ENHANCING FINANCIAL SUSTAINABILITY OF THE PROTECTED AREAS SYSTEM IN GEORGIA

TECHNICAL ASSISTANCE GRANT AGREEMENT

Monitoring of Short-listed Species Indicators in Selected Protected Areas in Georgia:

Ungulate monitoring in Adjara protected areas via intensive camera trapping

Final Report

[Draft]

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Photo on the cover: *Chamois in Mtirala NP (Camera trap photo).*

Contents

Background

As part of the GEF/UNDP project "Enhancing financial sustainability of the Protected Areas (PA) system in Georgia" (the "GEF/UNDP Project"), in May 2020 CNF commissioned a Technical Assistance to provide ***technical support to prioritize biodiversity monitoring indicators (species and habitats) for 12 target PAs in Georgia to support the development of standardized PA-specific Management Effectiveness Assessment plans (Biodiversity Monitoring Indicators)*** with agreed monitoring methodologies for each prioritized indicator. As the result of the Technical Assistance, an agreed shortlist of fauna indicators was elaborated through an intensive and participatory process that involved all leading relevant experts and key stockholders, conducted in close cooperation with the main beneficiaries – the Agency of Protected Areas (APA) and the Ministry of Environmental Protection and Agriculture (MEPA).

Ungulates such as Chamois (*Rupicapra rupicapra*) and Roe deer (*Capreolus capreolus*) were selected as a high priority indicator for the Adjara protected areas – Mtirala NP, Kintrishi PA and Machakhela NP.

1 Introduction

The monitoring of the ungulate populations − Chamois (*Rupicapra rupicapra*) and Roe deer (*Capreolus capreolus*) in Mtirala, Kintrishi and Machakhela protected areas was launched in November-December 2020. We continued the process throughout 2021 under the *Technical Assistance Grant Agreement* signed between CNF and NACRES on 21 February, 2021. According to the agreement with the main beneficiaries and following the TOR, the objective was to gather general information such as distribution of the target ungulate populations as well as any additional data on these and other species[1].

The study relied on the use of camera traps to collect data on (i) ungulate distribution, (ii) the composition of the ungulate (as well as other large mammal) community and (iii) any additional data on aspects of habitat use and daily activity in the three study areas.

2 Study areas

Kintrishi, Mtirala and Machakhela protected areas are located in the Autonomous Republic of Adjara, southwest Georgia (See Appendix #1). Mtirala and Kintrishi PAs are adjacent, creating a relatively large uninterrupted territory under protection regime. Machakhela national park borders Turkey and mostly include slopes of the Machakhela gorge.

The terrain in the three parks is rather rugged and is characterized with steep slopes and deep gorges. Khedismta mountain (2,151 m.) is the highest point in Machakhela is; in Mtirala national park it is Mtirala mountain (1,381 m.) and in Kintrishi, the highest elevation is at 2,435 m. The main river in

[1] The study did not aim at quantitative assessment of the populations since this would involve a different approach as well as more resources.

Mtirala is the Chakvistskali; the main rivers in the other two parks – the Kintrishistkali and the Machakhelastkali are excluded for the boundaries of the protected areas.

The Adjara region is characterized with sub-tropical, humid climate. Much of the study areas are covered with the unique Colchis rainforest with characteristic well-developed understory rich in endemic and relic species. This Colchis rainforest was recently designated as a UNESCO World Heritage Site.

Some parts of the forest in the study areas were heavily damaged in 1990s and early 2000s due to illegal logging. Logging reduced original beech (*Fagus orientalis*) and chestnut (*Castanea sativa*) stands, which became replaced by secondary alder (*Alnus glutinosa*) growths. Non-forested areas include settlements and agricultural lands both currently in use and abandoned. Warm and humid climate supports high rate vegetation growth and abandoned agricultural lands are quickly covered with fern and lianas. Meadows have a very limited distribution and some forested areas are used for cattle grazing. Forest surrounds settlements so tightly that in some areas the boundaries are not easily distinguishable.

There are 10 main villages in Machakhela with a total population of about 5,000. Chakvistavi is the only village at Mtirala national park with 60 residents. Village Khino is located in the middle of Kintrishi protected area and it is only occupied during the summer months.

3 Methodology

The ungulate study (focusing on chamois and roe deer) in Adjara protected areas relied on camera trapping. In late 2020, we placed camera traps on trails that were apparently actively used by ungulates and other large mammals. We made special efforts to ensure that the camera traps were distributed throughout the study areas as evenly as possible so that obtained data would help understand not only ungulate distribution but potentially their relative abundance too. In winter 2021, we critically evaluated the spatial distribution of the camera traps in order to plan any necessary changes in their locations. By placing a 2km X 2km grid over the study areas and looking at actual camera trap locations, we found certain gaps – relatively large sections of the study areas had no camera traps. We were able to redistribute the camera traps in Machakhela national park because border police roads and trails made almost all areas accessible. However, this process proved impossible in Kintrishi and Mtirala protected areas because of extremely dense, almost impenetrable understory vegetation. Unfortunately, we were able to relocate only few camera traps in those protected areas.

All camera trap data were processed and classified at NACRES office. Large mammals were visually identified and their photos were placed in relevant folders. We also created a separate folder with the name “Unknown” in which we put photos with animals whose identification was impossible. After carefully reviewing all photos, those without any wildlife were deleted from the data base.

Camera trap days give an understanding of the overall actual sampling effort. The figure is a simple sum of the numbers of working days separately calculated for each unit. This value represents the number of days a particular device had been in actual operation and it may not be equal to the number of days it had spent in the field. It is calculated by careful examination and looking through the camera

trap data because any camera could any moment simply stop collecting data due to one of the following two main reasons: (1) device malfunctioning and (2) overfilling the memory cards. Although each device was carefully checked prior and during the installation process, some still had operation problems – they simply shut down and did not collect data. We replaced such camera traps during subsequent visits to the site. Sometimes, false triggering filled the memory card and the device could no longer collect new data until we replaced the memory card . We considered the date of the last photo was taken as the last working day for that device.

Camera trap photos were translated into *independent* photos. Any consecutive two photos of the same species taken by the same unit were considered independent only when there was at least 2 minutes interval between them. This rule was obviously applied when individual identification of the animal was not possible.

In ungulates, the mean trapping rate i.e. the total number of independent photos of a species per 100 working days, is considered as a good index that is strongly related to the species density in forested habitats.[2] Therefore, such indices can be potentially used for comparing species abundance between the study areas as well as between years to monitor species population trend. We calculated trapping rate for the target species in each protected area and used these indices to compare relative densities of ungulates between Adjara protected areas.

Based on the camera trap data we were able to create maps with point data of the ungulate species in all three protected areas. We analyzed the data to look at species activity in different seasons and in some cases we were able to identify areas that appear to be preferred by ungulates. Many of the results and findings of this study have important implications for further biodiversity monitoring and effective adaptive management of the protected areas.

4 Placing camera traps

We had selected *Browning Spec OPS Edge* camera trap model for the ungulate monitoring in Adjara protected areas in autumn 2020. Among other features, the choice was made based on the compact design and camouflaged coloration that would make this camera trap less noticeable in the field; in addition, the daylight Image quality of this model is excellent both for photo and video; it also has a built-in small monitor that allows photo/videos viewing on the device. This feature is very helpful during the installation. In addition, battery life is excellent which can ensure continued data collection for a relatively long period of time.

Camera traps were installed in Adjara protected areas in December 2020 under the previous contract. Sixteen units were placed in Kintrishi protected areas, 18 In Mtirala and 17 in Machakhela national park (see Appendix #2 for map). We placed cameras on trails and forest roads that were apparently actively used by ungulates and other large mammals and made all efforts to distribute them as evenly as possible throughout the study areas.

[2] *Rovero F. and Marshall R. A. (2009) Camera trapping photographic rate as an index of density in forest ungulates.*

5 Maintaining camera traps in the field

The camera traps remained in the field throughout the winter 2021 and collected data on ungulates and other large mammals. NACRES team revisited the study areas in spring 2021.

The fieldwork began in mid April 2021 in Machakhela national park. Snow cover was still deep in the Adjara mountains. However, due to relatively low altitude of Machakhela national park we assumed that we could already access all the camera trap sites there.

With great help of the Machakhela administration's director, Mr. Giorgi Kuridze, the process of camera trap checking went very smoothly and all the units were tended in a relatively short period of time. Local rangers accompanied the NACRES team and thanks to them we were able to simultaneously work in four field teams. Even the director himself joined us in the field and guided us to certain sites. We visited all 17 units that were installed in autumn 2020. We relocated some of them and 6 new units were added in order to achieve a better coverage of the study area. As a result, a total of 22 camera traps collected data in Machakhela national park (see map in Appendix #3).

All the camera traps were brand new units that were purchased just before they were fielded. Therefore, it was a relief to see that overall they operated quite well. Most of them remained operational during the whole winter and the battery levels did not drop below 50%. On the other hand, we also found that there was a high rate of false triggering events – sometimes as high as up to 10 000 per camera and the 32 GB memory cards were full. We had to purchase an external memory disk to download all the stored data from the camera traps because our field computer was unable to store the vast volume of information.

We found that the camera traps required some adjustments – they appeared to be too sensitive and simply reacted to almost any kind of movement. Even a moving tree branch, snow or grass moved by the wind could trigger the sensor. Hence, we reduced the sensor sensitivity from *high* to *normal*. We also conducted some test shootings to select a suitable mode. We found that the fast triggering option – which was initially chosen to ensure capturing fast moving animals − also contributed to too many "empty" pictures. So we had to adjust that too. Previously the cameras were set in *the multiple shot mode* - four pictures per trigger. We found that this mode took too many photos, while bringing little added value to the data. Hence, we decided to put all the cameras in the *two-pictures-per-triggering mode*.

From Machakhela, we went over to Mtirala national park. We had a meeting with the park director, Mr. David Khomeriki and discussed possible ranger involvement and camera trap checking schedule. We also informed him about our plans to add new units in the south-eastern part of the protected area in order to achieve a better coverage of the study area. However, this had to be postponed till summer because the director informed us that those areas were still inaccessible due to deep snow. We visited and checked all the previously installed 18 units in Mtirala (see Appendix #4). Each camera was adjusted according to our new findings, reducing the sensitivity, trigger speed, and setting them in *two pictures-per-trigger mode*. The data were downloaded into the external memory device. Local rangers accompanied us most of the time and participated in the data collection process.

In Kintrishi protected areas, we were unable to meet the director, Mr. Amiran Khinikadze because he had just been hospitalized due to COVID-19 complications. We discussed our field plans with Mr. Alexandre Khabeishvili, Head of Ranger Service. We inquired about the possibility of installing additional units for better coverage of the study area. It turned out that access was still restricted to some of the areas where we intended to place new camera traps. So we decided to postpone visiting those areas till summer. We checked 14 out of 16 cameras that were installed in 2020. We had to relocate several camera traps – they had become obstructed by the vegetation. We also added one new camera trap on the trail that we found was actively used by large mammals (see Appendix #5). We could not reach two camera trap sites because on the way to those sites the river was too high and impossible to cross. Mr Khabeishvili agreed to check those units for us later and we left replacement batteries and memory cards with him.

The next field trip took place in August 2021. It was important to visit each of the installed units and assess their performance or relocate them if needed as well as to change their memory cards and batteries if they were below 50%.

We began with Kintrishi protected areas and park rangers accompanied us in the field providing a lot of help. No additional new units were installed in Kintrishi because we could not find any new suitable sites. One of the installed units was found to be not functional and the team replaced it with a new one. Two camera trap sites turned out to be inaccessible due to the fact that the trail had become totally invisible and impenetrable because of intense vegetation growth. Later park rangers were able to reach the sites. They had to relocate the two camera traps because they found that new vegetation growth had covered the view of the cameras. Subsequently, they went back to the units. They retrieved data and sent them to us via WeTransfer.

In Mtirala protected our team found that walking through the Colchic forest was even more difficult then in early spring. The trails were compactly covered with fresh vegetation including thorny plants. We had relocate some camera traps because the vegetation covered the camera's view. One of the units had been stolen. We then moved over to Machakhela national park where we checked all the units and changed memory cards.

Battery level was fine in all units so there was no need to replace them. However, because the censor sensitivity had been set too high we had many false triggering and some of the memory cards had become full well before we checked them.

Machakhela, Mtirala and Kintrishi protected area rangers removed the camera traps for us during the period from the end of November and beginning of December. They stored the units at their offices. Later we collected them and brought them back to NACRES office in Tbilisi.

After initial screening of the camera trap data, all images with people carrying hunting guns were immediately sent to the respective PA administration. (We later learnt that the park managements instantly processed and responded to the information).

6 Results

6.1 General results

The 61 camera traps installed in the Adjara parks collected huge amount of data. A total of 605,449 images were taken with a total volume of up to 1.3 TB. However, 91% of the images (i.e. 551,017 images) were a result of false triggering and only 9% (53,073 images) were triggered by animal activity within the sensor field of view. These results are summarized below (Table #1). As mentioned above, when the units were first installed in December 2020, the sensors were set at very high sensitivity. Hence the high proportion of false triggering i.e. pictures without any wildlife or human. In spring, we reduced the sensor sensitivity to a minimum and the performance of the camera traps improved. But we still had numerous images that were apparently triggered by a moving grass, etc.

We classified the data according to species. Cameras remained in the field almost a full year, but they were not active the whole time. On average each unit was active for 261 days, more specifically 277 days in Mtirala, 255 days in Kintrishi and 252 days in Machakhela.

Table #1. *Numbers of photo images by study area*

Protected areas	Number of Cameras	Number of photos
Kintrishi national park	18	53,356
Mtirala national park	18	289,412
Machakhela national park	23	262,681
Total	*61*	*605,449*

6.2 Camera trap data and human activity

Human and human related activities were quite intense in the protected areas. Humans and/or domestic animals (cattle, dogs, horses, etc.) appeared on 33,579 photos in all three protected areas combined (Table #2). Human presence is high in the three protected areas and the above high rate of human/livestock appearance in the camera trap data was not unexpected. All values are the highest for Machakhela NP, which is not surprising as the PA is surrounded by as many as 10 villages. In Machakhela, local livestock (cattle, goats, sheep) use small openings in the forest for grazing. Livestock grazing In Kintrishi is seasonal and the rate of domestic animals' appearance on camera trap data is relatively low. No livestock were captured by camera traps in Mtirala national park. Locals *do* keep small number of cattle in Chakvistavi village but they do not appear to go far from the village.

Table #2 *Humans and domestic animals on camera trap images*

Species / Protected Areas	Kintrishi	Mtirala	Machakhela	Total
Cattle, goats, sheep, horses	651	0	17,633	**18,271**
Other domestic animals (dogs, cats)	75	245	1,652	**1,985**
People (including rangers and border police)	1,868	2,966	8,541	**12,867**
Total	***2,594***	***3,159***	***27,826***	***33,579***

Dogs were commonly captured by the camera traps in Mtirala. Some of them looked like some kind of hunting breed (scent hounds). No human companion was recorded with them. Dogs were also

widely detected in Machakhela, but they appeared to be mostly accompanying herders or park rangers.

6.3 Wildlife

Camera traps captured a total of 22,236 images of wildlife (Table #3). The category "unknown" (335 images in total) includes night time pictures in which species identification was not possible. There is a high proportion of birds – 1,040 images in total. Some birds such as Eurasian jay (*Garrulus glandarius*), common blackbird (*Turdus merula*) apparently got very curious in camera traps and we have numerous close-up pictures of them. Tawny owl (*Strix aluco*) was repeatedly captured by camera traps while hunting or resting nearby. Small mammals, such as hedgehogs and squirrels are also quite common in the trap data (Table #3).

Table #3 *Wild animals in camera trap images*

Species / Protected Areas	Kintrishi	Mtirala	Machakhela	Total
Ungulates				
Chamois (*Rupicapra rupicapra*)	10	46	33	89
Roe deer (*Capreolus capreolus*)	213	1,153	822	2,188
Wild boar (*Sus scrofa*)	632	557	9,110	10,297
Carnivores				
Brown bear *(Ursus arctos*)	1,203	754	1,668	3,625
Wolf (*Canis lupus*)	29	10	0	39
Lynx (*Lynx lynx*)	18	14	20	52
Golden jackal (*Canis aureus*)	668	111	1,976	2,755
Badger (*Meles meles*)	58	38	116	212
Wild cat (*Felis silvestris*)	30	10	96	136
Marten (*Martes Spp.*)	367	426	255	1,048
Other				
Hedgehog (*Erinaceus concolor*)	26	102	10	138
Squirrel (*Sciurus spp.*)	127	3	146	276
Birds (all species)	320	215	505	1,040
Unknown	129	43	163	335
Total photos				***22 236***

***Photo #1**. Golden jackal in Kintrishi PA*

6.3.1 Ungulates

Ungulate data in all three protected areas combined were collected during a total of 15,368 camera trap days. Machakhela NP had the largest number of camera traps (23 cameras) of the three study areas, hence the highest number of camera trap days − 5,789. For Mtirala and Kintrishi PAs we had 4,988 and 4,591 camera trap days respectively.

The camera traps captured images of both target ungulates − chamois (*Rupicapra rupicapra*) and roe deer (*Capreolus capreolus*) as well as of wild boar (*Sus scrofa*) in all three protected areas.

6.3.1.1 Chamois (Rupicapra rupicapra)

We obtained 46 photos of chamois from Mtirala national park, 33 photos from Machakhela and 10 from Kintrishi. The locations of the camera traps that captured images of chamois are shown in Appendix #6. The lowest elevation of those locations was in Mtirala, 639 m and the highest in Machakhela 1,360 m. After translating the data into independent photos, there are only 3 independent chamois photos from Kintrishi, 6 from Machakhela and 15 from Mtirala national park. The highest chamois trapping rate was observed in Mtirala national park − 0.3 independent photos per 100 trap/days (see Table #4)

***Table #4.** Summary of chamois images in the trapping data.*

	No. of chamois photos	**No. of independent chamois photos**	**Chamois trapping rate** (No. of ind. photos per 100 trap/day)
Kintrishi	10	3	0.07
Mtirala	46	15	0.3
Machakhela	33	6	0.1

In all parks, chamois photos were taken during the period from March through December with a distinct peak number during the summer for Mtirala national park (Figure #1). In Kintrishi and Machakhela protected areas, chamois images were captured on trap cameras only in winter and spring. Most of the chamois images were taken during the day.

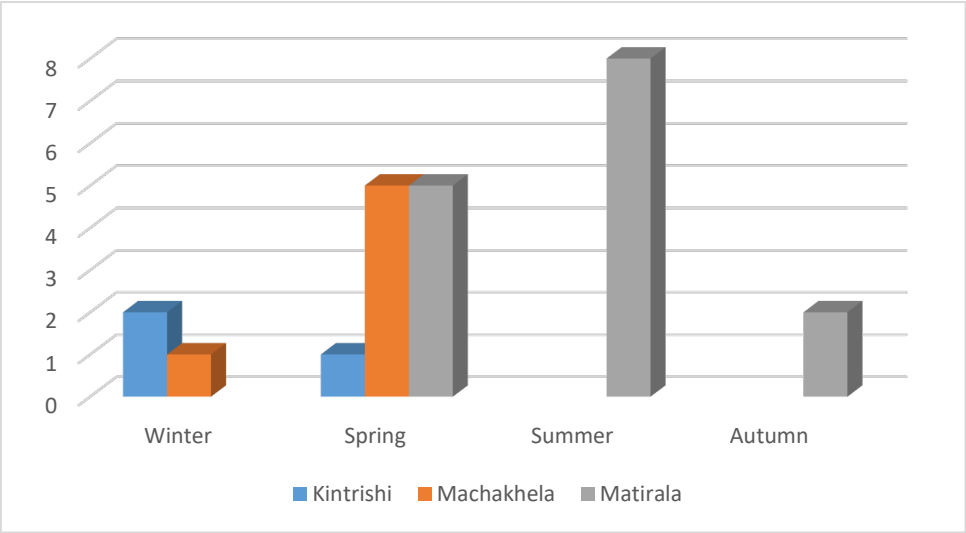


Fig. #1. *Independent chamois photos in different seasons*

Photo #2*. Chamois in Mtirala NP.*

6.3.1.2 Roe deer (Capreolus capreolus)

A total of 2,188 photos of roe deer were taken by the camera traps in the three protected areas with the highest number taken in Mtirala − 1,153 photos.

Mtirala also had the highest number of independent photos (333) and hence that of roe deer trapping rate – 6.68. (Table #5)

Table #5. *Summary of roe deer images in the trapping data.*

	No. of roe deer photos	**No. of independent photos**	**Roe deer trapping rate** (No. of ind. photos per 100 trap/day)
Kintrishi	213	60	1.31
Mtirala	1,153	333	6.68
Machakhela	822	182	3.14

The distribution of roe deer data is more even throughout the study areas as compared to the more restricted distribution of chamois data (Appendix #7). While there is a variation from zero to numerous in roe deer photo numbers taken by a single camera trap in all three parks, in Machakhela *every* camera trap took roe deer photos. The map in Appendix #8 shows camera trap units weighted with roe deer trapping rate – the darker locations probably indicate species preference of the habitat.

Photo #3. *Roe deer in Mtirala PA.*

Most of the roe deer photos were taken in spring and summer. Seasonal pattern is especially obvious in the Machakhela and Mtirala data (figure #2) with a distinct summer peak for Mtirala and low photo trapping rate in winter and autumn for all parks.

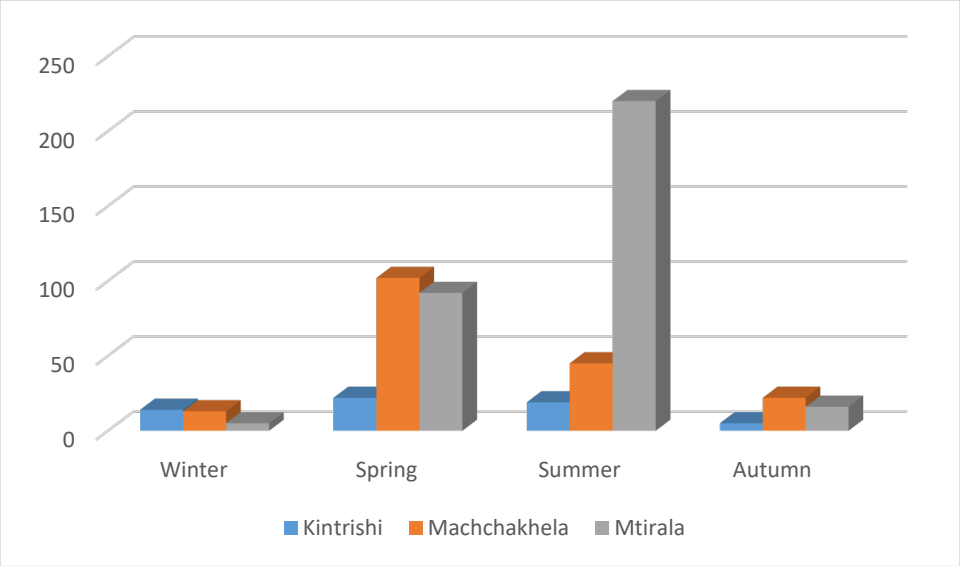


Fig. #2. *Independent roe deer photos in different seasons*

6.3.1.3 Wild boar (Sus scrofa)

The number of wild boar images in our camera trap data is the highest of all ungulates with a total of 10,297 photos. The majority of the images (9,110 photos i.e. 89%) is from Machakhela protected areas. Every single unit in Machakhela captured this animal, while wild boar data distribution in Kintrishi and Mtirala are more clumped (see Appendix #9).

Photo #4. *Wild boar in Mtirala NP.*

6.3.2 Large and medium-sized carnivores

Our camera traps captured numerous images of brown bear (*Ursus arctos*), golden jackal (*Canis aureus*), wolf (*Canis lupus*) and Eurasian lynx (*Lynx lynx*) in all three protected areas (Figure #3). Interestingly, there was no image of red fox (*Vulpes vulpes*). Brown bear dominates the camera trap data. In Kintrishi bear photos even outnumber those of all ungulates combined. While present in the trap data from all three parks, lynx photo trapping rate is very low with most pictures taken during the winter.

Photo #5. *Brown bear in Kintrishi PA.*

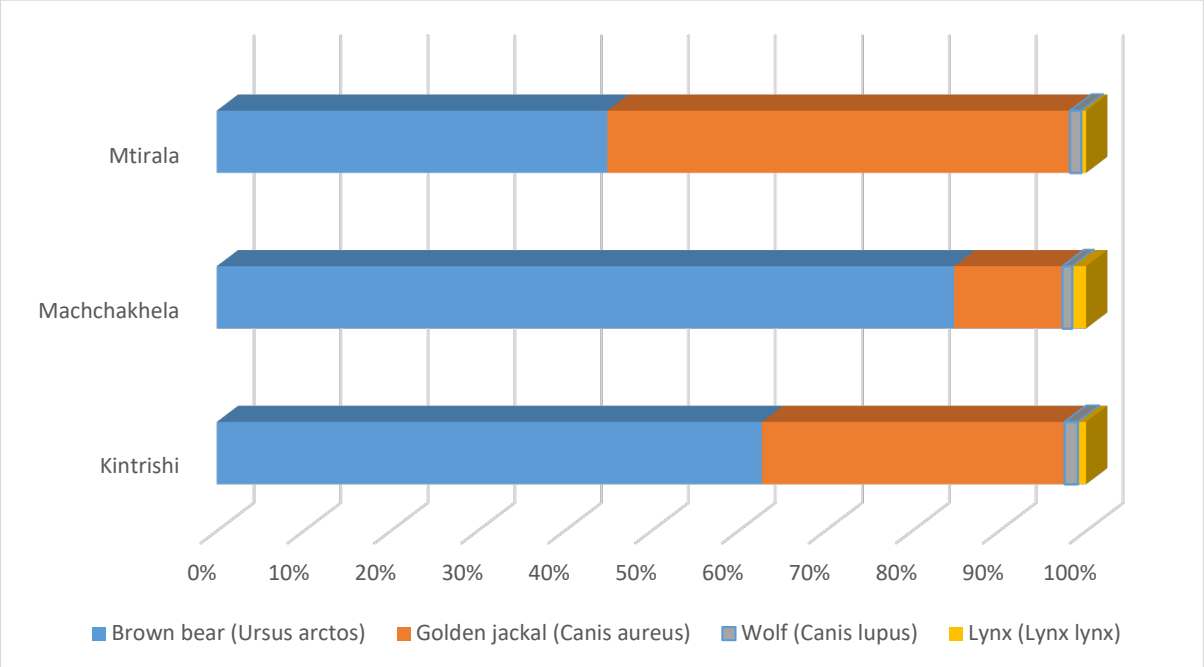


Figure #3. Images percentages of large carnivores by protected area

7 Discussion

Our camera trap data are most complete for Machakhela national park in which we were able to achieve even distribution of camera trap units (one unit per 2 km X 2km grid cell). Camera trap distribution was less even in Mtirala and in Kintrishi we were only able to place camera traps along the Kintrishitskali gorge (because other areas were not accessible). This limitation of the study must have significantly affected the results for that PA. Had there been a better coverage of the study area, the camera trapping rate for the target species including chamois could have been much higher.

Our trap cameras were active 261 days on average. They collected huge amount of data. As much as 63% of activities in front of the camera traps belonged to humans or human related activities. Relatively high human presence was expected in all three study areas because there are villages adjacent and even inside the populated areas; the three parks are very popular destinations and receive thousands of visitors each year. Machakhela NP, in addition is on the state border with Turkey and the border police regularly patrols the area. Not surprisingly the highest number of visitors were captured on the camera traps in Mtirala, the most visited park in Adjara. Livestock activity, on the other hand, was highest in Machakhela.

While the exact relationship can not be known at this point, we believe that the camera trap rate for a particular species *does* correlate with its density in Adjara protected areas and, therefore, could be used as an *index* of the overall status of the species.

The chamois is the rarest ungulate in Georgia and one of the rarest large mammals in Adjara protected areas. The species camera trapping rate was very low. It appeared only on few cameras in the study areas (Appendix #6). However, as mentioned above, we would probably have obtained more chamois photos if camera traps had been more evenly distributed in Kintrishi (which was not possible due to accessibility issues). Nevertheless, this study has indicated that camera trapping can be used as a suitable technique for the monitoring of chamois population trends in Adjara protected areas (probably elsewhere too). Notably, it is not necessary to conduct a year round camera trapping. It is probably sufficient to do it during the spring season and the results of subsequent monitoring can be compared with the baseline established by this study. It would be important to standardize the approach including by using the same 2 X 2 km grid in all three protected areas.

Based on the camera trapping rate we can conclude that, while rather widespread, the roe deer is most abundant in Mtirala national park, but more evenly distributed in Machakhela protected areas. The species trapping rate is lower in Kintrishi, but the above-mentioned gap in camera trap distribution might have affected this result.

According to our data, roe deer appears to be most active during spring and summer seasons. Fewer photos were taken during the winter. Deep snow cover probably restricted the ungulate movement. In Mtirala NP, roe deer appear to especially prefer areas around Mtirala mountain and the headwaters of Korolistrkali river (Appendix #8) that can be classified as local roe deer hotspots. Fewer roe deer photos were taken in areas that have relatively high tourist activity such as to the south of Chakvistavi village. In Machakhela the highest trapping rates were recorded in the southern part of protected areas as well as in the north, near Mtavarangelozi viewpoint.

Reo deer monitoring can be conducted via camera traps in spring together with chamois monitoring activities.

There are relatively few wolf photos in the trap data from all three protected areas. In Machakhela, only one unit captured wolf images. Notably, that camera trap was installed near a farm and it also took numerous photos of livestock. A map showing the locations of camera traps that took wolf photos can be found in Appendix #10.

The Eurasian lynx, one of the most elusive and low-density carnivores in Georgia, was captured by the camera traps in multiple locations in all three study areas (Appendix #11). As expected most of those images are from the period from December to early spring, the season during which individuals become particularly active covering long distances in search of a mate. However, there are also lynx images from Kintrishi and Mtirala that were taken in summer. **By comparing skin patterns we identified one resident individual (because it remained on the territory throughout summer), possibly a female, in photos taken in Kintrishi and Mtirala in summer.** This individual moved from Kintrishi to Mtirala covering at least 23 km in 5 days. Later it went back to Kintrishi – the individual appeared on one of the cameras there in fourteen days.

Photos 6 and 7: *Phots of the same individual of lynx taken in Kintrishi on17.06.2021 (left) and in Mtirala on 22.06.2021 (right).*

According to our camera trap data, the brown bear is one the most widespread species in the target protected areas (Appendix #12). Almost every camera trap in each protected area had bears and the trapping rate was rather high both in Machakhela and Kintrishi and only slightly lower in Mtirala. Presently, the relationship between the camera trapping rate and the real population density is unknown. This correlation can be established by conducting an independent population assessment using a robust technique such as noninvasive genetic method, after which it may be possible to continue with the much cheaper camera trapping option for brown bear monitoring in Adjara PAs.

Interestingly, no red fox photos were obtained. Although this carnivore it listed as common in the Adjaria mammal list. Fox photos are usually very common in any camera trap data in eastern Georgia and its absence from the data of this study is very unusual. This cannot be explained by technical reasons since most units *did* capture animals of all sizes. Perhaps, red fox density is very low in all three study areas. But this in turn is very difficult to explain; one possible theory could be the potential interaction with the increasing golden jackal population.

8 Threats

8.1 Poaching

Poaching is the most important threat to the ungulate populations in Georgia both inside and outside protected areas. This is particularly true for chamois whose numbers are very low throughout the country including protected areas.

All camera trap photos that had suspected poachers were forwarded to the respective protected area administration who immediately and effectively responded.

Photos, of both Machakhela and Mtirala rangers were repeatedly taken by the cameras while performing their duties i.e. patrolling on the trails as well as clearing vegetation in front of the cameras.

8.2 Hunting dogs

Unaccompanied dogs could cause disturbance to local wildlife. They may chase and even kill wild animals. We had especially high number of dog images including hunting scent dogs from Mtirala. Those dogs were not accompanied by humans and the analysis of the sequence of the pictures indicated no hunting activity. Two possibilities may be considered: (a) the dogs were indeed on their own wandering around or (b) their accompanies persons purposefully avoided the cameras. There are dog pictures from Machakhela too but most of the dogs were just accompanying livestock or humans including rangers and locals.

8.3 Climate change

It has been suggested that climate change has a significant impact on chamois and other mountain ungulates. Rising temperatures could affect high elevation vegetation, which in turn may cause changes in the distribution of mountain ungulates such as chamois (*Rupicapra rupicapra*) and even affect their survival[3]. **Therefore, chamois monitoring should continue in order to establish the population trend and, if necessary, adapt management through any possible effective mitigation measures including increasing the population's resilience.**

9 Lessons learned, Recommendations

As mentioned earlier, very sensitive sensors of the camera traps resulted in a large number of false triggering and contributed to huge overall number of photos. In some locations, this issue affected data collection as memory cards became full very quickly and cameras could no longer take and store new pictures. It is therefore advisable that each camera trap be visited at least every month to ensure that the camera traps remain operational throughout the study.

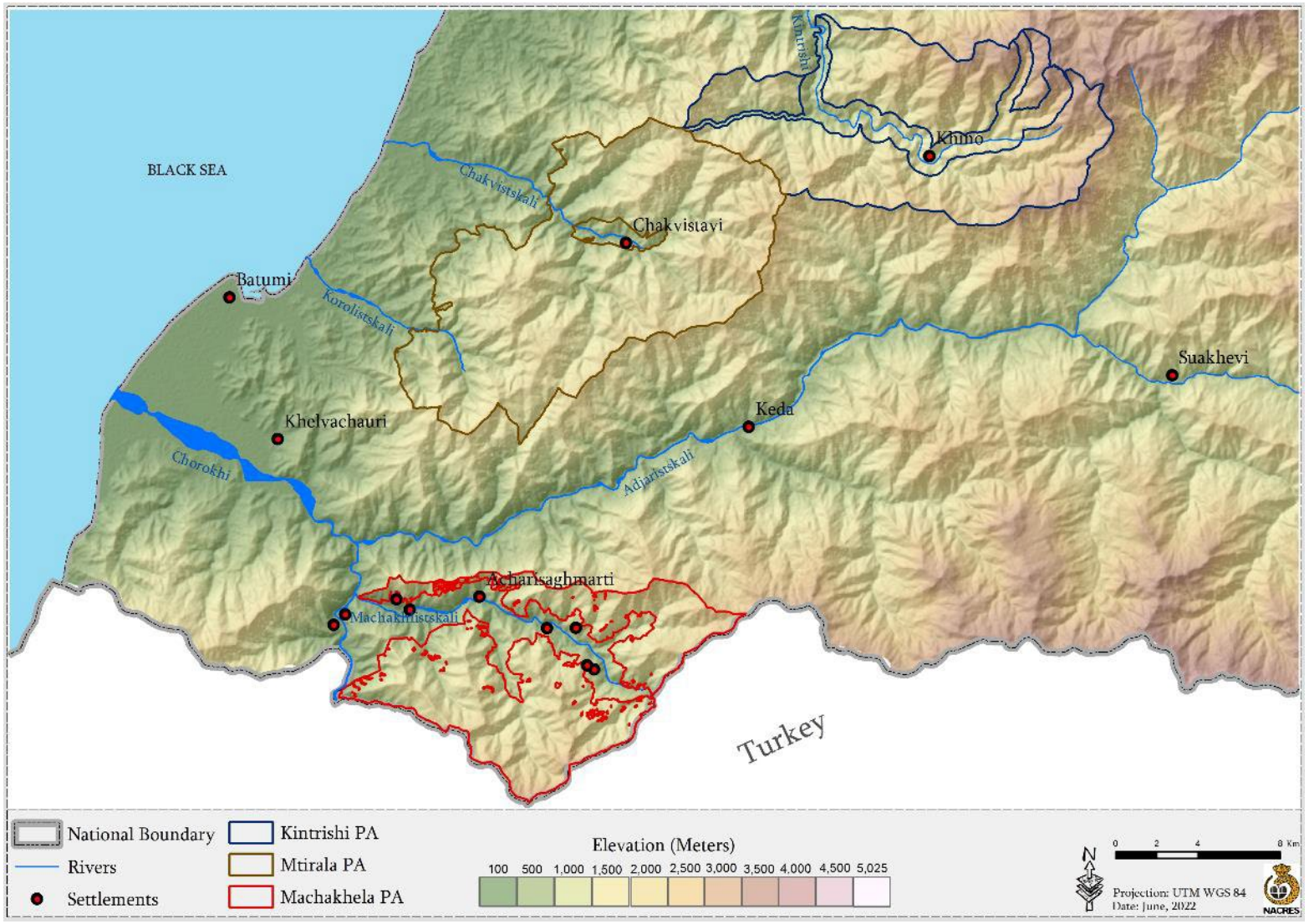
[3] Lovari, S., Franceschi, S., Chiatante, G. *et al.* Climatic changes and the fate of mountain herbivores. *Climatic Change* **162,** 2319–2337 (2020). https://doi.org/10.1007/s10584-020-02801-7

The following are specific recommendations for subsequent monitoring activities and improved management in Adjara PAs:

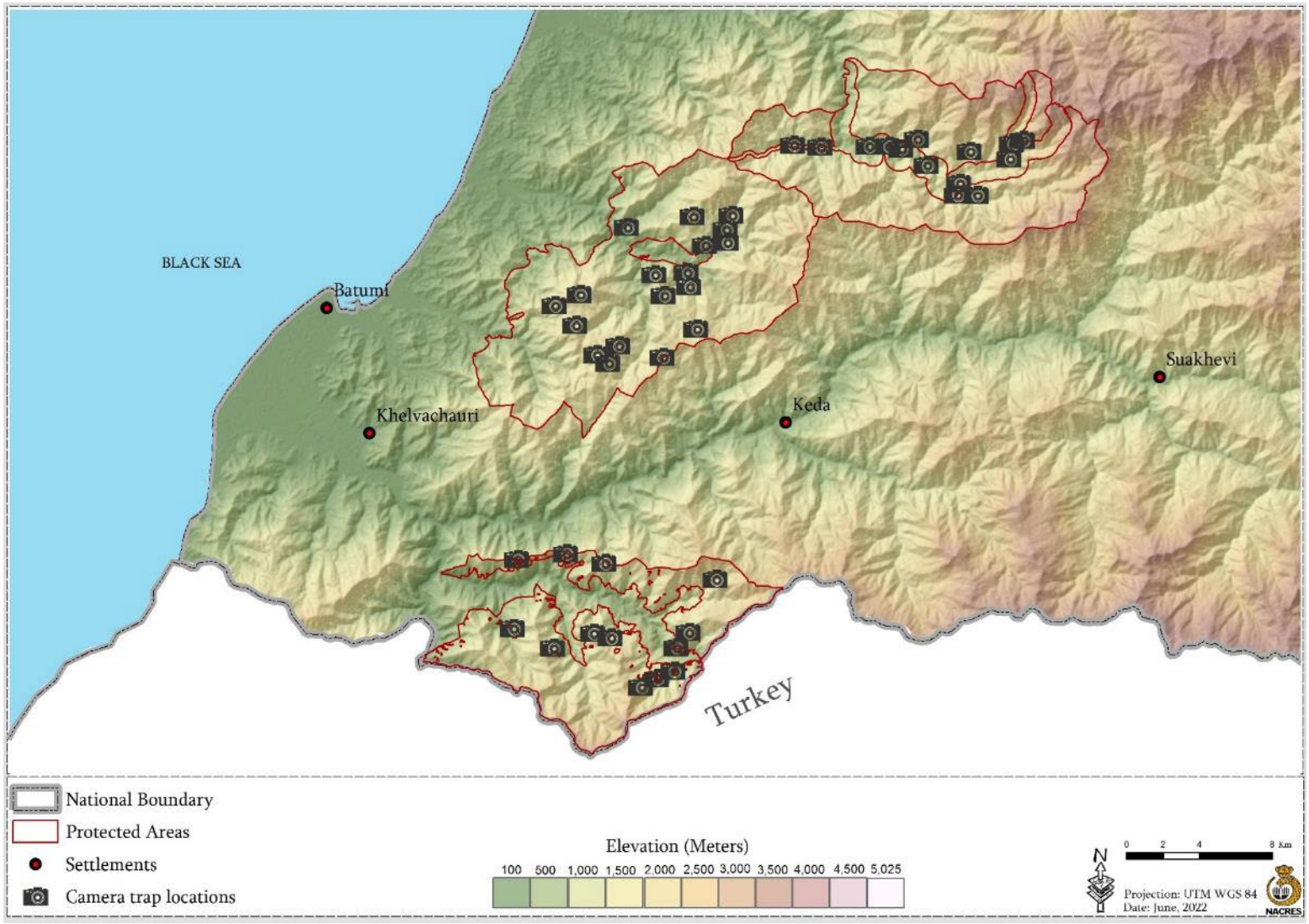
- Repeat camera trapping study in the three PA in 4-5 years;
- For the monitoring of chamois and roe deer population trends it is sufficient to conduct a three-month study during spring in which camera traps will be visited and checked at least once per month;
- A specialised study should be conducted to understand the absence of red fox in the current camera trap study data;
- If brown bear population assessment using noninvasive genetic method is conducted soon i.e. in 2023 it may be possible to establish the correlation between the camera trapping rate and the real population density and subsequently use camera trapping as an *index*.
- The presence and movement of dogs should be restricted/controlled in all three parks, especially in Mtirala.
- Law enforcement capabilities should be further improved in all three parks so that the local administrations are able to provide even better protection, especially in the winter months during which time illegal hunting risks appear to increase.

APPENDICES

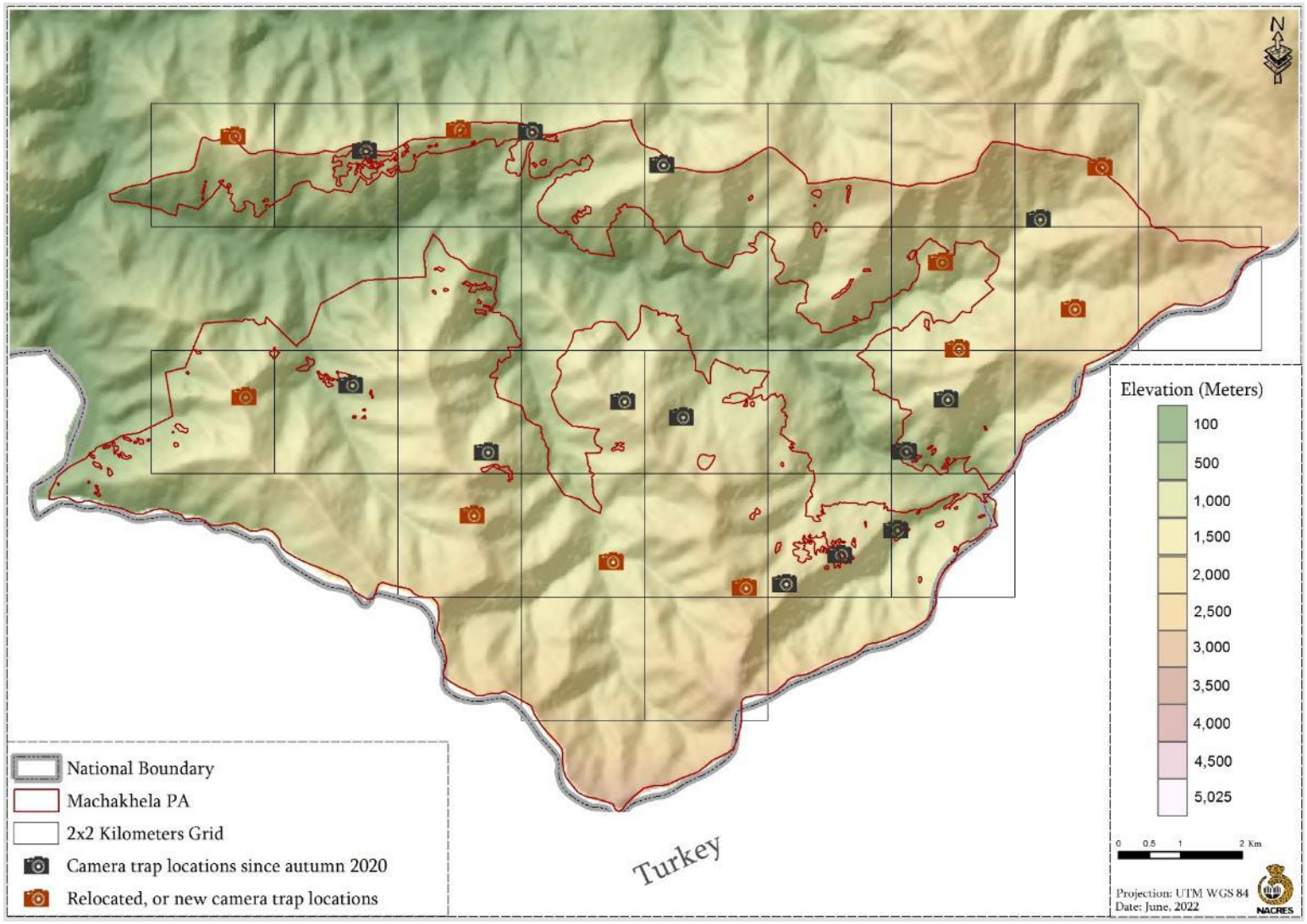
Appendix #1. Study Areas



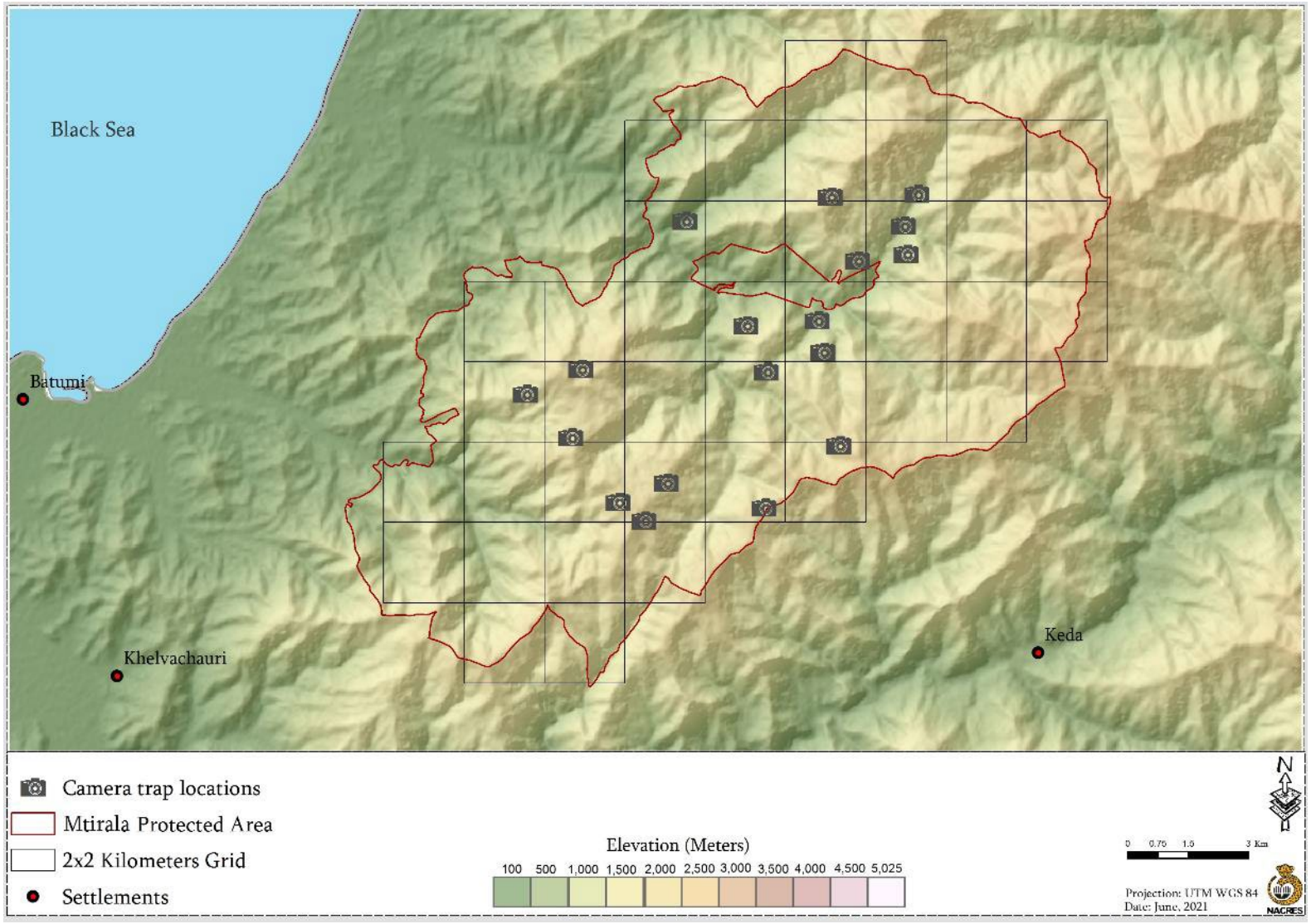
Appendix #2. Camera trap locations on Adjara PAs, 2020



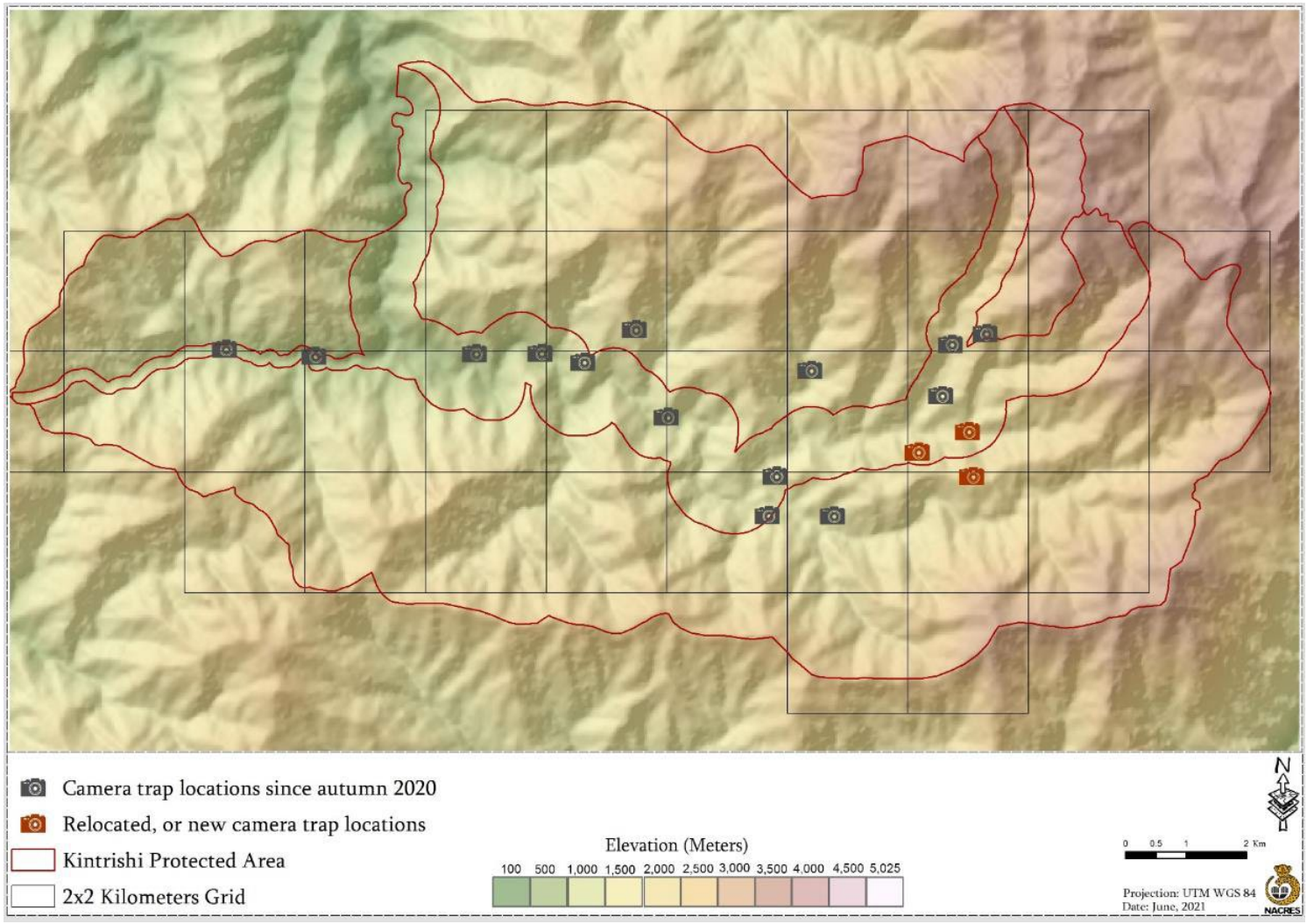
Appendix #3. Camera traps in Machakhela national park, 2021



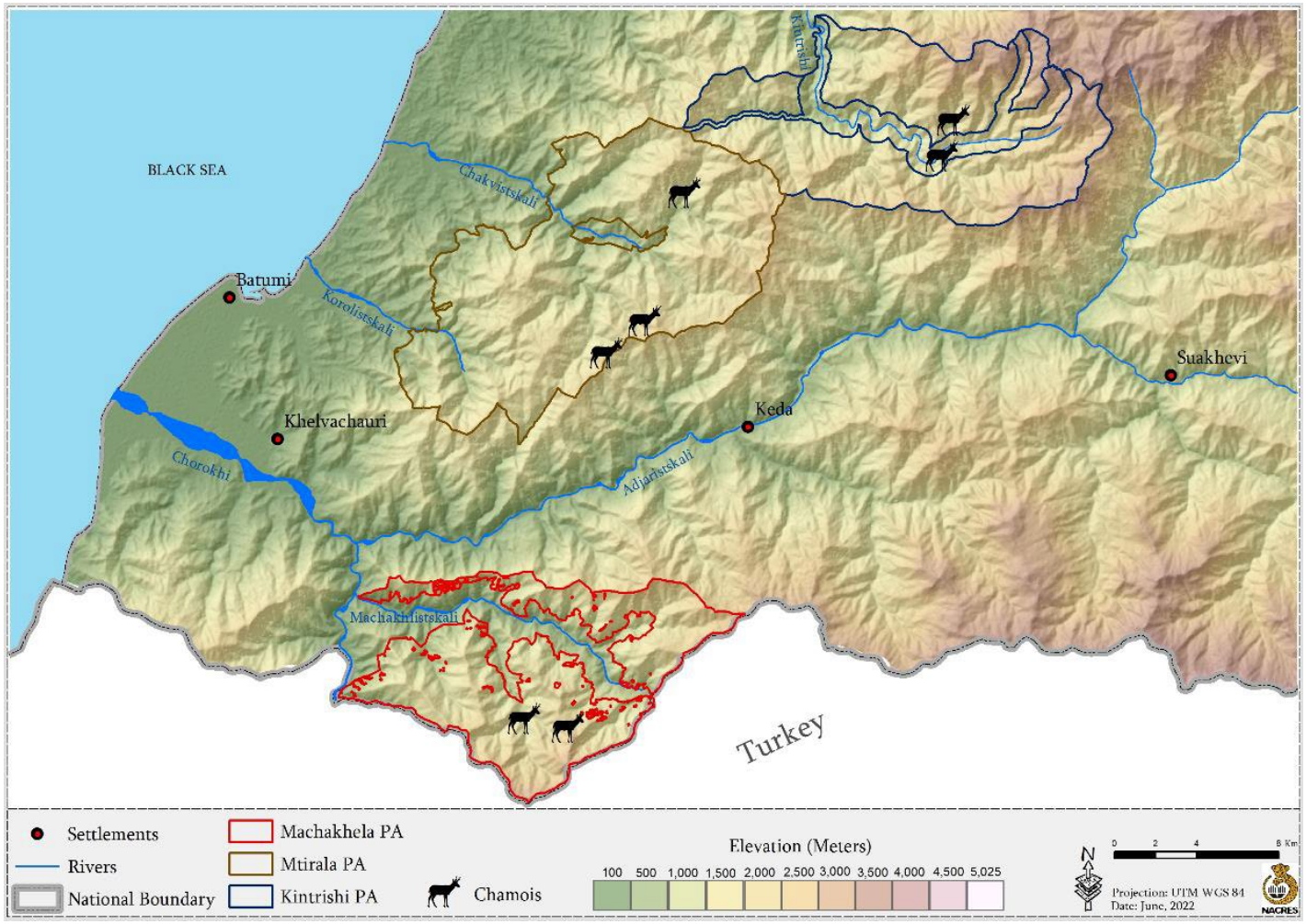
Appendix #4. Camera traps in Mtirala national park, 2021


Black Sea
Batumi
Khelvachauri
Keda
Camera trap locations
Mtirala Protected Area
2x2 Kilometers Grid
Settlements
Elevation (Meters)
100 500 1,000 1,500 2,000 2,500 3,000 3,500 4,000 4,500 5,025
N
0 0.75 1.5 3 Km
Projection: UTM WGS 84
Date: June, 2021
NACRES

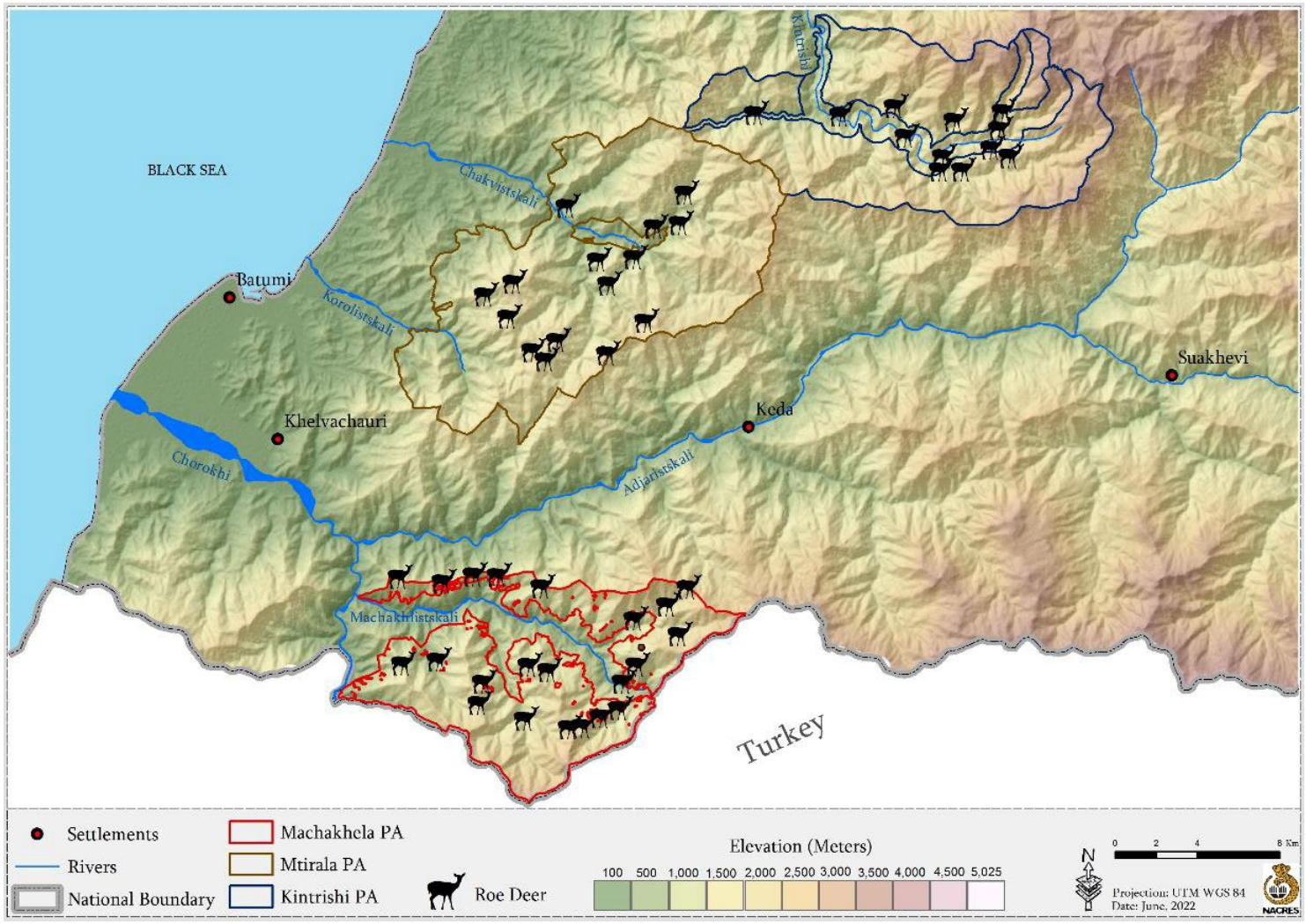
Appendix #5. Camera traps Kintrishi national park,2021



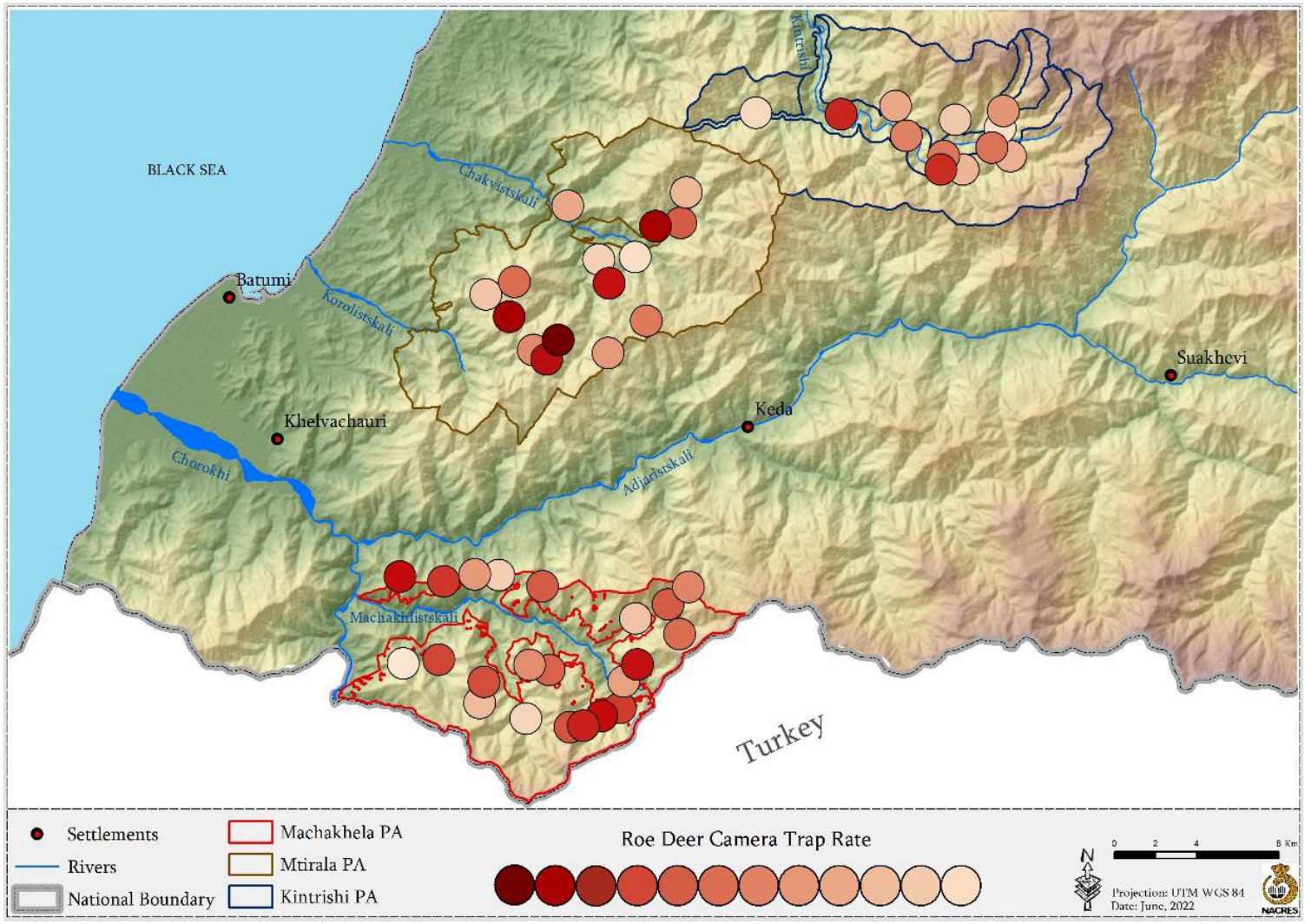
Appendix #6. Chamois locations in Adjara protected areas



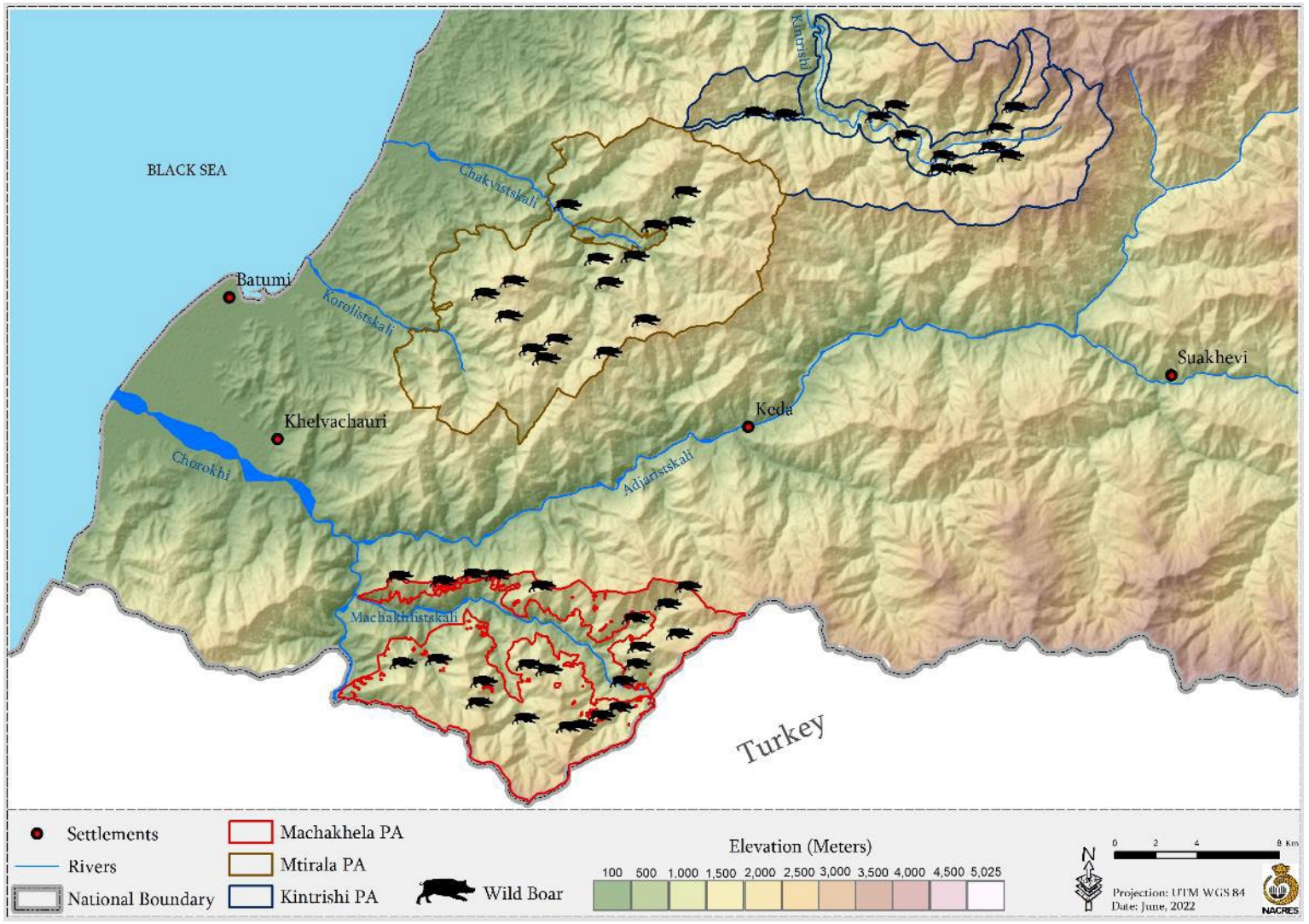
Appendix #7. Roe deer locations in Adjara protected areas



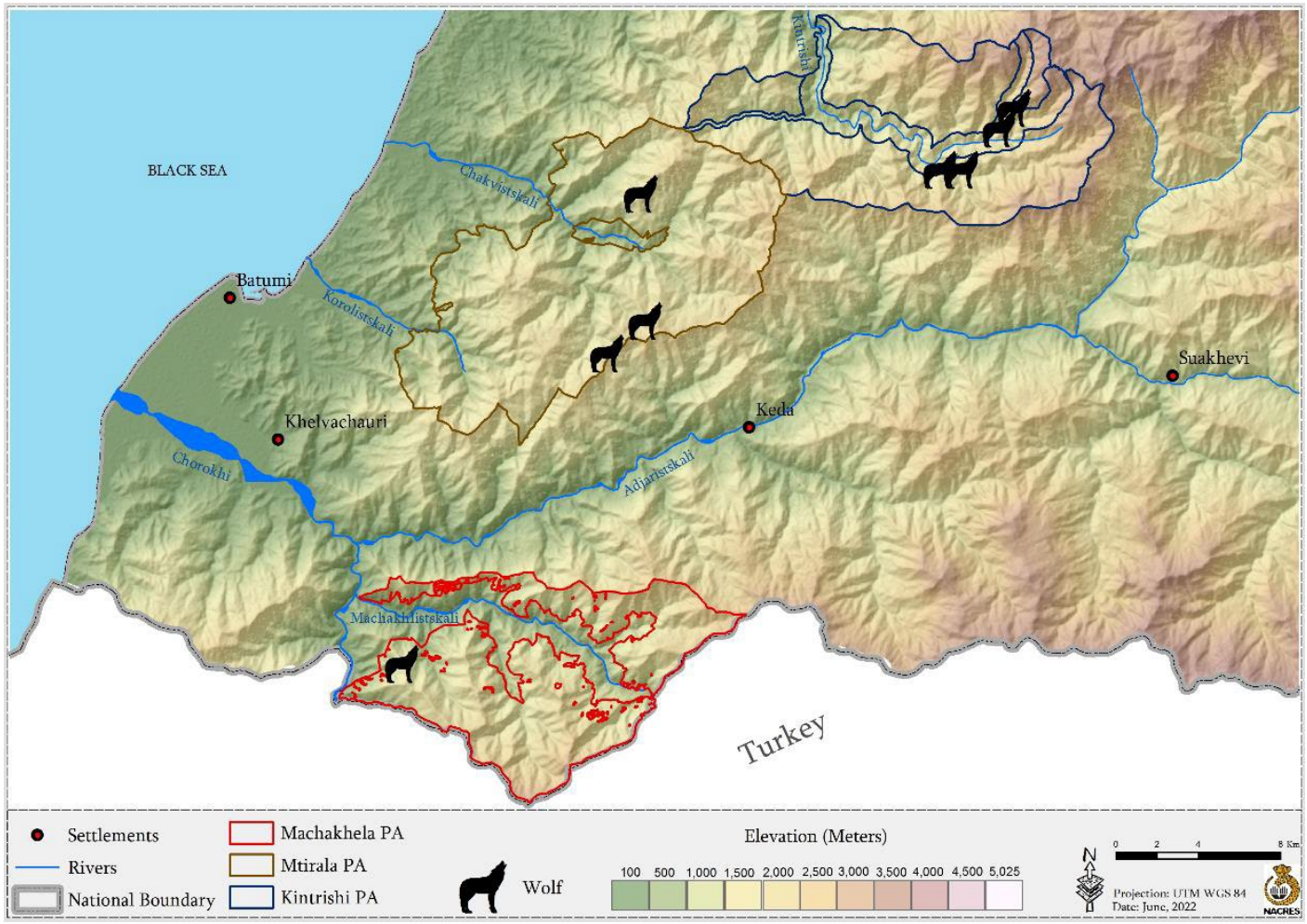
Appendix #8. Roe deer habitat preferences in the study areas



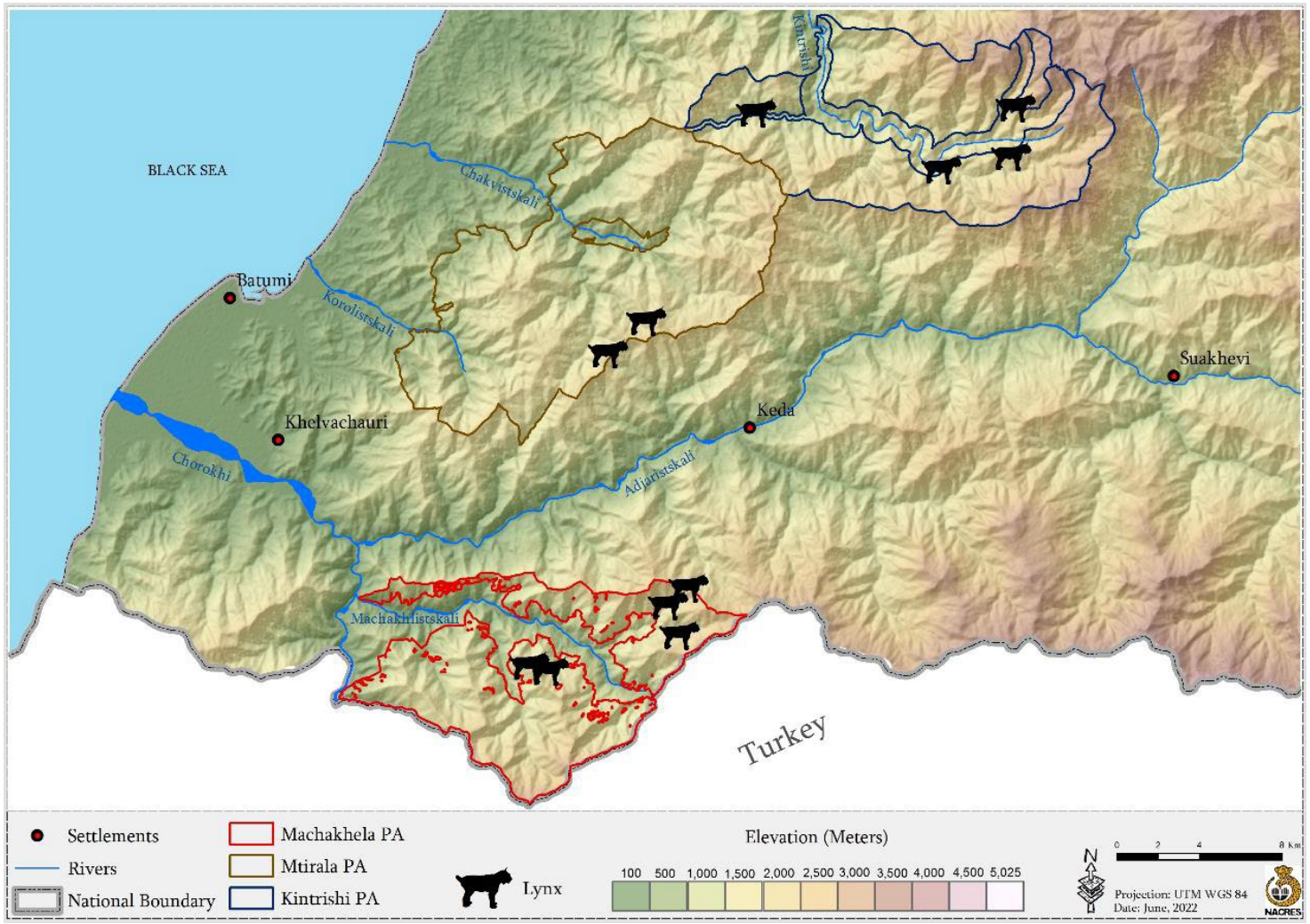
Appendix #9. Wild boar locations in Adjara protected areas



Appendix #10. Wolf locations in Adjara protected areas



Appendix #11. Lynx locations in Adjara protected areas



Appendix #12. Bear locations in Adjara protected areas