhe; Ninoskhevi waterfall and small waterfall in Shromiskhevi). The longest trail is about 30 km long and crosses the entire Lagodekhi reserve and goes through key wild ungulate habitats, including tur habitats. On this trail one needs to spend at least 2 nights in one the shelters or in a tent in the subalpine-alpine zones. Hence the presence of tourists and noises often disturb wildlife along this trail—presumably forcing animals to take shelter in more remote areas of LPA. In the future, the impact of tourists on local wildlife should be carefully studied to better manage LPA. Telemetry is one of the most robust methods to analyse whether or not target species will choose less preferable, but safe, areas to avoid visitors.

10 Conclusions and recommendations

10.1 Conclusions

- According to our assessment, there are at least 600 individuals of the Eastern tur in Lagodekhi PA — a likely indication that there has been a positive population trend over the last 17 years.
- Tur commonly use forest habitats above 1,000 m.
- Tur appear to prefer steep slopes of 32^0 - 52^0. Slope degree, snow cover and human disturbance are primary factors that determine tur range. In the summer, tur range covers 159 km^2; in late spring it covers 144 km^2. The autumn range is likely to coincide with that of late spring.
- The largest group observed was an all-male group that included 35 individuals. The average group size for females was 7 and 11 for males. We observed mixed groups during all seasons when carrying out surveys, but they were most common in November as they prepare for breeding.
- Notably, tur courtship behavior was recorded by a camera trap in the forest habitat at an elevation of 1,057 m.
- Chamois were not observed during tur counting. Contrary to the suggestion in the ToR, it is practically impossible to combine the tur and chamois censuses when using direct observation techniques.
- We hypothesize that growing tur numbers can have negative effects on the red deer population in LPA.
- Poaching is the most important human threat to the tur population. Livestock grazing tends to limit tur range in the summer and restricts their use of habitat in the north-west of LPA. With poor veterinary care, livestock (sheep and goats) may bring various diseases that can be passed onto wild ungulate populations. The rising number of visitors is an additional disturbance to tur and other wildlife, as visitors can restrict habitat use by wildlife.

10.2 Recommendations to improve tur conservation efforts in LPA

Monitoring tur as an indicator species provides a good assessment of overall threat levels in LPA. However, tur monitoring alone does not seem to provide us with the whole picture. As mentioned above, the red deer population may be declining. Currently, we speculate that a combination of human and natural factors are causing this decline. By monitoring both tur and red deer, it will be possible to cover most of LPA's and to fully assess threats to wildlife. It would also help us understand the relationship between different ungulates and their dynamics. This additional knowledge will have important implications for management strategies.

Other specific recommendations for further monitoring and for management improvement are as follows:

- Tur monitoring should be conducted once every 3 years to detect population trends. Late spring is the most suitable season for counting tur, as they are restricted from spreading out into high elevation areas, such as above 2,900, due to deep snow cover. Park rangers and volunteers should be actively involved as participants, but data collection, data analysis and interpretation should be coordinated and conducted by qualified specialists.

- Tur telemetry study would help determine tur habitat use, home range, migration and daily movement. This would significantly aid population assessment and provide a more accurate estimation of population size. It would also help us assess the impact of tourism and livestock grazing on the tur population.
- LPA administration's capability to combat poaching should be increased. A special needs assessment is required to reveal concrete needs. An effective anti-poaching strategy should be developed and implemented.
- The capacity of the LPA administration should be increased to better implement the activities proposed in their Pasture Management Plan (such as recruiting a resource specialist).
- The assessment of potential disease transmissions between livestock and wild ungulate populations should be carried out.

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APPENDICES

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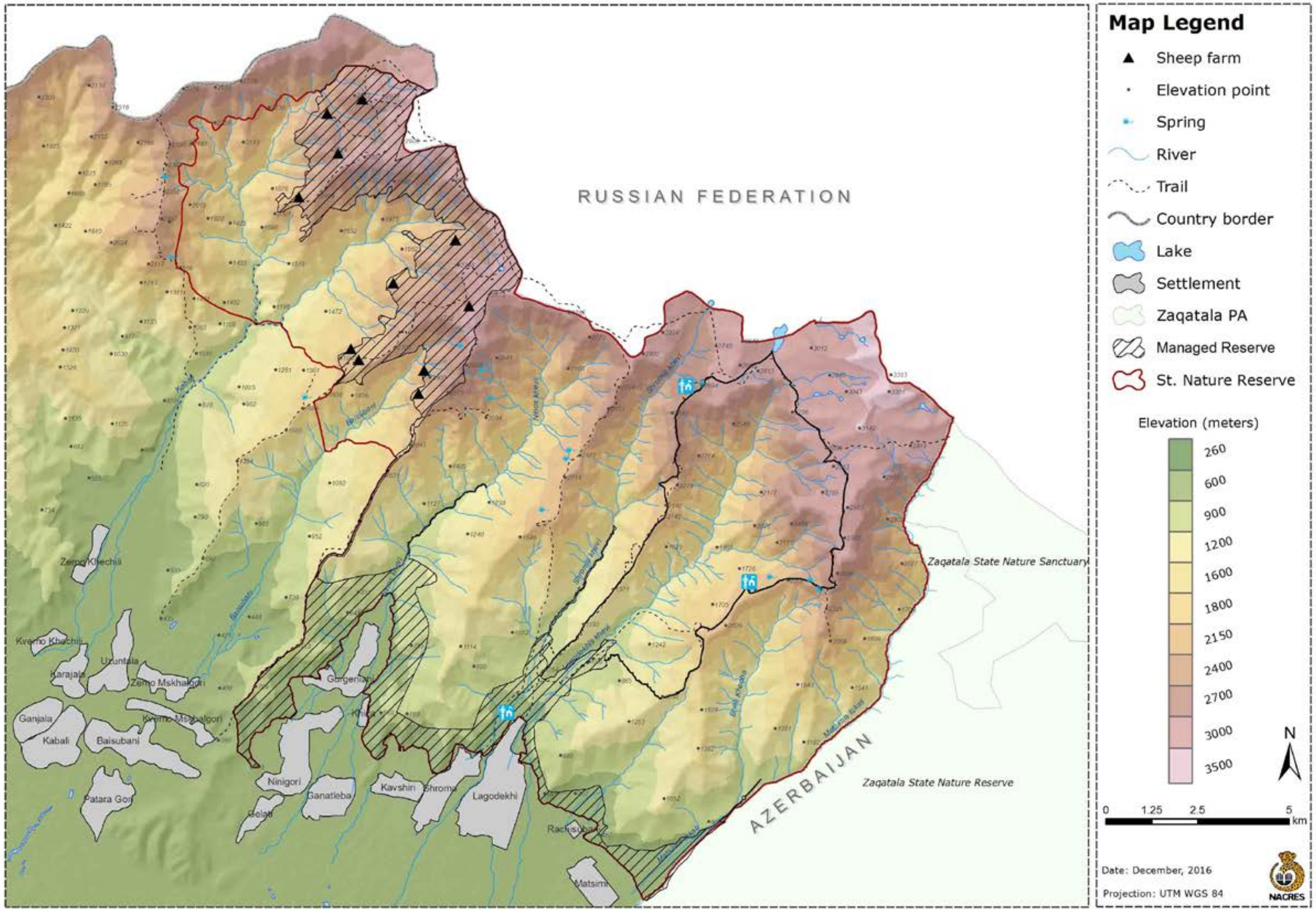
Appendix #1 – Study area map



Appendix #2 – Main habitats in Lagodekhi

Habitat description

The Lagodekhi PA has a distinct altitudinal character where environmental conditions change dramatically with respect to the altitudinal gradient. Most mammal species inhabiting the area show vertical distribution patterns. Therefore, it is logical to divide the reserve's territory into the following altitudinal segments:

- Forest (400-450 m.a.s.l. to 1,800-1,850 m.a.s.l.)
- Subalpine zones (1,800-1,850 m.a.s.l. to 2,200 m.a.s.l.)
- Alpine zone (2,450-2,500 m.a.s.l. to 3,000 m.a.s.l.)
- Subnival zone (3,000 m.a.s.l. to 3,500 m.a.s.l.).

The above altitudinal segments differ greatly with respect to relief, climatic conditions and vegetation cover. Using altitude and vegetation as the main criteria, the forested segment of the reserve may be divided into three zones: the lower, middle and upper forest zones. The boundaries between these zones are not always clear. Nevertheless, the variation in the type, structure and species composition of the forests still permits such division and it has been noted that many species respond to this pattern. Thus, it is logical to regard them as separate habitat classes. The other habitat classes that have been identified (see the list below) represent an assemblage of many different vegetation classes (or their specific variants). These habitat classes contribute to the overall heterogeneity of the habitat. For example, the subalpine zone includes subalpine forest, shrubbery, meadows and the so-called tall grasslands. In most areas, the latter three create a mosaic of shrubbery fragments scattered over larger areas of meadows and tall grasslands. Therefore, excluding the subalpine forest, vegetation classes (meadows, tall grasslands and subalpine shrubbery) have been grouped together as a separate habitat class.

Consequently, the following main habitat classes have been identified:

- The lower forest zone
- The middle forest zone
- The upper forest zone
- Subalpine forest
- Subalpine meadow and shrubbery
- Alpine zone
- Subnival zone

1.1 Lower forest zone

The lower forest zone occupies the altitudinal range from 400-450 to 1,000-1,050 m.a.s.l., covering areas of relatively soft relief (with the inclination of 5-8°) as well as extremely rugged terrain with deep and narrow gorges, such as steep rocky slopes and waterfalls. The forest is composed almost exclusively of beech (*Fagus orientalis*). In some areas, there are also single individuals of *Tilia caucasica, Carpinus caucasica, Acer velutinum* and *Acer lactum*. The undergrowth is either nonexistent or poorly developed. Where vegetation does occur, the typical sub-forest species are *Rubus caucasicus, Cephalanthera lonchophyllum, Neottia nidus avis, Athyrium filix femina* and *Dryopteris filix mas*. Non-woody vegetation cover usually develops only in forest openings. Southwestern and southeastern aspects are characterized by hornbeam and mixed broad-leaf stands.

1.2 Middle forest zone

The middle forest zone occupies the altitudinal range from 1,000 to 1,500-1,550 m.a.s.l., and is characterized by a heavily fragmented relief with deep gorges and ravines. The forest is remarkably diverse in its structure and species composition. The dominating forest types are beech (*Fagus orientalis*) and hornbeam (*Carpinus caucasica*). Rocky areas (which are quite common, especially on the southern aspects) are rich in endemic and relict plant species, such as *Taxus baccata, Hedera pastuchwii, Vaccinium arctostaphylos, Paeonia lagodechiana, Paeonia mlokosewitschii, Gentiana lagodechiana, Castanea sativa, Corylus iberica, etc*. The zone includes large stands of virgin forest.

1.3 Upper forest zone

The upper forest zone occupies the altitudinal range from 1,500-1,550 to 1,800-1,850 m.a.s.l. The relief is extremely rugged and steep slopes (60°) are common. However, it is softer on the northern aspects. The forest represents a mosaic of beech, beech and hornbeam, as well as mixed broad-leaf stands. The structure and species composition of the forest varies greatly with the degree of steepness, with aspect and most importantly with altitude. Beech stands are found in northern, western and eastern faces as well as the less steep southern faces. On the steep southern aspects (30-50°), beech and hornbeam and mixed broad-leaf stands prevail. Steep rocky areas are characterized by sparse mixed forest. As the altitude increases (at 1,700-1,800 m.a.s.l.), the forest thins out and forest openings become more common. Beech stands are also invaded by the subalpine trees of *Acer trautvetteri, Betula litwinowii, Sorbus caucasigena, Quercus macranthera,* etc. Additionally, the vegetation of forest openings becomes dominated by subalpine species.

1.4 Subalpine forests

Subalpine forests develop above 1,800-1,850 m.a.s.l. and may expand up to the tree line, which is typically 2,400-2,500 m.a.s.l. (The timberline along the northern, northwestern and northeastern aspects is found at altitudes of 2,250-2,300 m. and even higher in some places). Subalpine forests are represented by sparse, park-like and/or so-called crook-stem forests. They are composed of maple (*Acer trautvetteri*), oriental beech (*Fagus orientalis*), Caucasian oak (*Quercus macranthera*) and Litvinov birch (*Betula litwinowii*). Maple and beech forests prevail on the northern, western and northeastern slopes. Park-like forests composed of Litvinov birch (*Betula litwinowii*) are found on all except the southern aspects. The comparatively dry southern slopes are occupied by park-like forests of Caucasian oak (*Quercus macranthera*). Crook-stem forests of Litvinov birch attain higher altitudes than other subalpine forests. They are occasionally mixed with rowan (*Sorbus caucasigena*).

1.5 Subalpine meadow and shrubbery

Subalpine meadow and shrubbery represent a mosaic of several types of shrubbery, meadows and tall grasslands. Extremely dense rhododendron (*Rhododendron caucasicum*) formations have developed on the northern aspects. Fragments of azalea (*Rhododendron luteum*) are found on the northern as well as the western aspects. Bilberry (*Vaccinium myrtillus*) and juniper (*Juniperus depressa*) shrubbery also have a fragmented distribution.

There are secondary and primary sub-alpine meadows. Secondary meadows have developed in areas previously occupied by park-like and crook-stem forests. Hence, they occur at lower levels of elevation than in primary meadows. It is notable that secondary meadows are almost identical to primary meadows with respect to both species composition and structure. Secondary meadows are found mainly on the southern, southeastern and southwestern aspects, which are comparatively dry and previously occupied by Caucasian oak. Typical species of these meadows include: *Agrostis planifolia, Anthoxanthum odoratum, Calamagrostis arundinacea, Dactylis glomerata, Festuca ovina, Festuca pratensis, Helictotrichon pubescens, Phleum alpinum, Poa longifolia, Poa nemoralis*, *Achillea biserata, Alchemilla sericata, Anthemis rigescens, Astrantia maxima, Bupleurum polyphyllum, Campanula collina, Centaurea cheirantifolia, Cerastium purpurascens, Geranium ibericum, Leontodon hispidus, Primula macrocalyx, Psephellus dealbatus, Pyrethrum roseum,* and *Trifolium alpestre*.

Primary subalpine meadows occur from 2,200 m.a.s.l. to 2,450-2,500 m.a.s.l. The most important species of these meadows are *Anemone fasciculata, Geranium ibericum, Inula grandiflor, Nardus glabriculmis, Sibbaldia parfiflor, Alchemilla caucasica, A. sericata,* etc. Low density communities are composed of shrubs and herbs such as *Campanula argunensis, C. aucheri, C. doluchanovi, C. petrophila, Dianthus crinitus, Draba bryoides, Festuca ovina, F. varia, Minuartia inamoena, Saxigraga Kolenatiana, Sedum gracile, S. oppositifolium, Sempervivum caucasicum, Thymus transcaucasicus,* and *Trifolium canescens*.

1.5 Alpine zone

The alpine zone occupies the range from 2,450-2,500 to 3,000 m.a.s.l. The relief is extremely complicated with erosive, rocky and crumbling slopes that have a high degree of inclination (35-40°). There are soft relief forms (glacial circuses) and small glacial lakes. Mild relief is mostly characteristic at the middle part of the alpine zone between 2,600 and 2,850 m.a.s.l.

One of the characteristic features of the vegetation is the so-called alpine moles that develop in areas with wet conditions (flat areas, depressions, hollows etc.). Typical species of alpine moles are: *Alchemilla caucasica, Anthemis sosnowskyana, Carex tristis, Carum caucasicum, Colpodium supina, Gnaphalium supinum, Minuartia aizoides, Myosotis alpestris, Nardus glabriculmis, Phleum alpinum, Plantago saxatilis, Poa alpina, Potentilla crantzii, Primula algida, Sibbaldia parviflora, Sibbaldia semiglabra, Taraxacum crepidiforme, Tripleurospermum subnivale, Veronica gentianoides,* etc. Monodominant alpine meadows of *Festuca varia* are widely distributed on the southern and southwestern aspects. These communities are not species rich. The most important plant species are *Betonica macrantha, Leontodon hispidus, Sedum involucratum,* and *Trifolium canescens*. *Nardus glabriculmis* communities are common to steep slopes and plateaus up to an elevation of 3,000 m.a.s.l. Other variants of alpine meadows include *Festica ovina, Carex meinshauseniana*, *C. camescens, C. capillaris,* and *C. micropodioides*.

The vegetation characteristic of screes is dominated by *Anthennaria caucasica, Cerastium multiflorum, Colpodium versicolor, Corydalis alpestris, Festuca supina, Minuartia oreina, Plantago saxatilis, Potentilla crantzii, Thymus transcaucasicus, Veronica minuta, Viola minuta* etc.

1.6 Subnival zone

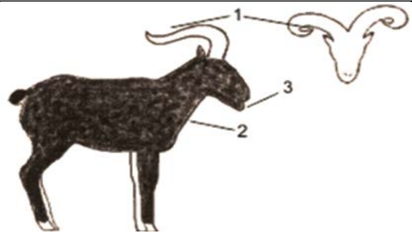
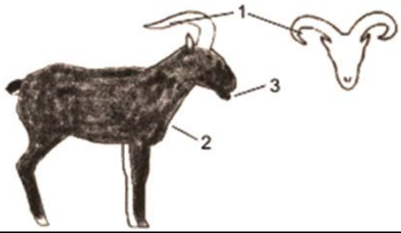
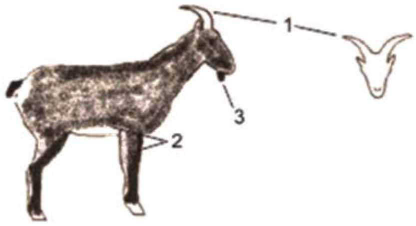
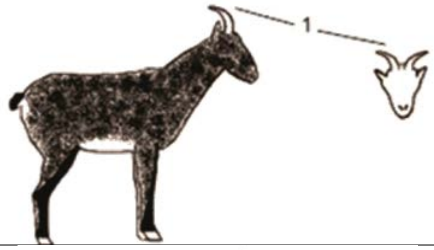
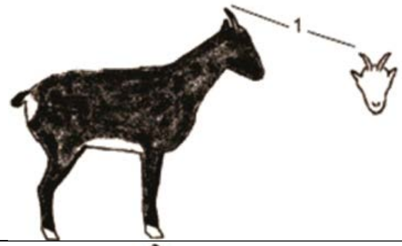
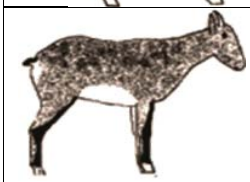
The subnival zone (3,000 to 3,500 m.a.s.l.) is characterized by extremely difficult terrain with barren rock and lots of screes. The vegetation has a highly fragmented structure, consisting only of plant cluster patches that are developed on sheltered sites. Each cluster typically consists of 3-7 species or, rarely, 9-11 species. Typical subnival species are: *Anthennaria caucasica, Campanula biebersteiniana, C. tridentata, Carex tristis, Carum caucasicum, Corydalis conorhiza, Festuca supina, Luzula pseudosudetica, L. spicata, Minuartia aizoides, Phleum alpinum, Poa alpina, Potentilla crantzii, Primula algida, Sibbaldia semiglabra, Taraxacum crepidiforme, T. porphyranthum, Viola minuta* and others. There are also a number of endemic species such as: *Alopecurus dasyanthus, Corydalis alpestric, Draba supranivalis, Nepeta supina, Scrophularia minuta, Senecio sosnowskyi, Veronica minuta,* and *Viola minuta*.

Appendix #3 – Field form

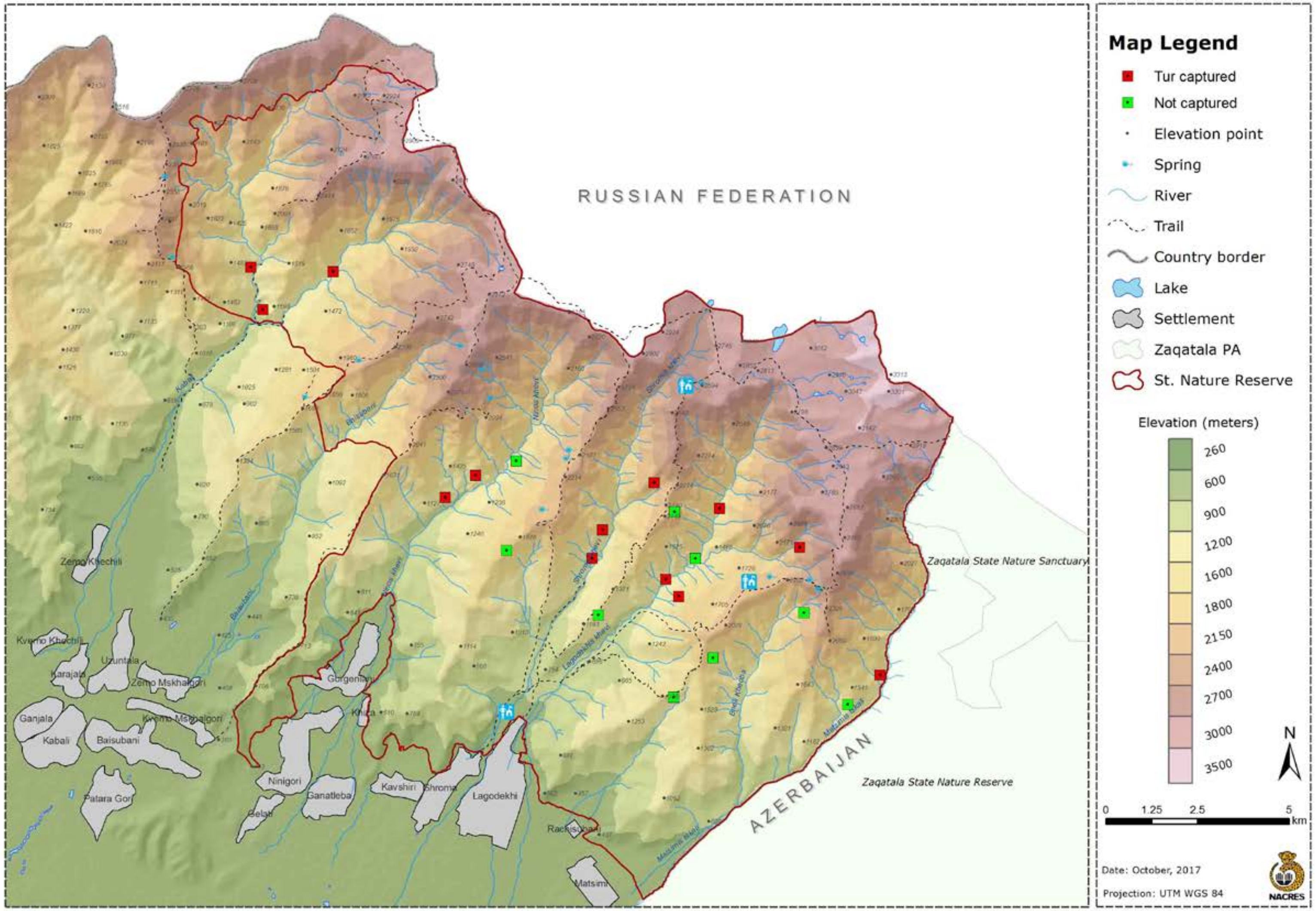
Date	**Weather**	**Observation start**	**Observation end**	**Observers**
				1. 2.
Observation Coordinates (GPS position)		X		**Y**

#	**Location** Name of the gorge or mountain	**Exact time of animal detection**	**Altitudinal zone** F: forest A: subalpine-alpine	**Surface type** S: scree C: cliffs SM: smooth	**Exposure** W, N-W, N, N-E, E, S-E, S, S-W	**Tur**							
						Adult male	4-5 y. male	2-3 y. male	Yearling male	Adult female	Yearling female	Juvenile	Unknown

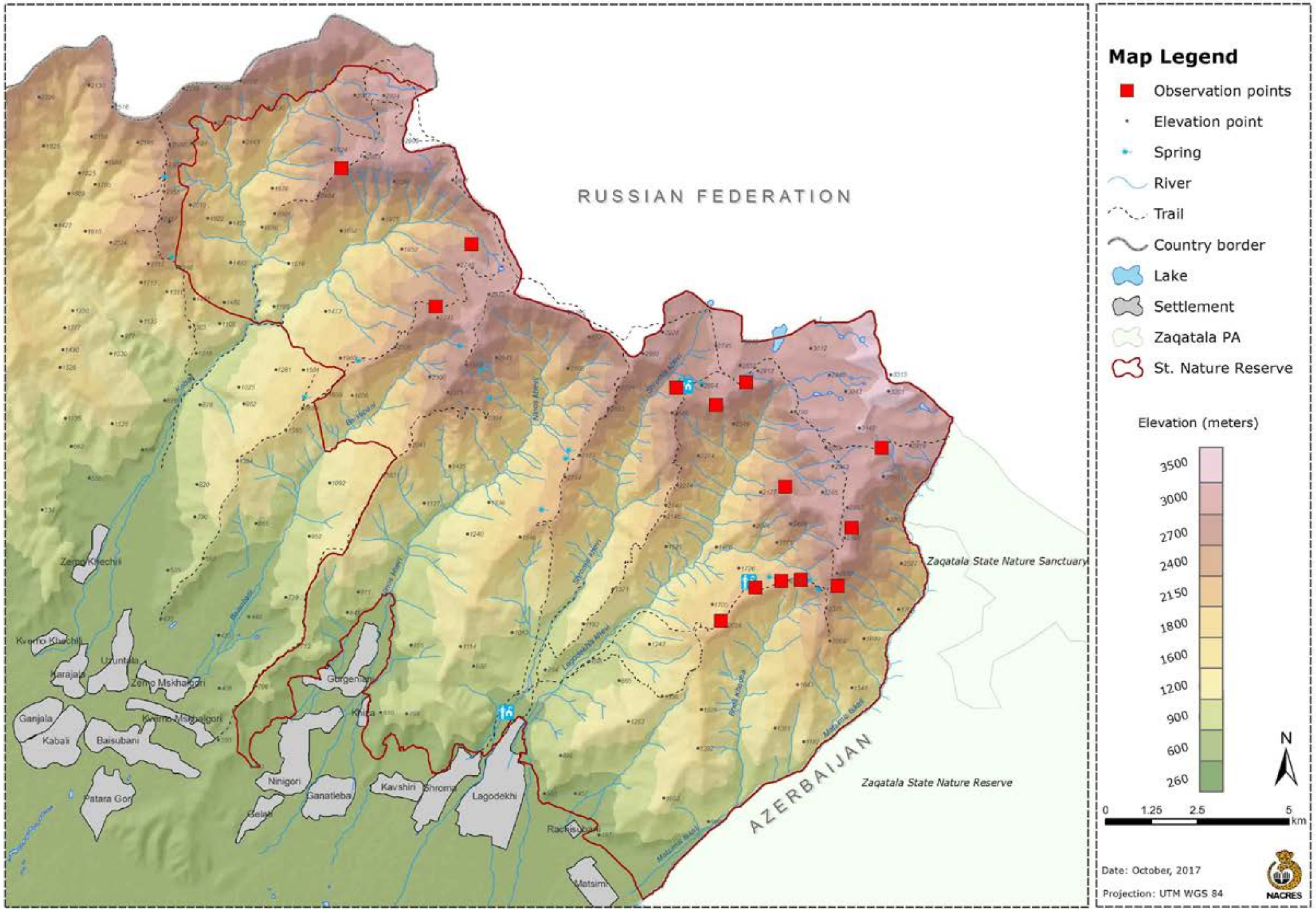
1. Each single animal or group should be written down separately (use separate row).
2. If the individual/group is isolated from others and the gap is 50-100 meters, it should be considered as a separate group.

According to Weinberg P. 2012	According to Magomedov R. et. al. 2001	Description
		**Adult male** 1. Horn tips curved up 2. Dark coloration 3. Solid beard pointed forward
		**Young male (4-5 years)** 1. Horn tips curved in 2. Dark coloration 3. Solid beard pointed forward
		**Young male (2-3 years)** 1. Horns thick at base, widely diverging, tips curved back 2. Animal coloration dark but belly and back sides of the legs light-colored 3. Beard wispy and hanging down
		**Yearling male** 1. Horns thick at base, sharply bent, widely diverging, tips curved back 2. No bread
		**Adult female** 1. Horns thin, a bit longer than ears 2. Animal coloration greyish-brown 2. No beard
		**Yearling females** 1. Horns usually shorter than ears
		**Juvenile**

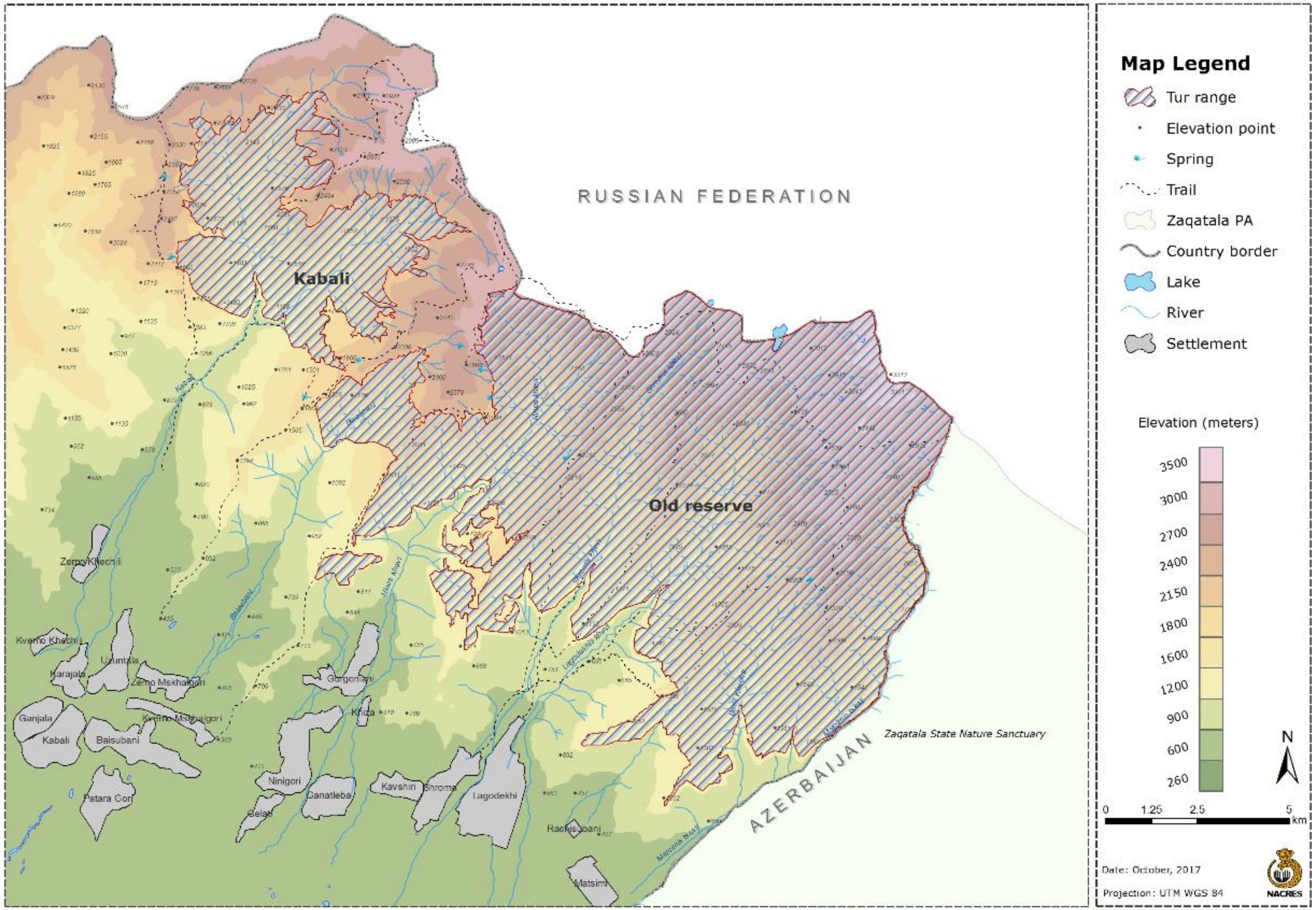
Appendix #4 – Camera trap distribution in LPA



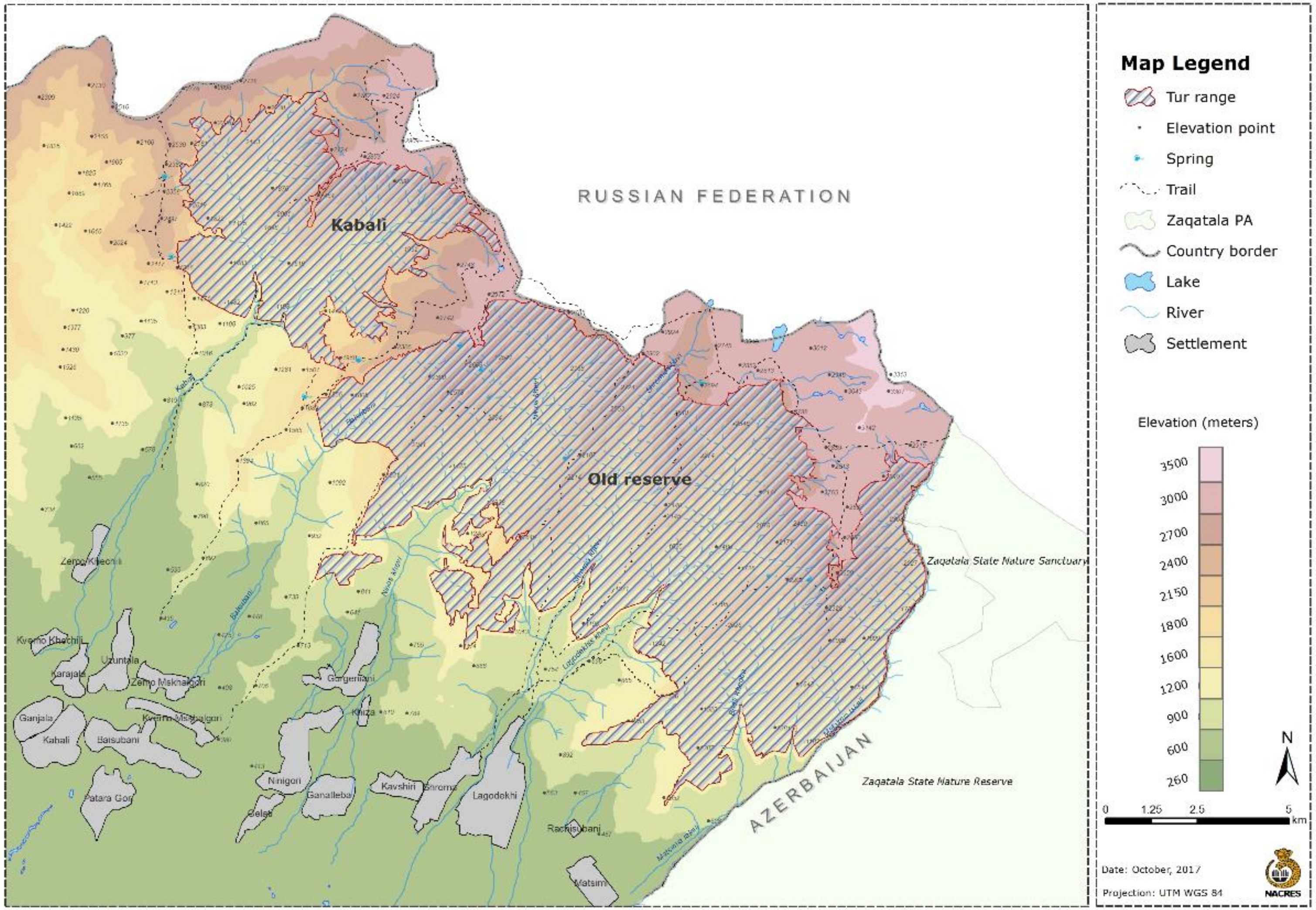
Appendix #5 – Observation points in LPA



Appendix #6 – Tur range in summer



Appendix #7 – Tur range in late spring



Appendix #8– Tur group number according to sex

Groups observed during tur counts in Lagodekhi Protected area

November 2016				May-June 2017				July 2017			
Mix	Male	Female	unknown	Mix	Male	Female	unknown	Mix	Male	Female	unknown
8				9	3	1	2	14	6	9	
11				3	22	3	2	6	2		
14				10	6	2	2	10	10		
10				11	1	7	1	32	28		
11	7			15	3	2			14		
13	1			34	35	11					
10					19	2					
11					4	1					
17					5	13					
3					9	1					
7					1	7					
3					29	6					
					3	1					
					31	11					
						1					
						12					
						13					
						18					
						10					
						9					
						3					
						2					
						4					
						13					
						8					
						22					
						13					
						6					
						10					
						2					
						1					
						4					
						2					
						1					
						7					

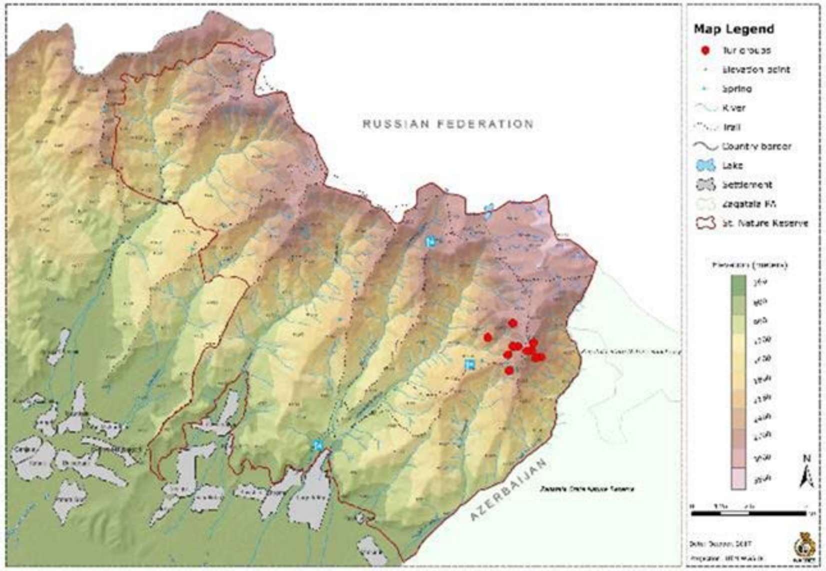
Appendix #9 – Tur group locations according to census sessions

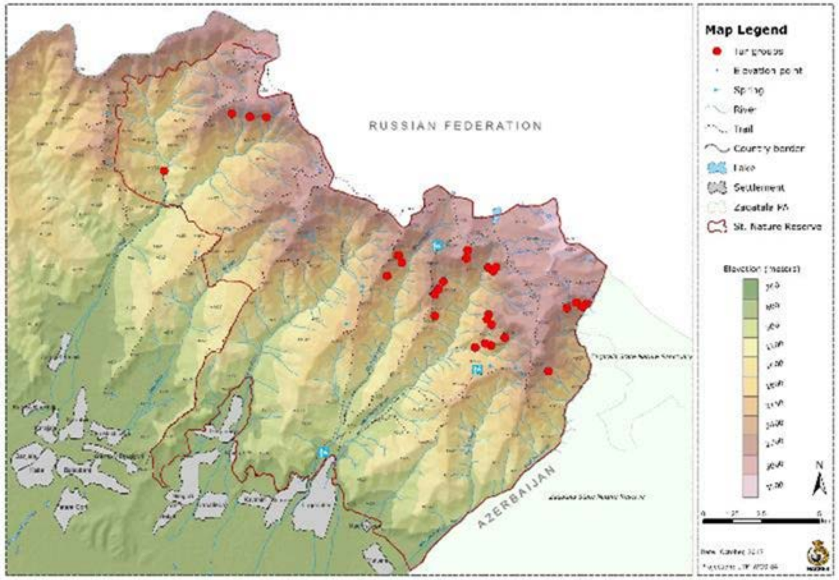
The map up, right – tur census in November;

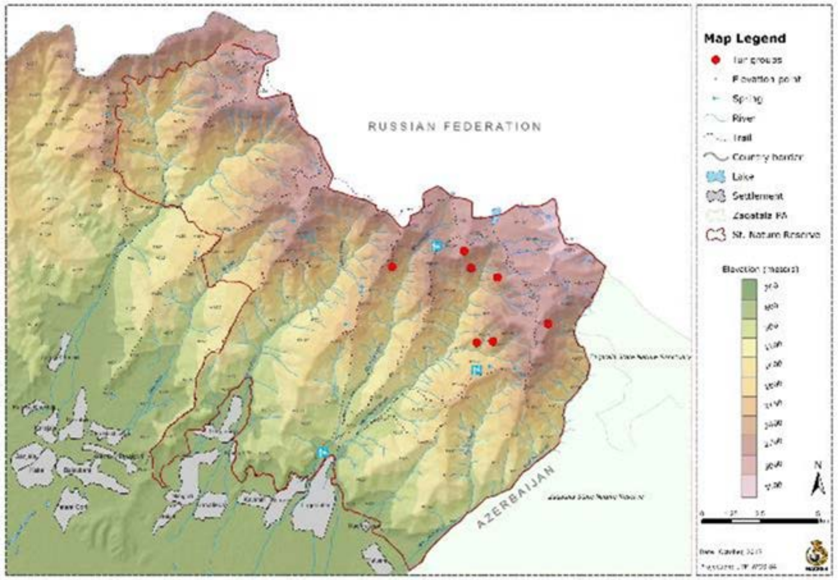
The map down, left – tur census in late May - early June;

The map down, right – tur census in July.

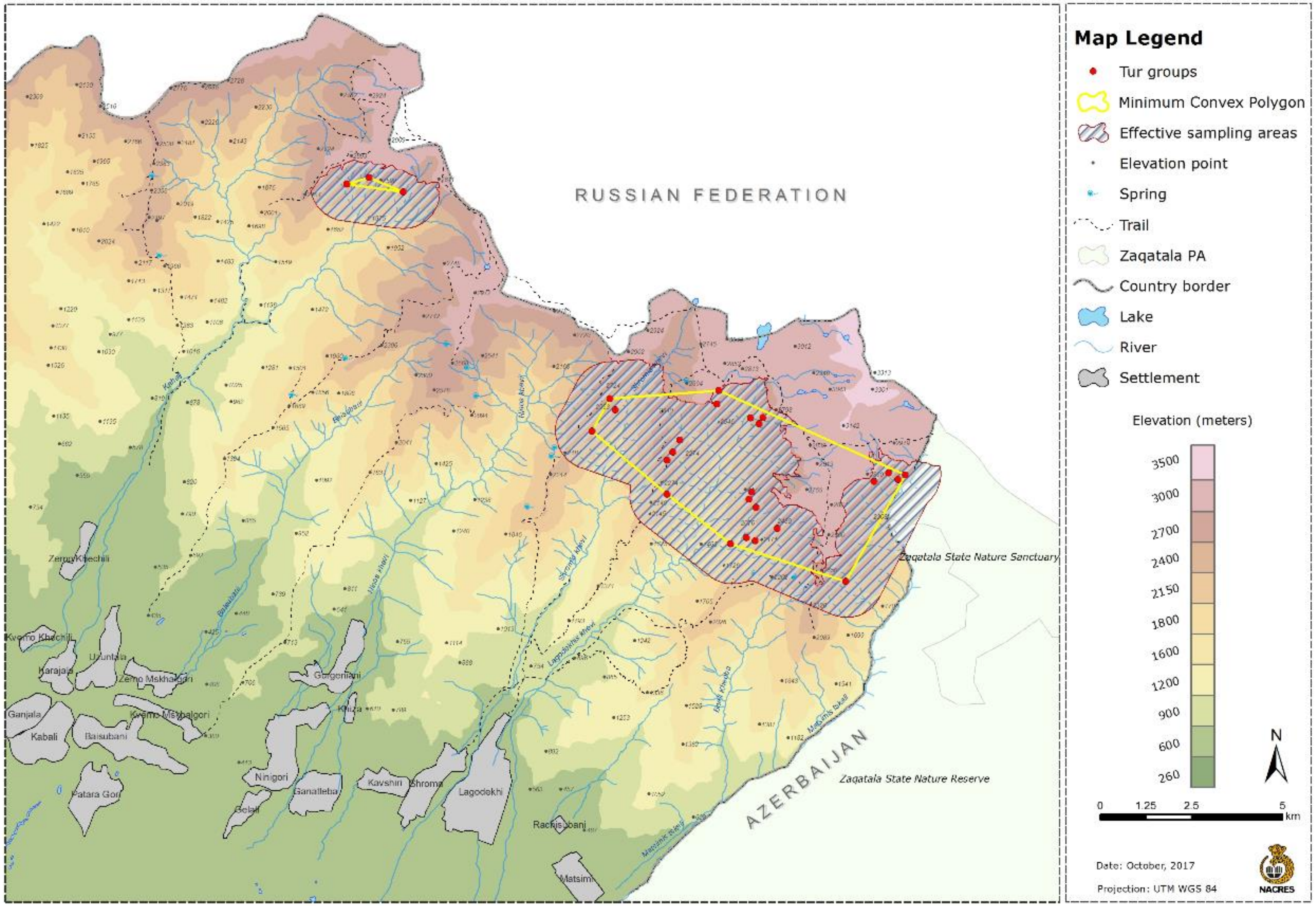
Note: Tur group locations marked with red points.







Appendix #10 – Effective sampling area



Appendix #11 – Chamois locations in Lagodekhi protected areas since 2012