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Oleg Brandler – Co-Chair, IDB, RAS (rusmarmot@yandex.ru)

Lkhagvasuren Badamjav – Conference Secretary, IGEB, MAS (lkhagvazeer@gmail.com)

Gantulga Gankhuyag – Assistant, IGEB, MAS (gantulgasage@gmail.com)



THE CHANGE OF COLONY DENSITY AND POPULATION SIZE OF STEPPE MARMOTS IN THE REGIONAL LANDSCAPE PARK "VELYKOBURLUTSKIY STEP" TERRITORY

Tokarska N. V., Tokarsky

V. A. Karazin Kharkiv National University. 61077, Ukraine, Kharkiv, Email V.Tokarsky@mail.ru

Substantial changes in land use, foremost the decrease in livestock grazing and the accompanying decrease in suitable marmot habitat has taken place across the range of European subspecies of steppe marmot. From 2005 to 2016, the number of cattle has decreased by a third and the number of steppe marmot by half. If the number of cattle and horses remain at their current population size, we predict a further sharp decline in marmot populations both in Russia and in Ukraine. An increase in agriculture, and particularly livestock, would result in the marmot population expanding its range to its former extent. Grazing large ungulates adjacent to gullies and ravines typical of those used by marmot colonies, create critical habitats for many species of herbivores of the steppe, including marmots.

Key words: steppe marmot, population, number, history, abundance, state of populations.

Introduction

The Regional landscape park "Velykoburlutskiy Step" was organized following the decision of Kharkiv regional council on June 27, 2000. The area of the park is 2042.6 hectares. The aim of the organization of the Regional landscape park "Velykoburlutskiy Step" is to preserve the steppe landscapes of Eastern Europe in their natural state, to provide multifaceted scientific research, to protect and rationally use natural resources, to ensure biological diversity rehabilitation, and to provide conditions for organized recovery(?) of edemic species populations. In 1929 this territory was planned to become a part of the Great Eastern Steppe Reserve (32,740 hectares), which was one of 12 sites involved in the first long-term plan of organization of new state reserves of Ukraine. The park is located in Velykoburlutskiy district, which is in the northeast of the Kharkiv region. Maximum elevations in the area reaches 230 - 239 m.

The predominant inclination of the surface is from north to south. The area is located on the southwestern slope of the Central Russian Upland. Geologically it is divided into two subareas, the Burluk plateau to the northwest and the Pryoskolske plateau to the southeast. They are broken up by river valleys, arroyos, and gullies. Among mineral resources there is raw material for building material production (chalk, loams, clay, sand). The main rivers of the district are Velykyi Burluk, Gnylytsia, and Plotva.

Agricultural land in the area covers 101.2 thousand hectares, of which 81.8 thousand hectares are cropland land and 18.8 thousand hectares are pastures and hayfields. There are 15 collective agricultural enterprises and four state farms (1995) in the area. The main specializations of agriculture in the area are grain cultivation, beetroot cultivation, and stock raising.

Великобурлутський степ

The river Velykyi Burluk is the confluent of the Siverskiy Donets River. It divides the Burluk Plateau in the north-east of Kharkiv Region. The width of the river valley varies from 0.5 to 3 km. The meadow terrace is well developed. The slopes are cut by gullies and arroyos. From the early 70's through the early 80's the river was reclaimed and turned into a canal.

Despite the fact that wide-open spaces prevail in the Velykoburlutskiy district, regional biotopes are quite diverse. In the low-lying steppe and meadow areas marshes and fens with overgrown shores occur frequently. Some of the gullies, where there is enough moisture, are covered with gully forests. Therefore, all biotopes characteristic of the forest-steppe of Ukraine can be found there. More open biotopes are the most common with motley grass – fescue – feather grass steppes (grasslands) and dry and floodplain meadows.

From a landscape perspective, the area of the park is a typical of the regions, with a system of arroyos that lead to an elevated plateau. The park is located in the steppe zone according to the geological and botanical zonation of Ukraine.

The modern conserved territory of the park consists of three parts: the gully forests near Nesterivka village, the steppe between Nesterivka and Zelenyi Gai villages, and the steppe near Rogozyanka village. In addition, the Regional Landscape Park "Velykoburlutskiy Step" included the reserves Ekaterynivskiy and Velykoburlutskiy, which are of national importance and were organized back in 1977 to protect colonies of steppe marmot.

The territory of the park is inhabited by many mammal species, including European polecat (*Mustela putorius*), stoat (*Mustela erminea*), least weasel (*Mustela nivalis*), Eurasian otter (*Lutra lutra*), European badger (*Meles meles*), martens – beech marten (*Martes foina*) and European pine marten (*Martes martes*), gray wolf (*Canis lupus*), red fox (*Vulpes vulpes*), and European hare (*Lepus europaeus*). In the recent past European mink (*Mustela lutreola*) were also found there. In the steppe areas of the gully-arroyos system there were numerous greater mole-rats (*Spalax microphthalmus*), steppe marmots (*Marmota bobak*), and steppe mice (*Mus spicilegus*). Less common species include the speckled ground squirrel (*Spermophilus suslicus*), the southern birch mouse (*Sicista subtilis*), the great jerboa (*Allactaga major*), the European hamster (*Cricetus cricetus*), the grey dwarf hamster (*Cricetulus migratorius*), and the northern mole vole (*Ellobius talpinus*). Species of moderate number include the steppe lemming (*Lagurus lagurus*) and the sibling vole (*Microtus rossiaemeridionalis*). The valleys of rivers Velykyi Burluk and Nyzhnya Dvorichna are inhabited by the Eurasian beaver (*Castor fiber*), which became established there in the 1980s. Ungulates include the wild boar (*Sus scrofa*) and the European roe deer (*Capreolus capreolus*), which are common in the territory. Elk (moose, *Alces alces*) migrations have also been noted.

Materials and methods

As mentioned above, the steppe marmot population in Velykoburlutsky district was studied for several years by a number of researchers. From their data it appears both the distribution and size of the steppe marmot population in the study area have changed over the years. To perform a detailed description of steppe marmot colony spatial structure, a plot with a typical steppe marmot colony was chosen in a broad gully-arroyos system station near Nesterivka village (that is about 90 km to the northeast of Kharkiv city). In-

The territory of the regional landscape park in Nesterivka village. In the center of the gully-arroyos system, one can notice light points which indicate steppe marmot burrows (Figure 1).



The work was carried out in two stages:

1. Mapping of colonies using a GPS-navigator.
2. Counting the number of individuals in the family.

Observations were carried out with binoculars from the shelter immediately after the animals emerged above ground, usually from 7 a.m. to 10 a.m. in the morning and then in the evening from 5 p.m. to 8 p.m. In a number of cases, a visual count was performed along a survey route, where the observer walked past on foot and recorded the number of animals in each family. Counts were conducted across three days. The number of families (family plots), the total number of adults, and the total number of yearlings was counted. Average family size and average number of adults and yearlings per burrow was calculated by dividing the number of adults (or the number of yearlings) by the number of families.

To analyze the distribution of marmot settlements over the terrain an electronic image compiled from topographic maps (scale 1: 100,000) was used. From these data the boundaries of the local population were projected.

At the beginning of the 20th century, in the Velykyi Burluk District a small number of marmots lived in three areas: on the gully slopes of the Burlukriver valley, on the lands of the Shipovate horse farm, and near the farmsteads of Ploske and Tsytsorino. From 1966-1968, the marmots occurred in 16 collective and/or state farms (Krivitsky, Tokarsky, 1983). According to V.I. Abelentsev (1971), in 1967 the whole Velykyi Burluk marmot population totaled 1,710 animals. The majority were observed in the studied administrative district but several localities out of 28 listed by the author belonged to other neighbouring districts.

Due to organized protection, as well as the almost complete absence of natural predators and the marmot's high ecological plasticity, its population in this region continued to increase until 1980-1981. Marmots settled almost all areas used for grazing. Their number was the highest in the Kharkiv Region (28 000 individuals in 1987) due to the ideal habitat presented by a well-developed ravine and gully system, which occupies about 17-18 thousand hectares (14.2%) of the district's territory.

Our records indicate overall a large number of animals in the colonies and some peculiarities of their distribution in the Velykyi Burluk District. The marmot's population density largely depended on the age of the colonies; being larger in the plots where families had been living for many years (Tokarsky, 1997; Tokarsky et al., 2006).

A survey of the colonies conducted in June, 1977 showed that the number of residential burrows had significantly decreased in the areas bordering villages and frequented by people. A total of 50 families were mapped.

In the marmot colonies more remote from the District center and the main roads (for instance, near the village of Andriivka), the total number of individuals was higher and the colony conditions were better. Interestingly, some families that were forced out by plowing from the gully bottom dug burrows on the sides of an asphalt road, which crossed the lower part of the gully. Here, on the road slopes, the animals fed freely near the asphalt, and would cross the road within a few meters of passing cars (Tokarsky et al., 2006).

Wild gregarious ungulates are an integral component of pasture ecosystems. Their vital activities form and maintain open and semi-open landscapes. However, they were the first to suffer significant losses because of human activities, and during the historical period gradually lost their positions as major players in the ecosystems' structural organization (Abaturov, 2006; Kolesnikov, 1997). Their loss resulted in a significant decrease in the biological and landscape diversity in the forest and steppe zones of Eastern Europe



(Smirnova et al, 2001a). Awareness of this fact has recently led to development of methods for ecosystem recovery and conservation through reintroduction of key species into their former ranges (Smirnova et al., 2001b; Akimov et al., 1999). Grazing of large ungulates is one of the key ecological factors that create habitat for many herbivorous steppe species such as marmots, and thus the presence or absence of ungulates affects the number and density of their populations (Kolesnikov, 1997; Ronkin, Savchenko, 2000; Tokarsky et al., 2006). We attribute the decrease in the number of marmot family colonies, as well as their number per area unit, to the decrease in grazing pressure on the steppe marmot habitats. The area of the ravine and gully system occupied by the colonies in the study area has remained practically unchanged since the late 1980s, while the number of livestock (including cattle) has decreased dramatically (Table 1).

Table 1. The number of steppe marmots in the area of. Nesterika (Tokarsky A., Savchenko, Ronkin, 2012, 2016- our results)

Location of colonies	Area (ha)	Number of households		
		1992-1996	2005-2006	2016
Seredniy Burluk, a beam north of the village, beyond the pond	31	19	12	5
Seredniy Burluk, a beam north-west of the village, behind the pond	98	49	19	6
Green Guy, a beam Babachi yar	70	30	28	5
Nesterivka, a neighborhood of the village within the right bank of the river. V.Burluk: - Extensively grazed beams; - non-unstained beams	93	28	37	4
	77	14	15	1

Table 2. Steppe marmot habitat size, number of cattle, and number of steppe marmots in the Velikoburluisky district

	1987	2005	2016
Total area, ha	17712	17412	17412
haymaking;	2429	3011	3011
pasture;	14589	13774	13774
yarov	694	627	627
Number of cattle	52760	10237	3750
Pasture load, head / ha	3,6	0,7	0,27
Total	28100	10550	5000

During the last ten years livestock numbers decreased by a third and the marmot numbers by half. From the curve of the cattle dynamics in Velykei Burluk district, seen in Fig.2, livestock numbers reached their peak in the 1980s and then began a rapid decline in the 1990s.

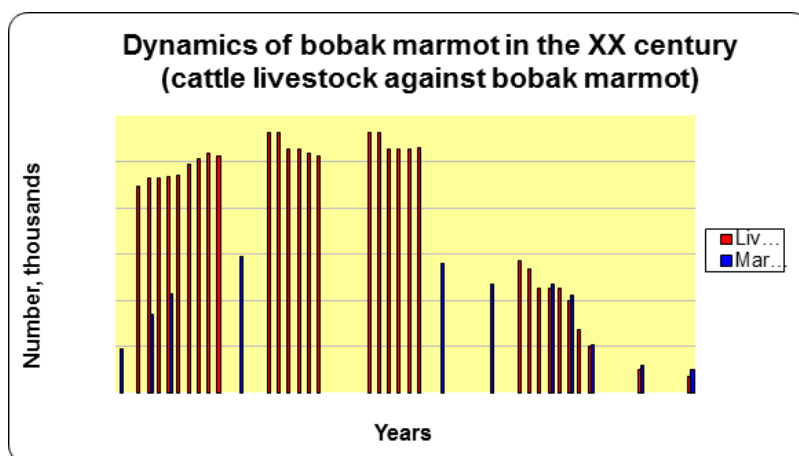


Fig. 2. Dynamics of the number of marmots relative to livestock pasture load in the Velykoburluisky district in 1970-2005.

A sharp decrease in grazing pressure caused qualitative changes in steppe marmot habitat that resulted in an unbroken "forest" (often at human growth height) of ruderal plants, with *Carduusacanthoides* sp. L. and *Onopordumacanthium* sp. L. as the dominant species'. The growth of these plants significantly reduced the quality of forage at marmot family plots, as the ratio of forage to non-forage phytomass had changed radically (Ronkin, Savenko, 2000; Ronkin, 2003). Deterioration of forage quality led to a decrease in marmot numbers. Figure 2 depicts the dependence of marmot numbers on the level of grazing pressure in Velykyi Burluk district in 1970-2005. The number of steppe marmots dropped from 28 thousand individuals in the late 1980s to about 10.5 thousand (2110 families) in 2005 (Figure 2).

In the late 1990s, we found a steppe marmot settlement near the village of Nesterivka (Velykyi Burluk distr.) with 39 family plots (fig. 3). Of these, two were located at a distance from the main colony. Fourteen plots formed the center and four plots the periphery of the colony. The nearest (in both sides) colony centers were located at a distance of about 2 km along the gully system. Three family plots partly encompassed agricultural areas and eight plots bordered a country road. After the complete cessation of cattle grazing in 2015, marmots almost completely disappeared in this territory.

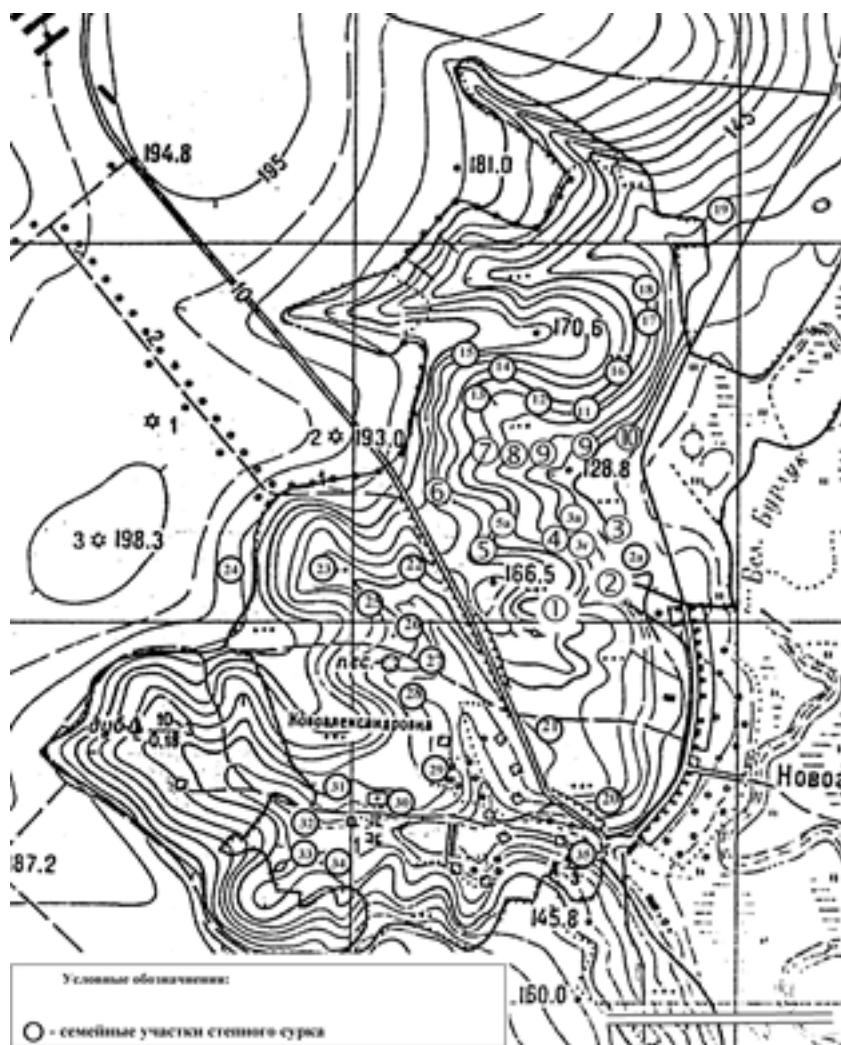


Fig. 3. Placing of family sites of steppe marmots in the territory of the regional landscape park "Velikoburlukskaya Steppe" near the village of Nesterivka (2010). Scale 1:12500.

We registered repeated cases of dispersal by young marmots, and sometimes the adults, to neighbouring and more distant family plots. The latter were out of the line of sight and up to 850 m away from the original burrow. Males were more active than females, and juveniles more active than adults. In the monitored colony, it was possible to distinguish relatively isolated stable families and the unstable ones, with a complete change of family members and continuous rotation between neighbouring groups (Savchenko, 2012). Two adult marmots placed into a man-made burrow at a distance of 1 km from their family plot, unerringly found their way home.

The average distance between the nearest winter burrows was 119 ± 31 m ($n = 45$). In five cases out of 50, the distance did not exceed 25 m. Observing individually marked animals, we found that in three cases such closely spaced wintering burrows belonged to the same family, whose members year after year shared these burrows and the area around them. In two other cases, we observed either separate use of neighbouring winter burrows by two social groups, whose joint hibernation had not been fixed but still was possible, or marmots sharing territory and burrows but hibernating in two separate sealed burrows (Ronkin, Savchenko, 2000; Savchenko, 2002).

The number of adult animals in each family varied from two to five. The density of the burrows in which hibernation was possible (i.e., recorded at least once for the entire observation period) was similar throughout the colony, 1.5-1.7 burrows / ha. The density of the animal population in different parts of the colony showed sharp contrast, from 1.2 families / ha at the center to 0.3 families / ha at the periphery.

Since a single family may have a varying number of wintering burrows (in our case, from one to three), the average distance between the burrows of neighboring families also varied considerably. The average distance between the wintering burrows of neighboring families in the center of the colony was 61 ± 8 m ($n = 10$, $p < 0.01$). In the rest of the colony it was almost twice as high and equal to 115 ± 26 m ($n = 46$, $p = 0.5$) (Savchenko, 2000).

Disrupted topography created a variety of conditions important for steppe marmot activity. Each animal used multiple tree landscape elements: watershed, gully slope, and gully bottom. Wintering burrows were usually located on the slopes and in watersheds, while the meadows on lower slopes and gully bottoms were preferred for feeding.

As has been discussed throughout the article, certain historical periods are followed by a decrease in the number of domestic animals. The most noteworthy were the decreases in livestock numbers during the First World War, collectivization, and then from the 1980s to now. The latter is associated with the adaptation to modern market conditions. During these periods, we observed a sharp decline in the number of steppe marmots despite a total hunting ban (since 1929, the commercial hunting on this species has been banned).

The third period of decline is ongoing. Now we can foresee two possible futures. If the number of cattle and horses remains at the same level, we can confidently predict a further sharp decline in marmot population in both in Russia and Ukraine. If this happens, the marmot will disappear in thirty years. If agriculture, and primarily cattle breeding, activities increase the marmot population should be capable of restoring its geographic range to its former extent.

Grazing of large ungulates, in combination with terrain typified by ravines and gullies, are key environmental factors that influence habitat suitability for many herbivorous steppe species, including marmots. Pasture steppe ecosystems are necessary conditions for biodiversity conservation.

Conclusions

A significant decrease in the steppe marmot numbers has occurred in Velykyi Burluk district. The population declined from 28 000 individuals in the late 1980s to 10 500 (2110 families) in 2005. After the complete cessation of cattle grazing in 2015, marmots almost completely disappeared from the area.



Livestock numbers decreased by one third while marmot numbers decreased by half. At present, there is a catastrophic decline in the number of steppe marmots. We can envision two possible futures for the steppe marmot in Russia and Ukraine. If the number of cattle and horses remains at the same level, we can confidently predict an ongoing sharp decline in the marmot populations of both Russia and Ukraine. If agricultural activities, and primarily cattle breeding, increase, the marmot population should be capable of recovering and re-expanding to cover its former range.

Grazing of large ungulates, in combination with terrain typified by ravines and gullies, are key environmental factors that influence the habitat suitability for many herbivorous steppe species, including marmots. Pasture steppe ecosystems are necessary conditions for biodiversity conservation.

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