
SYSTEMATIC STUDY
OF ARID TERRITORIES

Status of Reintroduced Marmot Populations in Two Forest–Steppe Reserves of European Russia

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Abstract—The steppe marmot (baibak) is one of the typical rodents of the Eastern European forest–steppe and steppe. In the mid-twentieth century, European populations of the species were on the verge of extinction, but then, thanks to conservation measures and reintroductions, the population of baibak and range were largely restored. This work collects and presents data on two restored marmot colonies in the forest–steppe of European Russia. The research was carried out in the Central Black Earth Nature Reserve (Streletskaya steppe, two sections) and in the Volga Forest–Steppe Nature Reserve (Ostrovtsovskaya forest–steppe, three sections). The number and age composition of marmots are described. Maps of settlements with burrows and trails of marmots have been compiled; for each burrow the coordinates and type (temporary or permanent) are indicated. The population density and the number of burrows per marmot were calculated. In total, 12 marmots live in the Streletskaya steppe: ten on the “Pasture” site and two on the “Restored Steppe” site. In the first area, seven adult and three young marmots were noted, in the second, two adult marmots. Here, the reintroduction of the baibak was not entirely successful. From 2015 to 2023 the number of marmots decreased sharply, from 38 to 12 individuals, and the area of the inhabited territory fell from 10 to 3.7 hectares. In the Ostrovtsovskaya forest–steppe, 48 marmots (eight families) were recorded, of which 40 were in the first area (six families), two were in the second area (one family), and six were in the third area (one family). Of the 48 individuals, 29 (61%) are underyearlings. The reintroduction of the baibak into the Ostrovtsovskaya forest–steppe was relatively successful: the total number of animals is comparable to the number of marmots initially released (48 and 64).

Keywords: steppe marmot, forest–steppe, habitat restoration, marmot colony, population composition, settlement structure, population dynamics

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The steppe marmot, or baibak (*Marmota bobak* Müll., 1776), is one of the most typical rodents of the Eastern European steppe and forest–steppe, as well as the steppes of Kazakhstan. This large colonial burrowing rodent played an important role in steppe ecosystems. Marmots were one of the most numerous and most important herbivores, and their burrows (marmots) largely formed the microrelief of steppe and forest–steppe territories, and, accordingly, the zoogenic complexity of plant and soil covers. In the nineteenth and twentieth centuries, the range of the steppe marmot in Europe, especially to the west of the Volga, due to the almost complete plowing of the steppes and mass hunting, was reduced to single local areas with low numbers. In the middle of the twentieth century, European populations of the species were on the verge of extinction (Bibikov et al., 1990).

In the 1980s in the Soviet Union, large-scale efforts were carried out to save the marmot. Thanks to conservation measures and numerous reintroductions and

reintroductions, the range of the species has been largely restored and even expanded, and populations have stabilized. Many artificial marmot settlements were created in different regions of European Russia (Dmitriev, 2001). The fate of such settlements varies (Rumyantsev, 1997). Some function successfully, the marmots in them reach high numbers and successfully resettle; others exist quite stably at a fairly low number, and others disappear for various reasons. Reintroductions of marmots into their former habitats have continued in recent decades. In two forest–steppe reserves of European Russia—the Alekhina State Natural Biosphere Central Chernozem Reserve and the Volga Forest–Steppe State Nature Reserve, they were held in 2013–2014.

The purpose of this work is to assess the results of reintroduction in the named reserves as of 2023. The following tasks were set: to characterize the territories where marmots were introduced; to describe the initial stages of reintroduction; to explore the current

state of the colonies; and to assess the success of reintroduction in each of the reserves.

MATERIALS AND METHODS

Artificially created settlements of the steppe marmot were examined in two forest–steppe reserves—Central Chernozemnyi (June 1–20, 2023) and “Privolzhskaya forest–steppe” (July 3–23, 2023). The number and age composition of marmots and the composition and territorial location of family groups are described. Individuals of the dominant pair and one-year-old marmots, due to inaccuracies in their visual discrimination, were counted together and defined as “adults”; for the same reason, as a rule, males and females were not distinguished. Individuals of the current year of birth (young yearlings) were defined as “young.” Nesting (wintering and summer) burrows were counted together as “permanent” because they are difficult to distinguish during the observation season. The remaining burrows were called “temporary.” A “group of burrows” meant several exits within one burrow or no further than 5 m from its center. In most cases, these are several exits from one burrow. A hole with one exit was considered single. The population density and the number of burrows per marmot were calculated. Maps of settlements with burrows and trails of marmots have been compiled; for each burrow the type (temporary or permanent) and geographical coordinates are indicated. When working with cartographic materials, the GIS program MapInfo Professional 15.0.1 was used.

Central Black Earth Reserve located in the southwestern part of the Central Russian Upland, in Kursk oblast (*Tsentral'no-Chernozemnyi...*, 2016). The study was carried out on the Streletskaya Steppe site (7 km south of the city of Kursk), having an area of 2046 hectares, of which steppe, mainly meadows, cover 870 hectares or about 42.5% of the site. The vegetation cover of the steppe is dominated by feather grass, feathery (*Stipa pennata*¹) and narrow-leaved (*S. tirsia*; *Streletskii uchastok...*, 2014).

This work was carried out in two areas: “Restored steppe” (one hectare, fenced with a marmot-impassable fence) and “Pasture” (3.7 hectares, fenced with a marmot-passable fence). Both areas are located in the western part of the site. The “restored steppe” is subject to regular haymaking, and within its borders the vegetation of cereal meadow steppe is widely developed. The “pasture” is under the slight influence of livestock grazing and is covered with grass–forb meadow steppe, overgrown with shrubs (Brandler et al., 2012). Marmots were studied through visual observations with binoculars. The burrows and their clusters were mapped, the types and coordinates of the

burrows were noted, the system of marmot trails in both areas was studied.

The “*Privolzhskaya Forest–Steppe*” Nature Reserve is located in Penza oblast, in the western part of the Volga Upland. The Ostrovtsovskaya forest–steppe site, where the research was carried out, is located in the southern part of the region, in the Kolysheiskii district. The area of the site is 404.7 hectares; the length from east to west is 3.9 km, and from north to south, 2.2 km. The Ostrovtsovskaya forest–steppe is located on the watershed between the valleys of the Archada (west) and Khoper (east) rivers. The territory of the reserve is bordered from the south and east by a rather deep gully and its numerous branches (*Privolzhskaya Lesostep' Nature Reserve Website...*, 2023). The communities of meadow and steppe vegetation are dominated by fescue (*Festuca valesiaca*), brome and coastal brome (*Bromus riparia*, *B. inermis*), and ground reed grass (*Calamagrostis epigeios*). Among the meadow steppes there are small areas of forest and shrubs, the so-called “kolki” (Novikova, 2012).

Work here was carried out in three areas, in the eastern, southeastern, and western parts of the site, with an area of 20.3, 1.4, and 2.4 hectares, respectively. Observations were carried out in the same way as in the Central Black Earth Reserve. In addition, data from KeepGuard and SeeLock camera traps installed at nine points near the supposed main burrows of marmot family groups were used.

RESULTS AND DISCUSSION

Central Black Earth Reserve. In Kursk oblast (province) by the beginning of the twentieth century, the marmot had disappeared completely (Brandler et al., 2012). Reintroduction was carried out in 2013–2014; animals were imported from Belgorod oblast. In 2013, 40 marmots were released into the “Pasture” (Brandler and Kolesnikov, 2014). The area of the part of the “Pasture” inhabited by marmots was then about 20 hectares (personal communication from A.A. Vlasova; Fig. 1a).

The marmots mostly overwintered safely, but in the spring of 2014 they left the protected area and some of them died. Then the marmots were redelivered to the “Pasture” and released to the “Restored Steppe,” which was fenced with a fence impassable for marmots. A total of 78 marmots brought from Belgorod oblast were released into prepared artificial burrows. In the “Pasture” this time we managed to detain some of the marmots (about 60%). Of the escaped marmots, some settled north of the “Pasture,” on the other side of the Petrin Log gully, in the protected zone of the reserve. The marmots were unable to leave the “Restored Steppe” territory. In the fall of 2014, 30 marmots hibernated on the “Pasture,” five on the northern side of the gully next to the “Pasture,” and

¹ Latin names of plants are given according to the work of S.K. Cherenpanova (1995).

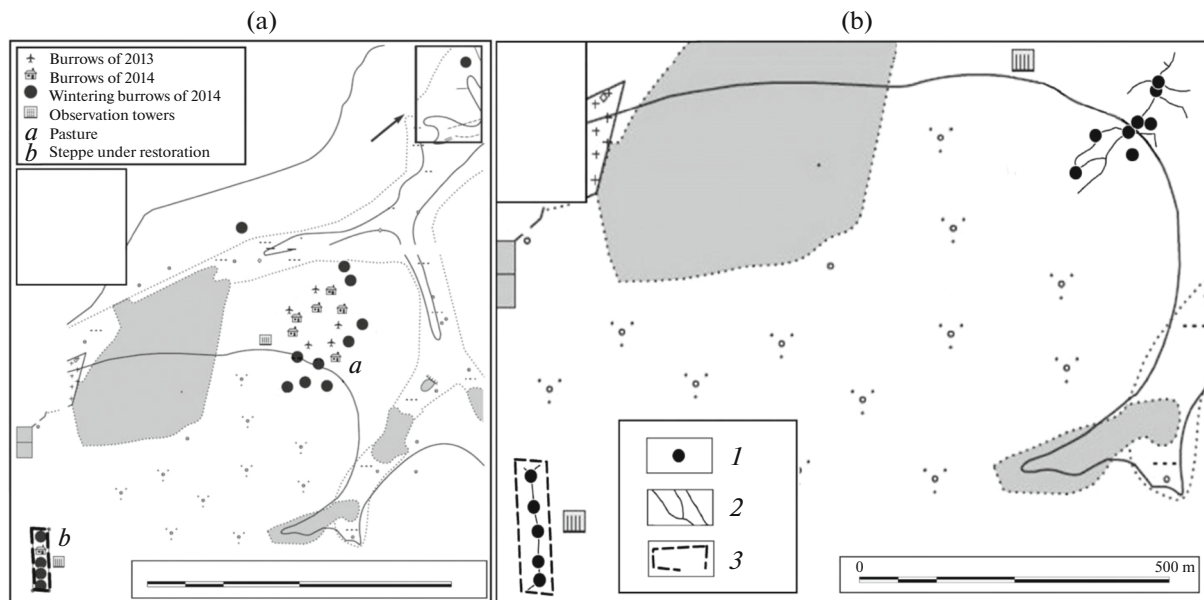


Fig. 1. Reintroduced marmot settlements in the Streletskaya steppe: (a) in 2013–2014 (Brandler et al. (2015) with amendments and additions); (b) in June 2023. 1, Permanent burrows (nesting, wintering and summer); 2, main paths of marmots; 3, an insurmountable fence for marmots in the “Restored Steppe” territory.

20 on the territory of the “Recoverable Steppe.” In the spring of 2015, 38 marmots emerged from hibernation: 13 in the “Restored Steppe” territory, 18 in the “Pasture,” and seven in the buffer zone of the reserve (Brandler and Kolesnikov, 2014; Brandler et al., 2015; Verwald and Brandler, 2015). The area inhabited by marmots was about ten hectares (personal communication from O.V. Brandler; Fig. 1a).

By 2023, the number of marmots and the territory they occupy had greatly decreased. On the “Restoring Steppe” in the fall of 2022, four marmots hibernated, and only two came out the following spring (personal communication from A.A. Vlasov). In the “Pasture,” the number of marmots in the spring of 2023 was estimated at 7–8 individuals (personal communication from A.A. Vlasov). The area occupied by marmots in the “Pasture” decreased to 3.7 hectares or 18–19% of the original (Fig. 1b).

According to our observations, in June 2023, two adult marmots lived on the “Restoring Steppe.” They lived in the northern and southern parts of the territory separately and did not meet together. Within the territory, five permanent burrows (groups of burrows) of artificial origin and three temporary burrows were noted. Both marmots lived in old, artificially created burrows. For each marmot there are four burrows (groups of burrows), most of which are abandoned. The trails of marmots are poorly expressed. The population density is two individuals/ha (Fig. 2a).

There are ten marmots (seven adults and three young) living on the “Pasture” and in its surroundings.

This area looks well-inhabited by marmots. Their distribution is uneven. Marmots currently do not live in the western part of the “Pasture”; the holes are overgrown with grass or have collapsed. In the southeast, three solitary adult marmots live in three burrows. A group of marmots lives in the northeastern part of the “Pasture”: three adults and three young. Outside the “Pasture,” a little to the northeast, one adult marmot was noted. The population density is 3.6 individuals/ha. A total of 38 burrows (groups of burrows) were noted, including 18 permanent. For each marmot there are 3.8 burrows (groups of burrows), many of which are abandoned (Fig. 2b).

Thus, from 2015 to 2023, the total number of marmots in the Streletskaya steppe decreased from 38 to 12 individuals, and the area of the territory inhabited by them decreased from ten to 3.7 hectares. In the fenced area “Restored Steppe,” the number of marmots fell from 13 to two single individuals, although the area occupied by marmots did not change. In the “Pasture” the number decreased from 18 to ten individuals, decreasing by 1.8 times. At the same time, the number of family groups decreased from nine to one, but the average number in a group increased from two to seven individuals (five marmots, apparently, do not belong to a family group). The area occupied by marmots fell from ten to 3.7 hectares, or 2.7 times. Marmots disappeared from most of the “Pasture,” but a fairly densely populated area formed in its center (Fig. 2b). Breeding continues here, and marmot numbers have probably stabilized, albeit at a low level.

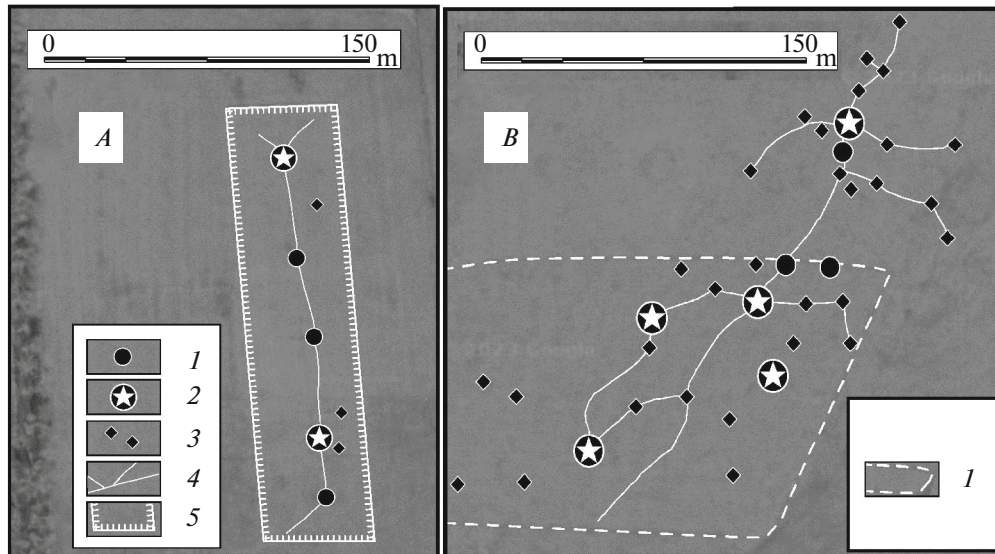


Fig. 2. Marmot settlements in the Streletskaia steppe in 2023: (a) “Restored steppe,” (b) “Pasture”. 1, Permanent burrows; 2, permanent burrows where marmots are found; 3, temporary burrows (protective or feeding); 4, main paths of marmots; 5, a fence insurmountable for marmots; 1 (on b), the initially created fence, surmountable for marmots.

Nature Reserve “Volga Forest–Steppe.” In Penza oblast (province) in the 19th century, marmots inhabited almost the entire forest–steppe part, but by the beginning of the 20th century, they had completely disappeared (Sprygin, 1925). In the years 1985–1989, activities for the reintroduction of the marmot were carried out here. 655 marmots were released at ten points in six districts of the region. Some of the established colonies disappeared, but some of the livestock settled in the surrounding area, giving rise to new settlements. In 2010, the marmot lived only in the southeastern part of the region, in the Bessonovskii, Neverkinskii, and Mokshanskii districts; in the Bolshaya Endova and Malaya Endova gully (Bessonovskii and Mokshanskii districts), the most numerous marmot settlements were formed in 2010 (at least 300 individuals) (Rumyantsev et al., 2012).

The reintroduction of marmots into the Ostrovtsovskaya forest–steppe began in 2013. The marmots were imported from Penza (Neverkinskii and Mokshanskii districts) and Saratov (Kalininskii district) oblasts (Dobrolyubov, 2015). The release was carried out in several batches with a total number of 39 individuals. The animals were released in two places, in the valley (a circus-shaped relief formed during the meandering of the Khopra tributary) and on the northern slope of the valley of the same tributary in the western part of the site. In 2014, several artificial burrows were built and another 25 individuals were released. Of these, nine marmots overwintered in the reserve; one died, the rest went 11 km to the south, forming a colony in a ravine near the village of Chebo-taevka (Dobrolyubov, 2015).

In 2023, marmots in the Ostrovtsovskaya forest–steppe lived in three areas. The *first* and the largest (20.3 hectares) is located in east and north of the Skripitsinka River, occupying its floodplain, floodplain terraces (FPT), ledges of the main bank, and part of the upland. These relief elements change in this order from south to north, and the river flows from west to east (Fig. 3). The main part of the settlement is occupied by cereal–strawberry–forb meadow steppe with isolated shrubs (thorn, cherry). The slope of the bedrock bank is well defined, reaching up to 8–10 m of relative height, and is dissected by small beams in which almonds and spirea grow in patches. On the platform, marmots occupied part of the sunflower field located next to the reserve.

The *second* site (about 1.4 hectares) is located on the other side of the river, slightly to the southwest (Fig. 3). In terms of relief and vegetation, it is similar to the previous one, differing in its small size and significantly smaller height difference. The floodplain with floodplain meadows occupies about half of its territory. To the south of it is a wheat field.

The *third* plot (about 2.4 hectares) is also located in the valley of the Skripitsinka River, in the western part of the Ostrovtsovskaya forest–steppe (Fig. 3). The relief shows the ridged southern edges of the flat plain, dissected by beams leading to the river. To the south, the site is limited by the river floodplain, and to the north, by a sunflower field. On the upland, the vegetation is dominated by grass–strawberry–bedstraw meadow steppes, while in the ravines and lower parts of the slopes, there are tall grass floodplain meadows.

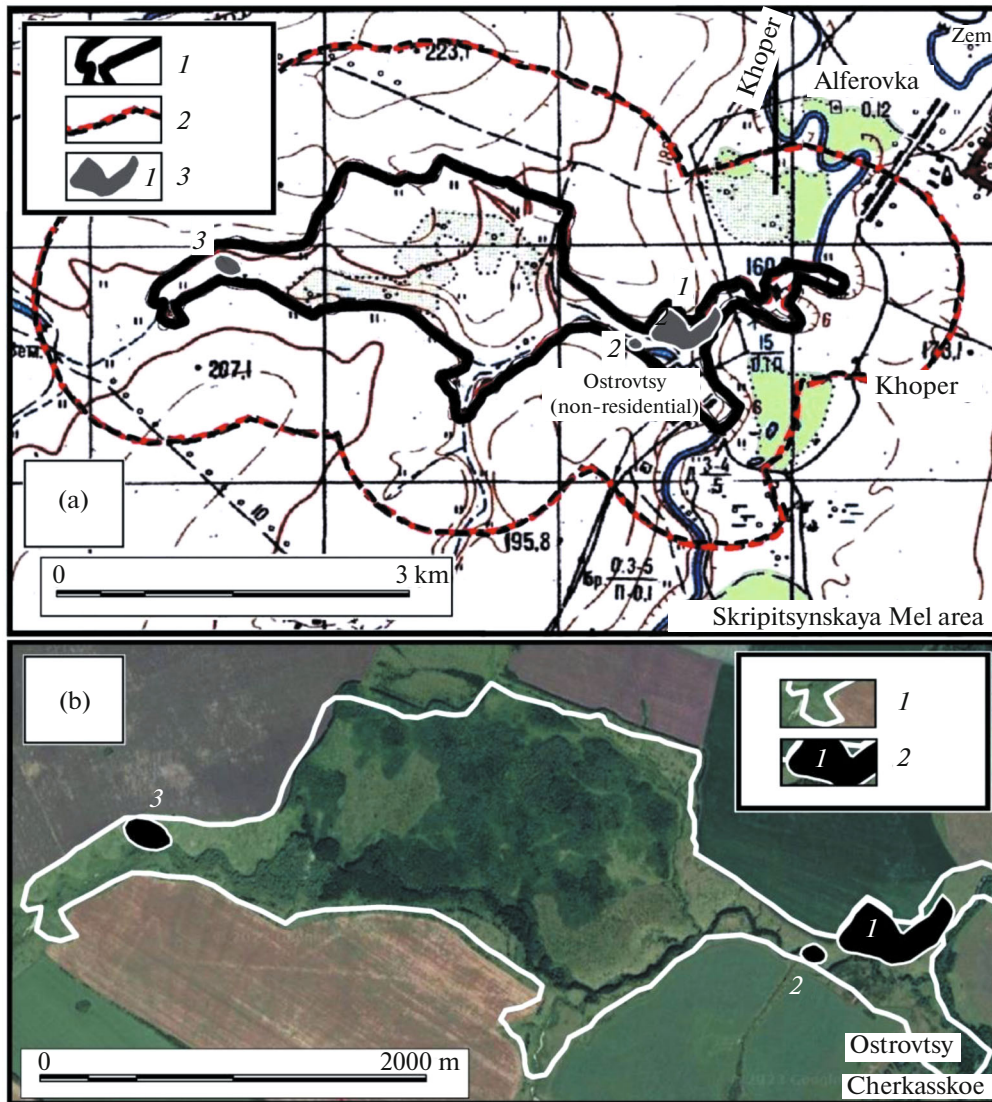


Fig. 3. Marmot settlements in the Ostrovtsovskaya forest–steppe: (a) on a topographic map; (b) on a satellite image. 1, Border of the protected area; 2, border of the protected zone of the reserve; 3, marmot settlements; 1 (on b), border of the protected area; 2 (on b), marmot settlements.

In 2023, 42 marmots were counted in the eastern sections (40 in the first, two in the second), and six in the western. In total, at least 48 marmots live in three areas: 29 of them (61%) are young, and 19 (39%) are adults. There are only eight marmot families, and the average number of animals in a family is six, of which 3.6 are adults and 2.4 are young. Burrows (groups of burrows) total 115. Temporary burrows, 73 (57%); and permanent burrows, 55 (43%). On average, each marmot has 2.7 burrows, of which 1.15 are permanent; per family, there are 16.2 and 6.9, respectively.

The *first area*, the largest and most populous, is home to 40 marmots (average density, 1.97 individuals/ha). They are united into six well-separated families. There are from five to eight individuals in a family,

on average, 6.67. Among all the marmots, 16 (40%) are adults and 24 (60%) are young. The number of young marmots in families varies from two to six. On average there are four of them in each family. The total number of burrow groups is 103, with 116 burrows. There are 66 temporary holes (56.9%) and 50 permanent ones (43.1%). Each marmot has 2.9 burrows, of which 1.25 are permanent. There are practically no abandoned holes. Marmots live almost throughout the entire area, leaving unoccupied only the floodplain and the floodplain part of the FPT, as well as the section of the bedrock bank that is most extended to the south (Fig. 4a).

The *first family* lives in the western part; its territory occupies the upland, the slope of the indigenous bank,

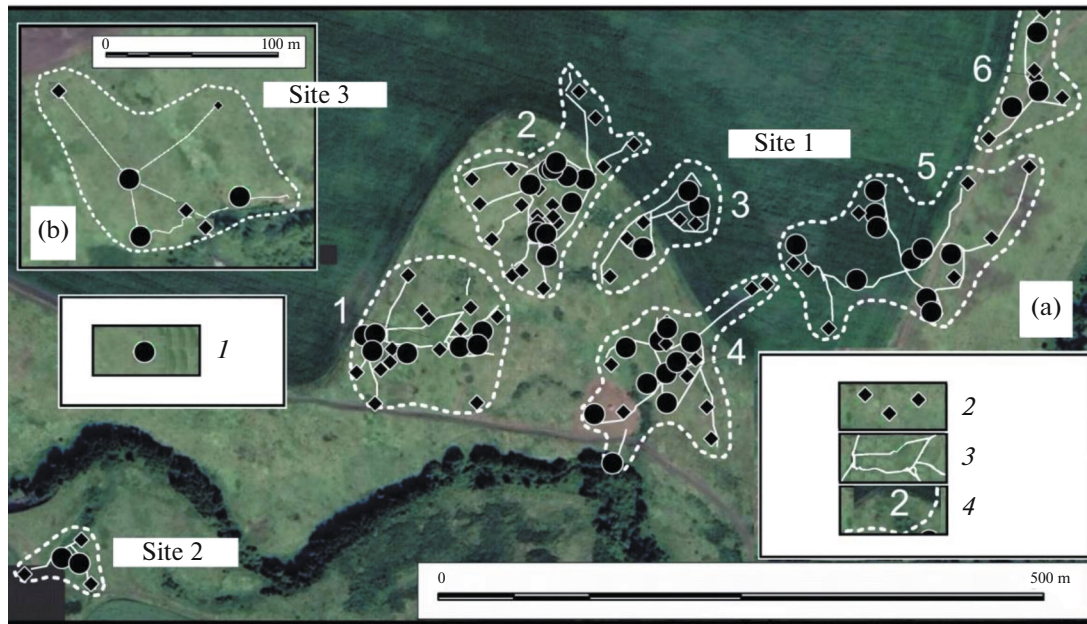


Fig. 4. Family groups of marmots in the Ostrovtsovskaya forest–steppe: (a) areas 1 and 2; (b) area 3 (Fig. 3). 1, Permanent burrows; 2, temporary burrows; 3, main trails of marmots; 4, approximate boundaries of the territories of family groups; white numbers 1–6 are the numbers of family plots.

and part of the FPT. It consists of eight individuals: three adults and five fingerlings. In total, there are 17 groups of burrows on the site of this group, including 21 burrows. There are 2.6 burrows for each marmot.

The *second family* lives in the northern part. Its property occupies part of the FPT, a ravine that cuts the main bank, and goes north, to the plain, beyond the boundaries of the reserve, to the sunflower field. There are seven individuals in it: two adults and five young ones. The family owns 29 burrow groups, including 32 burrows. There are 4.55 burrows for each marmot.

The *third family* lives a little southeast of the second. Its main burrows are confined to the upper part of the slope of the bedrock bank, and on the FPT there is only one temporary burrow. Representatives of this group also make burrows in sunflower fields and eat sunflowers. There are eight individuals in it: two adults and six fingerlings. The family owns eight groups of burrows, including nine burrows. There are 1.11 burrows for each marmot. Thus, the third family is distinguished by a relatively small number of burrows.

The *fourth family* lives southeast of the third. Its territory ranges from the edge of the floodplain in the southwest to the sunflower field on the plain in the northeast. Six individuals were noted in it: four adults and two young. The family owns 23 groups of burrows, including 25 burrows. There are 4.17 burrows for each marmot.

The *fifth* and *sixth families* live in the northeastern part: one is to the southwest, and the second is to the northeast. Both families inhabit territories from the edge of the floodplain to the sunflower field. In this part of the river valley, the FPT is not expressed and the floodplain immediately passes into the slope of the bedrock bank, in the upper part of which the main burrows are located. In the *fifth* family of five individuals, there are two adults and three young. The family owns 18 groups of burrows, including 20 burrows. There are four holes for each marmot. In the *sixth* family, the most northeastern one, there are six individuals: three adults and three young. The family owns eight groups of burrows, including nine burrows. There are 1.5 burrows for each marmot.

In this area, marmots from five families, with a total number of 32 individuals, use part of the sunflower field bordering the colony for feeding. The area of sunflower crops poisoned by marmots in May–July is about 4.2 hectares. Consequently, one marmot eats up approximately 0.13 hectares of sunflower on average during May–July.

On the *second area*, there are only two adult marmots (male and female), one small family. It occupies the western part of the site from the floodplain to the southern border (Fig. 4a). There are three temporary holes and two permanent, making five in total. There are 2.5 burrows per marmot, including one constant.

On the *third section* (Fig. 4b), there is one family of six individuals. One of them is an adult female, and

five are young of the year. The family occupies the western part of the site, the edge of the upland and the slope of the bedrock bank. The group of burrows numbers 7, with nine burrows. There are four temporary holes and five permanent ones. Each marmot has 1.5 burrows, of which 0.83 are permanent.

The population density of marmot in the Strelets-kaya steppe ranges from 2 to 3.6 ind./ha, and in the Ostrovtsovskaya forest—steppe, there are about 2 ind./ha. Let us compare these indicators with data on other artificially created marmot colonies in the forest—steppe and in the southern part of the deciduous forest zone. The average population density of marmots in one of the areas of Mordovia (Lashtyrme) was 1.03 individuals per hectare (Andreichev et al., 2019), and in Mordovia as a whole, 1.54 individuals/ha (Andreichev et al., 2019). In Ulyanovsk oblast, the average population density is 1.6 individuals/ha (Naumov et al., 2014; Titov et al., 2015). In the largest marmot settlement in the Penza region, the population density is 1–1.25 individuals/ha (Rumyantsev et al., 2012; Rumyantsev et al., 2012). In Nizhny Novgorod oblast (Urazovskaya colony), the marmot population density is 1.04 individuals/ha (Andreichev et al., 2017). In southern Udmurtia, the average marmot population density is about 0.9 individuals/ha (Zagumenov, 2015). Thus, in the forest—steppe, the usual density of marmot population in colonies is about 1–1.5 individuals/ha, although under optimal conditions it can reach 4–5 individuals/ha or one family/ha (Rumyantsev et al., 2012).

CONCLUSIONS

In the Strelets-kaya steppe, reintroduction was not very successful. Initially, 118 individuals were released here, but by 2015 there were 38 left. From 2015 to 2023, the number of marmots had decreased to 12 individuals, and the total territory inhabited by them decreased from ten hectares to 3.7 hectares. Obviously, this is due to the limited area of habitats favorable for marmots. This is especially true for the fenced “Restored Steppe,” the area of which is sufficient for only one family, and there is no possibility of settling young animals. But on the “Pasture,” the marmots apparently mastered the most favorable, albeit small, territory, where their numbers stabilized at a low level. The population density here is normal for marmots in the forest—steppe, and the population is being reproduced.

The reintroduction of marmots into the Ostrovtsovskaya forest—steppe was more successful. The total number of animals for 2023 (48) is comparable to the number of marmots released in two years (64), and young ones make up a significant part of the population (61%), which indicates a fairly high intensity of

reproduction. Animals are settling within the Ostrovtsovskaya forest—steppe.

The population density in the surveyed marmot colonies ranges from two to 3.6 individuals/ha, which is apparently even slightly higher than the average for artificially created marmot settlements in the forest—steppe and neighboring territories. This is evidence that the colonies were created in biotopes suitable for marmots and are in normal condition.

In the Strelets-kaya steppe (“Pasture”), the marmot settlement is close to the steppe (diffuse) type. In the Ostrovtsovskaya forest—steppe, marmot settlements have a beam-type structure. Family plots are located in a “garland” along the slope of the river valley, in stripes from the edge of the main bank to the floodplain.

Data from the Ostrovtsovskaya forest—steppe confirm that the marmot can be a pest of some agricultural crops, like succulent plants, such as the sunflower. On the other hand, there have been no cases of damage to grain crops (wheat) by marmots.

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ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This work does not contain any studies involving human and animal subjects.

CONFLICT OF INTEREST

The authors of this work declare that they have no conflicts of interest.

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