

Preliminary assessment of Chvizhepse and Sochi complex for potential recovery of Persian leopards

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Abstract. During the realization of The Program for Reintroduction of the Leopard in the Caucasus in Russian Federation the mountain landscapes of the Western Caucasus within the boundaries of the historical habitat of the *Panthera pardus saxicolor* were explored. On the border of the Caucasian State Reserve and the Sochi National Park (Russia), we selected the area (50 km²) covered by mountain forests (95%). The most common tree species are: *Fagus orientalis* (40.9%), *Quercus pubescence*, *Quercus petraea*, *Quercus iberica* and *Quercus hartwissiana* (24.6%), *Buxus colhica* (1.4%), *Castanea sativa* (13.6%), *Carpinus betulus* and *Carpinus orientalis* (8.4%), and *Alnus glutinosa* (3.3%). We have revealed the presence of the following potential prey species: 3 individuals of *Sus scrofa*, 35 ones of *Cervus elaphus maral*, 20 – of *Capreolus capreolus*, and 12 – of *Rupicapra rupicapra caucasica*. Also we have noted that there are *Lepus europaeus*, *Meles meles*, *Nyctereutes procyonoides*, and *Procyon lotor* on the studied are. Based on the natural land' capacity, the population density of potential prey species has growth potential. The results showed that the territory has a high potential not only for periodic visits, but also as one of the permanent habitats of the leopard.

1. Introduction

Leopard (*Panthera pardus*) has a wide geographic range, remarkable adaptability, and hidden lifestyle contributed to a mistaken belief that this species cannot be seriously threatened [1]. Many researchers note that several subspecies and regional leopard populations are threatened with extinction [2-4]. Besides, the overall decline in the leopard range is greater than the average decline for large terrestrial carnivores [5]. Human-mediated mortality constitutes a major threat to species persistence, particularly for widespread carnivores that undergo harvest and population control, such as leopard [6]. That is why top predators are seen as keystone species of ecosystems. Knowledge of their habitat requirements is important for their conservation and the stability of the wildlife communities that depend on them.

It is a priority that international collaboration secures the leopard's conservation in the wider landscape spanning the borders of Caucasian countries [7]. The Russian program to for Reintroduction (Restoration) of the leopard in the Western Caucasus [8] is one of the key points in this international priority.

The Russian program for Reintroduction (Restoration) of the Leopard in the Caucasus dictates the need to find and prepare additional areas for the formation of local leopard groupings. Increasing well-managed protected area coverage in other regions has demonstrated that this can contribute to leopard



population recovery [9]; therefore, providing additional migration routes in the Western Caucasus region is an urgent task.

Since the territory of the upper reaches of the Chvizhepse and the Sochi rivers lies within the boundaries of historical habitat of the Persian leopard *P. p. saxicolor*, the goal of the research is to examine potential suitability of the region's landscapes for permanent or temporary leopard's habitats.

2. Experimental part

In this work we had two main data sources: Chronicle of the nature of the Sochi National Park (Russia), 2003-2015 and the data collected during a full-scale survey of the landscape. Field studies was conducted in September 10–20, 2016, and covered the upper part of the Sochi river basin from the confluence with the river Agva to the Chernye Skaly area, within the boundaries of the Sochi National Park, and the Agva river basin from the confluence of the Sochi river to the Borodavka, Sakharnaya and Amuko upper mountains.

The research transects method was used to assess the state of the landscape. At the same time, to assess the structure of mammal populations, research transects were laid to cover several high-altitude zones and types of landscape, taking into account the peculiarities of daily and seasonal movements of animals. GPS coordinates of species occurrence and their signs of their life were noted with the help of satellite receivers to determine the geographical coordinates, which made it possible to assess the spatial structure of their populations.

Besides the method of assessing the state of wildlife populations using camera traps was used. The survey method, during which local rangers of the National Park recorded features of seasonal occurrence of wild animals, hunting sites, cases of poaching and cases of conflict situations between predator and humans, was also important. The result of the work was a comparison of obtained data and allocation of the territory, which was potentially suitable for the habitat of the Persian leopard, with the necessary recommendations.

3. Results and discussion

Understanding the carrying capacity of the landscape, based on prey availability, also helps to formulate recovery plans for persecuted species [10]. The surveyed landscape is located within the boundaries of the Kepshinsky and Verkhnesochinsky forest districts of the Federal State Budgetary Institution Sochi National Park; it covers the area of the upper reaches of the Chvizhepse and Sochi rivers.

The climate of the territory (table 1) is primarily determined by the influence of altitudinal zoning, proximity to the Main Caucasus Range and the Black Sea.

Table 1. Climatic characteristics according to weather stations.

Meteorological station	Months												year
	1	2	3	4	5	6	7	8	9	10	11	12	
	Mean temperature												
Sochi	5.8	5.9	8.1	11.6	16.1	19.9	22.8	23.2	19.9	15.9	11.6	8.2	14.1
Krasnaya polyana	0.1	0.8	4.8	9.2	14	16.9	19.3	19.4	15.3	10.9	6.3	2	9.8
Achishkho	5.5	5.5	2.5	2.2	6.9	9.8	12.6	12.9	9.4	5.7	1.1	2.7	3.7
	Mean monthly precipitation												
Sochi	197	163	137	113	81	93	102	111	141	152	173	201	1664
Krasnaya polyana	194	178	168	137	125	133	120	112	143	179	193	220	1904
Achishkho	468	430	393	237	204	225	167	167	211	312	385	483	3682

In the highlands, snowfall is observed throughout the year, but steady snow cover is formed only at the end of October. The height of the snow cover in the medium elevations is 0.5–1 m, in the high mountains - up to 4–6 m, and it is even higher at winded areas (table 2).

Table 2. Average of the highest snow cover heights (cm)

Observation point	November	December	January	February	March	April	May
Sochi	0	14	6	12	2	0	0
Krasnaya polyana	4	38	51	73	44	11	0
Achishkho	18	64	100	310	375	338	155

A distinctive feature of the geomorphological structure of the territory is strong ruggedness of the surface. The elevation points range from 350 m in the south to 1.918 m above sea level (Amuko mountain). The main rivers (Sochi, Agva, Ushkha and Chvizhepsse) are full-flowing throughout the year due to the uniform annual distribution of precipitation.

About 95% of the area of the Sochi National Park is covered with mountain forests (figure 1). About 94% of the forested area consists of deciduous species: *Fagus orientalis* (40.9%); *Quercus pubescence*, *Quercus petraea*, *Quercus iberica* and *Quercus hartwissiana* (24.6%); *Buxus colhica* (1.4%), *Castanea sativa* (13.6%), *Carpinus betulus* and *Carpinus orientalis* (8.4%), *Alnus glutinosa* (3.3%). There are wild fruit trees and bushes (*Malus sylvestris*, *Pyrus communis*, *Cornus mas*, etc.) in the forests, as well as planted and wild gardens of cultivated apple and pear, cherry and cherry plum. As for coniferous species, 93% of the area is occupied by *Abies nordmanniana*, the other species are *Picea abies*, *Pinus brutia* var. *pityusa* and *Pinus kochiana* Klotsch. Top predators are necessary for the viability of healthy ecosystems. By studying the ecology of carnivorous animals feeding, we can better understand environmental limits, sustainability and dynamics of prey predators that control these populations formed at heights of 2300-2800 m and found within the Park only in the area of the Aul, Achishkho Mountains and the Aibga range. An important element of critical situation in the state of forest stands (in particular at Kepshinskoe forest district, the basin of the Biryuchka and Chernaya rivers) is drying *Castanea sativa*, one of the main feed for the fauna representatives of the region.

Apex predators are essential for the viability of healthy ecosystems. By studying carnivoran feeding ecology, we can obtain a better understanding of the ecological limits, resilience and predator-prey dynamics that govern these populations [12].

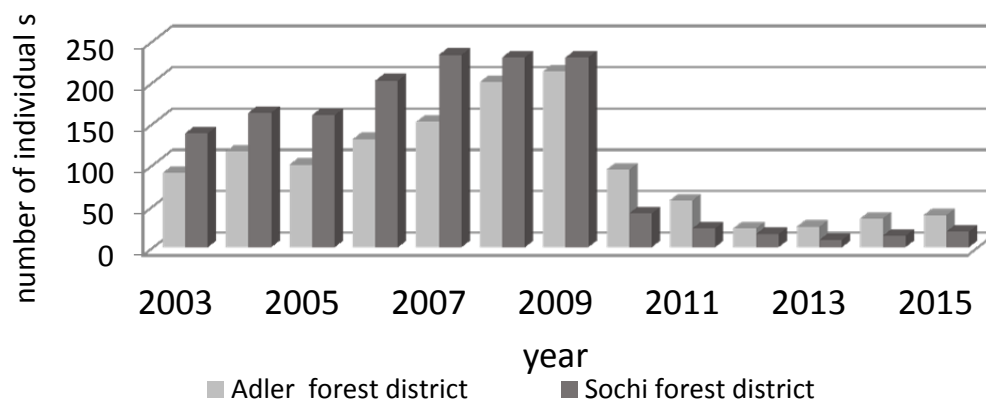


Figure 1. Population size of wild boar in the Adler and Sochi forest districts.

During the territory survey, our attention has been mostly focused on the assessment of the condition of wild ungulates populations, which are typical objects of food for leopard in this area.

Wild boar (*Sus scrofa*, L. 1758) is one of the most important preys of leopards. The low number of wild boars within the Adler forest districts of the Sochi National Park can be associated with climatic and biotopic factors which affect seasonal yields that wild boars feed on. Also, African swine fever (*Pestis africana suum*) in 2010 had detrimental effect on the animal population (figure 2)

At the same time, a positive trend is currently observed in the dynamics of the boar abundance due to cessation of the spread of this infection (table 3).

Table 3. Results of winter route accounting of wild boar.

Years	Habitable area (ha)	The area on which the account was carried out (ha)	Number of tracks recorded	The population density, animals per 1000 ha	Total number
		Adler groups of forest areas			
2014	50000	5000	4	0.7	37
2015	50000	5000	3	0.6	30
		Sochi groups of forest areas			
2014	35000	4800	2	0.4	15
2015	35000	4800	1	0.2	7

During the survey of the landscape, signs of wild boar activity have been observed in the low-mountain part of the area and, to a greater extent, they are confined to the forest plots with predominance of beech and chestnut species.

The Caucasian red deer (*Cervus elaphus maral* Ogilby, 1840) – most of the signs of the red deer have been detected in the low-mountainous part of the landscape and in the middle mountains, in the zone of deciduous forests. Especially it is necessary to mark a plot in the basin of the river Biryuchka, and Alitipovsky range. We mark it as the area with the highest density of the animal population within the surveyed landscape. When moving along the study route, we have noted 14 single traces of red deer, 5 trails (highly likely permanently used by animals, judging by the degree of knocking out), one group bed of 9 animal units, as well as numerous trees with stripped bark. Locations of artificial sodic soils, most favorably located in terms of biotopic distribution, are actively visited by deer. At this local area we have the number of deer of about 25-35 animal units (figure 2).

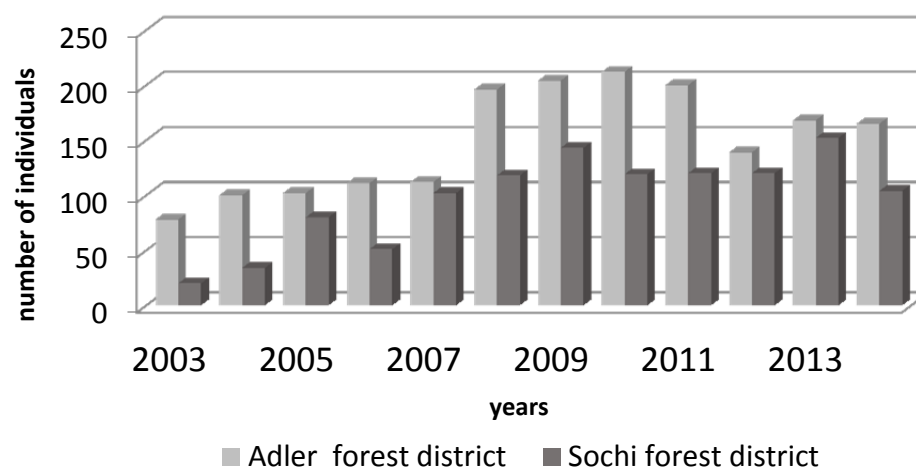


Figure 2. Population size of the Caucasian red deer in the Adler and Sochi forest districts.

The European roe deer (*Capreolus capreolus*) is represented by Caucasian roe deer subspecies (*Capreolus capreolus caucasicus*, Dinnik, 1910) within the territory of the Sochi National Park. The results of the research enable to conclude that, along with the peculiarities of the relief and climate (rocky areas and deep snows), the main limiting factor is predators' hunting (especially wolves and jackals, as well as stray dogs). Thus, taking into account the intensity of natural land, we attribute the number of roe deer within the survey area to the "rare" category (table 4, figure 3).

Table 4. The results of winter route accounting of Roe deer.

Years	Habitable area (ha)	The area on which the account was carried out (ha)	Number of tracks recorded	The population density, animals per 1000 ha	Total number
		Adler groups of forest areas			
2014	50000	5000	17	3.4	150
2015	50000	5000	15	3	150
		Sochi groups of forest areas			
2014	35000	4800	14	2.9	102
2015	35000	4800	20	4.2	146

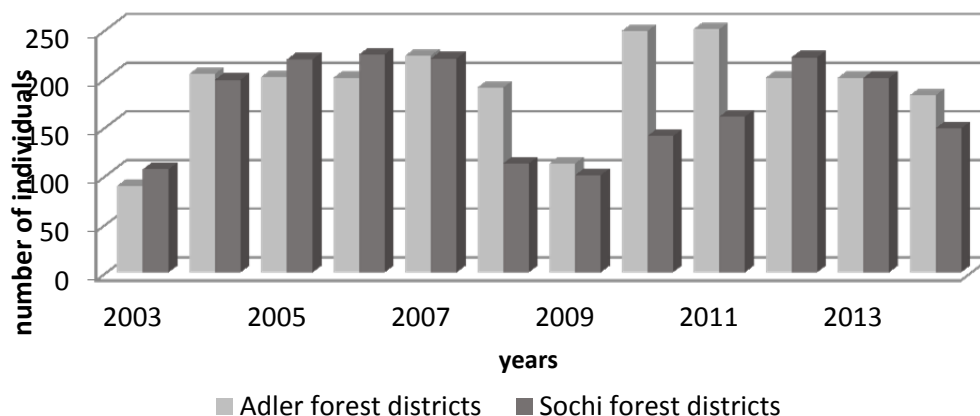


Figure 3. Population size of the European roe deer abundance in the Adler and Sochi forest districts.

Alpine chamois (*Rupicapra rupicapra caucasica* Lydekker, 1910) is met very locally in the surveyed district [13]. This area is less favored by chamois in comparison with the territory of Krasnopolyansky and Aibginsky forest districts, because of their high selectivity of habitats, and as a result, the number of these ungulates from the family of tubicorns is lower (Fig. 4). The upper reaches of the Chvizhepse and Sochi rivers adjoin the Iyegosh range, on which one of the chamois groups is located in the Adler group of forest districts. Moreover, the conditions of territorial distribution of chamois in this area provide the possibility of periodic migrations to the Mount Achishkho (which is not included in the surveyed area).



Figure 4. Caucasian chamois on the isthmus between the Sakharnaya and Amuko mountains (camera trap photo).

The group of chamois adhering to the southwestern slopes of the Amuko Mount falls into the area of our surveys and it is one of the smallest ones not only within the boundaries of the studied areas but the entire Sochi National Park (table 5).

Table 5. Visual accounting of the chamois number in the Sochi National Park.

Groups of forest areas	# points	Accounting territory	Number of animals		
			2013	2014	2015
The Adler group of forest areas	4	Iegosh mountain range (upper river Biryuchka)	22	8	27
	5	Aibga and Turinyye Gory mountain ranges (upper left tributaries of the river Mzymta)	96	67	72
The Sochi group of forest areas	3	m. Amuko, (upper rivers Agva, Ushkho)	17	28	21

Thus, the abundance of chamois in the studied area can be considered as rare one; primarily because of the limited habitable area.

West Caucasian tur (*Capra caucasica* Gldenstaedt and Pallas, 1783) was seen lives locally in the Sochi National Park near the Turin Mountains and the South-Western slopes of the Achishkho. No signs of vital activity of the turs, as well as visual meetings and a snapshot of camera traps have been recorded within this survey area.

Related hunting objects for the leopard are smaller animals such as hare (*Lepus europaeus*), the badger (*Meles meles*), raccoon dog (*Nyctereutes procyonoides*), North American raccoon (*Procyon lotor*), European marten (*Martes martes*), European wildcat (*Felis silvestris silvestris*), jackal (*Canis aureus*). However, additional research is necessary for an objective assessment of the state of the population of these animals.

4. Conclusions

The territory from the Iyegosh mountain in the west further along the Iyegoshka and Ushka rivers in the direction of the Sakharnaya Mountain, then in the north-west direction to the Borodavka Mountain

and from it to the north to the confluence of the Krivoi Ruchey river into the Bzych river, and further south-west along the border with the Caucasus Reserve is recognized as a potentially habitable for the leopard. The area size is about 50 km²). The designated area adjoins the headwaters of the Sochi and Bzych rivers, as well as the Amuko Range, located on the territory of the Caucasian State Reserve.

The area is favorable from the point of view of the protection: on the north it borders on the Caucasian State Reserve, which excludes the possibility of poachers entering, the territory is sufficiently accessible for protective and biotechnical measures on the south side.

About 95% of the area is covered by mountain forests. The most common tree species are: *Fagus orientalis* – 40.9%, *Quercus pubescence*, *Quercus petraea*, *Quercus iberica* and *Quercus hartwissiana* – 24.6%, *Buxus colhica* – 1.4%, *Castanea sativa* – 13.6%, *Carpinus betulus* and *Carpinus orientalis* – 8.4%, *Alnus glutinosa* – 3.3%.

The presence of the following potential prey species was established in the area: 3 individuals of *Sus scrofa*, 35 individuals of *Cervus elaphus maral*, 20 individuals of *Capreolus capreolus*, 12 individuals of *Rupicapra rupicapra caucasica* is recorded. Also noted are *Lepus europaeus*, *Meles Meles*, *Nyctereutes procyonoides*, *Procyon lotor*. Given the natural capacity of the land, the population density of potential prey species has growth potential.

Formation of one of the nuclei of the Persian leopard population within the territory designated by us, through the so-called "soft" release into nature, is inappropriate due to the human development of the greater part of the territory of the Sochi National Park. In this case, the most appropriate decision is to carry out a set of measures aimed at ensuring the restoration of the density of ungulate populations to optimal values (primarily for boars, deer and roe deer), as well as strengthening the protection activities in the area. When the leopard population density increases in the territory of the Caucasus State Reserve, this will create conditions not only for periodic visits, but also for the use of the designated area as one of the permanent hunting areas of the predator, forming an ecological corridor between neighboring protected areas.

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