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# Current condition of populations and spatial-environmental features of habitats of russet ground squirrel *Spermophilus major*

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**Abstract.** The russet ground squirrel *(Spermophilus major*) is known in the literature as a numerous widespread ground squirrel species. In recent decades, a decline in its abundance was found in some parts of its range. We have assessed the condition of this species in most parts of its distribution area based on our observations and interviews with local people. Spatial, landscape and vegetation cover parameters of *S. major* settlements have been studied. The research results showed a decline in the number, disappearance of settlements and a decrease in suitable habitats for this species. Small and medium-sized settlements with relatively low density of burrows, associated with low grass meadow communities typical for pastures and cattle grazing, prevail among the found settlements. One of the main factors for the decline in the number and disappearance of settlements of russet ground squirrel is, apparently, a decrease of pasture cattle grazing intensity. The continuing trend of degradation of pasture ecosystems may pose a threat to the existence of this species.

**Keywords:** ecology, *Spermophilus major*, features of settlement, species condition

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# Современное состояние популяций и пространственно-экологические особенности местообитаний большого суслика *Spermophilus major*

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**Аннотация.** Большой суслик (*Spermophilus major*) известен как многочисленный широкоареальный вид наземных беличьих. В последние десятилетия обнаружено падение его численности в отдельных частях ареала. Проведена оценка состояния вида на большей части территории его распространения на основании собственных наблюдений и данных интервьюирования местного населения. Исследованы пространственные, ландшафтные и фитоценотические параметры поселений *S. major*. Результаты показали снижение численности, исчезновение поселений и сокращение пригодных мест обитания данного вида. Среди обнаруженных колоний преобладают малые и средние по площади с относительно низкой плотностью нор, приуроченные к низкотравным луговым сообщества, характерным для пастбищ и выгонов скота. Одной из основных причин падения численности и исчезновения колоний большого суслика является, по-видимому, снижение интенсивности выгонного скотоводства крупного рогатого скота. Сохраняющаяся тенденция деградации пастбищных экосистем может представлять угрозу существованию вида.

**Ключевые слова:** экология, *Spermophilus major*, особенности расселения, состояние вида

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## Introduction

The russet ground squirrel, or russet souslik, *Spermophilus major* Pallas, 1778 is a typical representative of Eurasian wide-spread ground squirrels inhabiting open steppe biotopes. The species' range extends from the right bank of the Volga River to the Tobol-Ishim interfluve, bypassing the Ural Mountain Range from the south [1–3]. The russet ground squirrel, such as many other ground squirrel's species, is traditionally considered as an agricultural pest [4]. According to the literature data, this species can form large extensional settlements and inhabit even forest glades with extremely high numbers [5]. Many researchers at different times have noted the expansion of the limits of this species range in different directions [6–8]. However, there are evidences of a decrease in the number and extinction of russet ground squirrels in some parts of their area at present [9].

A significant number of studies of the russet souslik ecology [10; 11] and its hybridization with other species [12; 13] was conducted in marginal populations. Earlier, the specific discrete distribution [14] and a decline of population number [15] were observed in frontier parts of the species area. However, the central parts of the range remained under-researched, and the latest studies covering most of the range were conducted in the 1950s [1]. Meanwhile, conditions of ground squirrel habitats have changed overall significantly under the influence of changing kind and intensity of human activity since then, that was reflected in population demography. Recently, a decrease of the population number of small, red-cheeked and some other ground squirrels was shown [16; 17]. Some ground squirrel are endangered species now such as spotted souslik [18].

Global change of steppe biotopes occurring in recent decades under the influence of anthropogenic and natural factors can significantly affect the population conditions of their typical inhabitants such as the russet ground squirrel. In this regard, **the main task of our study** was to assess the demographic dynamics and factors affecting conditions and conservation of *S. major* populations. We also studied the spatial and ecological parameters at which the settlement of russet ground squirrel is stable and viable under the conditions of a decrease of suitable habitats, which is relevant both for predicting the state of the species and for planning conservation measures.

## Materials and methods

We have carried out 3 route expeditions in 2016–2018 with the total length of 14 000 km to find settlements of *S. major* throughout the most of the known species range for to assess the current state of its populations (Figure 1). Souslik's settlements were searched by surveying of potentially suitable habitats for the species living basing on literature data and interviewing of local people. Places of ground squirrels finding were recorded with GPS navigators. Both spatial and biotopic features of settlements and presence of key landscape elements were studied. The interview information and our observation data were compared.

The interview data was recorded in the original form. Due to heterogeneity, the obtained information was formalized and categorized within each data type. The information collected by local people interviews was categorized as follows:

1 – ground squirrels have been always, and they are now; 2 – ground squirrels were many but now they are few; 3 – ground squirrels were many but now they are none; 4 – ground squirrels were always few; 5 – ground squirrels have been never. Categories 1–4 include data from literature [1, 6; 7; 12; 19–21] in addition to the respondent reports. Our findings were categorized as follows: 1 – ground squirrels were observed; 2 – no ground squirrels were observed, inhabited burrows were found; 3 – only uninhabited burrows were found; 4 – no burrows were found. All found settlements were divided into 3 categories for convenience as follows: 1 – successful; 2 – stable; 3 – endangered. The settlements were categorized basing on general estimations of the area size and activity of animals. Due to the fact that russet ground squirrels are strongly attracted by pastures as it was shown earlier [1], we estimated the grazing pressure intensity on potential habitable for russet ground squirrel places during our survey by categories as follows: 1 – intensive grazing affecting the vegetation cover significantly; 2 – low pasture pressure weakly and locally affecting on vegetation; 3 – no pasture pressure. Different completeness data are collected for 168 localities.


**Figure 1.** Investigation area (compiled from [1–3] with changes):
*1* – studied settlements (settlement numbers correspond to the numbers in Table 1); *2* – route expeditions 2016–2018; *3* – border of russet ground squirrel distribution

Biotopic and spatial characteristics were collected for 24 settlements (Table 1) such as: area of settlement, type of plant community, grass height. Also, an approximate estimation of plant cover density on the most settlement area was made. The presence or absence of grazing, vegetable rags, road, and water body near the settlement were recorded. The area of the settlement was measured by determining the polygon area built along frontier burrows in the MapInfo Professional 8.5 software. The surveyed settlements were divided into three groups depending on occupied area: 1 – large (over 15 ha), 2 – medium (1.5 – 15 ha) and

3 – small (less than 1.5 ha). This part of the work included unpublished data collected in ground squirrel settlements near Skorodumskoye, Retnevo and Rechkalovo villages in 2009–2010 and in the vicinity of the Kharlovskoye village in 2012.

*Table 1*

**Spatial and ecological characteristics of studied russet ground squirrel settlements**

| Settlement No. | Location | Latitude | Longitude | *S*, ha | Density of holes, hole/ha | Grass height | Plant cover density, min–max, % | Water body/ road | Grazing/ vegetable rags |
|---|---|---|---|---|---|---|---|---|---|
| 1 | Sverdlovsk region, Irbit district, vicinities of Skorodumskoe village | 62.7039 | 57.5658 | 34 | 800 | 1–2 | 93<br>40–100 | +/+ | +/– |
| 2 | Sverdlovsk region, Irbit district, vicinity of Rechkalovo village | 62.8276 | 57.5853 | 8.84 | 317 | 1 | 87<br>40–100 | +/+ | +/– |
| 3 | Sverdlovsk region, Irbit district, vicinities of Retnevo village | 62.6361 | 57.5485 | 7.69 | 29 | 1–2 | 90 | +/+ | +/– |
| 4 | Sverdlovsk region, Irbit district, vicinities of Harlovskoe village | 63.0988 | 57.4361 | 6.05 | 318 | 1 | 70 | +/+ | +/– |
| 5 | Republic of Tatarstan, Aznakayevsky district, vicinities of Ursaevo village | 53.2206 | 55.0985 | 3.29 | 120 | 1 | 80 | +/+ | +/– |
| 6 | Republic of Bashkortostan, Iglinsky district, vicinities of Okhlebinino village | 56.3360 | 54.4966 | 0.9 | 45 | | 75 | +/+ | +/– |
| 7 | Republic of Bashkortostan, Davlekanovsky district, vicinities of Mikyashevo village | 54.6527 | 54.2184 | 6.38 | 146 | | | +/+ | +/– |
| 8 | Republic of Bashkortostan, Birsk district, vicinities of Mayadykovo village | 55.2152 | 55.2453 | 0.89 | 48 | 1 | 80 | +/+ | +/– |
| 9 | Republic of Bashkortostan, Iglinsky district, Kuyanovo village | 56.2237 | 54.6097 | 0.85 | 59 | 1 | 40 | +/– | +/– |
| 10 | Republic of Bashkortostan, Ufa district, vicinities of Stukolkino village | 55.8743 | 54.509 | 1.04 | 177 | 1 | 50 | +/+ | +/– |
| 11 | Kurgan region, Vargashinsky district, Verkhnesuerskoe village | 66.3034 | 55.9092 | 1 | – | 1 | 95 | +/+ | +/– |
| 12 | Kurgan region, Kurtamysh district, Stepnoe village | 64.8176 | 55.0795 | 0.99 | 94 | 1 | 90 | +/+ | +/– |
| 13 | Kurgan region, Safakulevsky district, vicinities of Safakulevo village | 62.5018 | 54.9953 | 1.52 | 58 | 1 | 85 | +/+ | +/– |
| 14 | Chelyabinsk region, Sosnovsky district, Dolgoderevenskoe village | 61.3091 | 55.3502 | 5.6 | 189 | 1; 3 | 50 | +/+ | +/– |
| 15 | Chelyabinsk region, Miass city district, vicinities of Chernivskoye village | 60.0525 | 54.9433 | 3.78 | 201 | 1 | 75 | +/+ | +/– |
| 16 | Orenburg region, Saraktash district, Ablyazovo village | 56.0682 | 51.8747 | 1.55 | 107 | 1 | 50 | –/+ | +/+ |

*Table 1, ending*

| Settlement No. | Location | Latitude | Longitude | *S*, ha | Density of holes, hole/ha | Grass height | Plant cover density, min–max, % | Water body/ road | Grazing/ vegetable rags |
|---|---|---|---|---|---|---|---|---|---|
| 17 | Orenburg region, Alexandrovsky district, Mikhailovka village | 54.7307 | 52.57042 | 1 | 18 | 1 | 75 | –/+ | +/– |
| 18 | Orenburg region, Novosergievskiy district, vicinities of Sredneuranskiy township | 53.9094 | 52.4031 | 8.6 | 52 | 1 | 50 | +/+ | +/+ |
| 19 | Orenburg region, Grachevsky district, Yagodnoye village | 52.9347 | 53.0493 | 13.24 | 94 | 1 | 95 | +/+ | +/+ |
| 20 | Orenburg region, Buguruslan district, Vishnevka township | 52.7786 | 53.7437 | 14 | 65 | 1–2 | | +/+ | +/+ |
| 21 | Orenburg region, Abdulinskiy urban district, Yegoryevka village | 53.8792 | 53.4771 | 3.68 | 75 | 1–2 | | +/+ | +/+ |
| 22 | Republic of Bashkortostan, Sharansky district, vicinities of Naratasty village | 53.9853 | 54.7869 | 1.8 | 93 | 1 | 80 | +/+ | +/– |
| 23 | Samara region, Klyavlinskiy district, 1.7 km W from Novyi Maklaush village | 52.0782 | 54.2472 | 1 | 251 | 1 | | –/+ | –/– |
| 24 | Samara region, Shentalinsky district, Tatar Abdikeevo village | 51.7605 | 54.4027 | 5.98 | 78 | 1-2 | 70 | +/+ | +/– |

The type of plant community was determined by photos of general views and model plots. A scale of categories has been adopted for formalizing of grass height measuring: 1 – grass to the ankle height; 2 – grass height to the middle of the shin; 3 – grass height above the knee. The density of burrow holes per hectare (hole/ha) was used as an indirect estimation of the settlement activity. We called exits from the burrow as burrow holes, while for the burrow we took a system of underground passages and dwelling chambers connected to each other in such a way that any point of the burrow could be reached without leaving the surface. This measure is not causally related to the number of animals but reflects the level of their digging activities. To search for burrow holes from one to several routes were installed through the settlement, in the course of which souslik's burrow holes found in the registration zone (2.5 m to the right and left of the researcher) were recorded. The density of burrow holes in the settlement was determined by the ratio of the number of found burrows holes to the registration zone area calculated per 1 ha. The results were extrapolated to the whole settlement.

A more accurate method of standard sampling was used in 2009–2010 in Skorodumskoye and Rechkalovo settlements to determine the density of holes. Seven routes were completed in Rechkalovo settlement and 15 routes in Skorodumskoye settlement A set of sites with an area of 25 $m^2$ each was installed on every route. Densities of burrow holes in the Skorodumskoye and Rechkalovo settlements were determined as the arithmetic mean density of burrow holes on all accounting sites of all routes in recalculation for 1 ha of area. For these settlements, we also calculated the Savage Selectivity Index for height and type of ve-

getation [22]. The selectivity index $w_i$ for each of factors was determined by dividing the number of sites used by ground squirrels ($O_i$) to the available sites in the settlement $\pi_i$:

$$w_i = O_i / \pi_i.$$

We applied the method of total mapping of burrow holes in Retnevo settlement and have mapped all the holes located at no more than 100 m from each other in it. The coordinates of the holes, which are located at least 6 m away, were determined by GPS-navigator Garmin Venture. Exits from the holes were searched for by zigzagging through the whole settlement. The step between turns was 3–4 meters. Burrow holes not considered during the first round were counted during the second round of the settlement. The location of burrow holes, which are closer than 6 m from each other, was measured by azimuth using a compass and a tape measure. Coordinates of this close located holes were calculated in the program MapInfo Professional 8.5 by the construction of segments with a given length and angle in relation to Greenwich from a point (burrow hole) with known coordinates. To estimate the validity of the method of route accounting of burrow holes and standardization of methods for estimating the density of burrow holes in this settlement resulting densities of burrow holes in 2 routes were compared with the calculated density by the results of total mapping.

The nonparametric Mann – Whitney test was used to compare categories of settlements. The average values of the area, density of burrow holes and projective vegetation cover were calculated with the standard error of the mean. Statistical processing of the material was carried out in Microsoft Excel and Statistica 8.0 software.

## Results

In total we examined 168 potential habitats of the russet ground squirrel (Table 2). According to our observations, most of the previously potentially suitable habitats for ground squirrels are now covered with high grass. Dwelling settlements of ground squirrels were found in only 79 surveyed areas (categories 1 and 2). Almost half of them (47%) are endangered settlements or alone burrows. Almost one-fifth of all found settlements (18%) was empty. Another 20% were settlements with low activity. Almost all successful settlements were in areas with intensive grazing, and most of the settlements found were located near a road and/or close to a water body.

According to our surveys, the number of empty settlements and places without traces of ground squirrel's vital activity increases on territories with low-intensity grazing (Figure 2). Since the priority task of the study was to search for ground squirrels settlements, which was carried out mainly in potentially suitable habitats or in sites described in the literature, most areas with high grass were not investigated as not promising for ground squirrel finding. Therefore, some settlements in areas with no grazing may be under-recorded.

In addition to wide settlements of ground squirrels, we also found lighted strip settlements along large roads with embankments and mowed roadsides. The longest

and most densely populated settlements of this type were found along the road between Tolyatti and Samara cities. For several tens of kilometers along this road, ground squirrels standing in a column were observed. In other parts of our route, it was rarely possible to see more than 2–3 ground squirrels for several kilometers. In total, we met 11 such settlements.

*Table 2*

**Information on the condition of settlements of russet ground squirrel by results of surveys of local people and our observations, number**

| Categories of data | Number of settlements by categories | | | |
|---|---|---|---|---|
| | Survey data | Our observations | Settlement condition | Grazing intensity |
| 1 | 20 | 60 | 25 | 50 |
| 2 | 32 | 19 | 16 | 57 |
| 3 | 19 | 17 | 37 | 38 |
| 4 | 8 | 72 | – | – |
| 5 | 3 | – | – | – |
| Total | 82 | 168 | 78 | 145 |

*Note:* category meanings are explained in the text in "Materials and methods" section.

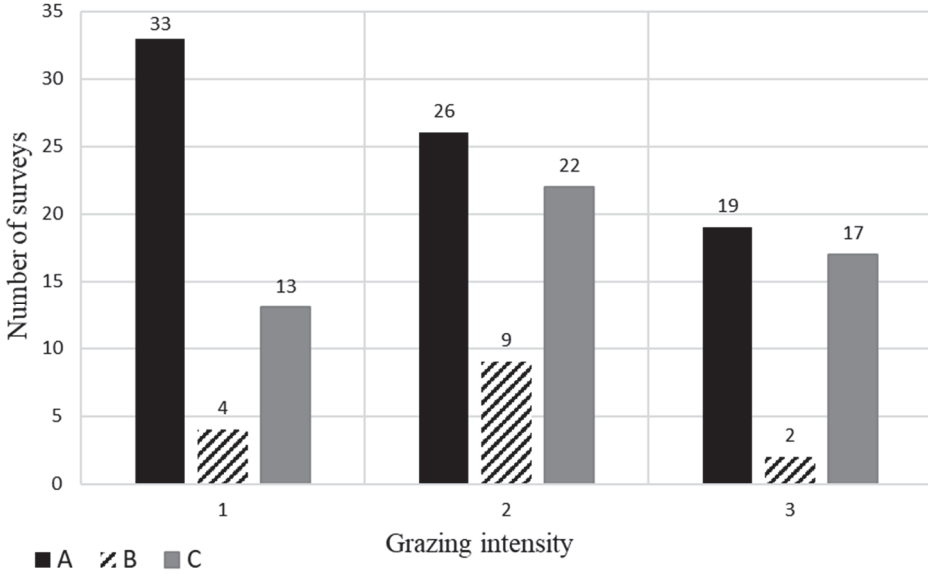


**Figure 2.** Encounter and habitability of russet ground squirrel settlements depending on presence and intensity of grazing:
categories of grazing intensity: *1* – intensive grazing, *2* – weak grazing, *3* – no grazing; habitats of settlements: *A* – inhabited settlements (1–2 categories of observations), *B* – uninhabited settlements (3), *C* – no settlements were found (4)

We obtained survey data for 82 out of 168 surveyed habitats from local people on habitat of the russet ground squirrel in the vicinity of the respondents' residence. The survey data in 96% of respondents indicate the presence of the russet ground squirrel in the past, with 86% of respondents talking about its high numbers (Figure 3, *a*). However, only 24% say that ground squirrels are still numerous, and 23% say that they have completely disappeared. Local people reported saving the species in 52 out of 82 cases, but only 60% of such reports were confirmed during survey of the territory. 32% of the interviewed respondents re-

ported the presence of animals, while they are not in this area at present day (Figure 3, *b*). However, only 2 out of 21 locations with ground squirrels, respondents reported as not having sousliks in the vicinity. In those places where a russet ground squirrel has always been rare according to the local people, only one inactive settlement has been found to date by us.

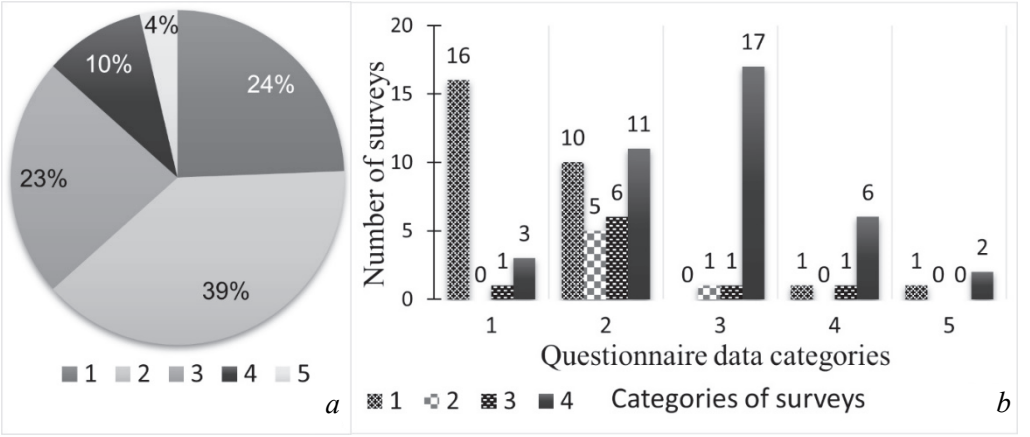


**Figure 3.** The condition of the russet ground squirrel populations according to the survey data (*a*) and the compare of our observations with the interview results (*b*): categories of survey data: *1* – ground squirrels have been always, and they are now, *2* – ground squirrels were many but now they are few, *3* – ground squirrels were many but now they are none, *4* – ground squirrels were always few, *5* – ground squirrels have been never; categories of our observations: *1* – ground squirrels were observed, *2* – no ground squirrels were observed, inhabited burrows were found, *3* – only uninhabited burrows were found, *4* – no burrows were found

A settlement near the village Skorodumskoye in the Sverdlovsk region has the largest area (34 ha in 2010) of the 24 studied settlements (Table 1). This settlement located near the northern boundary of the species range. The areas of all other settlements did not exceed 14 ha, and the minimum area was 0.85 ha. Fifteen settlements were classified as middle and eight as small ones. The average area of middle settlements was 6 ± 1 ha (limit min – max 1.52–13.24 ha). The average area of small settlements was 0.96 ± 0.02 ha (min – max 0.85–1.04 ha).

Analysis of the validity of the route method of registration of holes showed a tendency to overestimate by 10% comparing to the method of total mapping. The density of burrow holes in the only big settlement (Skorodumskoye) was 800 burrow/ha, which is considerably higher than in other studied settlements. The density of burrow holes in the category of medium-sized settlements averaged 129.5 ± 23 burrow/ha (min – max 29–318 burrow/ha). The average density of burrow holes in small settlements was 98.9 ± 31 burrow/ha (min – max 18–251 burrow/ha). No reliable differences in burrow densities were found between small and medium-sized settlements using Mann – Whitney test ($p > 0.5$).

All studied settlements are located in small-grass-forb meadows of various species composition with a herbage height up to 10 cm and rare low grasses up to 30 cm. Projective coverage varies from 40 to 100% in settlements. The average projective coverage across the total sample was 74 ± 4%. The projective coverage in medium and small settlements was 71 ± 4% and 73 ± 8% respectively. The only big settlement also does not differ from the other two categories of settlements by this feature.

On the bank of the pond are located 21 out of 24 settlements and only 1 settlement of all is not near the road. Almost all the surveyed settlements (23) have intensive grazing. An only settlement without grazing is located on overgrowing arable land. Among all surveyed settlements grass rags are found only in 7 small settlements.

Skorodumskoye and Rechkalovo settlements were used as model settlements for analysis of habitat preferences of the russet ground squirrel. Our data show that ground squirrels prefer to burrow in sites located on the slopes of river valley terraces. Despite the relatively low availability of slopes (the share of sites on slopes did not exceed 20% in the Skorodumskoye settlement), $w_i$ for such sites is 1.5 times higher than for sites without slopes in this settlement. This difference is even higher (3.8 times) in the Rechkalovo settlement (Table 3). In terms of vegetation type, ground squirrels clearly preferred areas with low grass. For such sites $w_i$ is almost 5 times higher than for sites with medium and high vegetation in Skorodumskoye and 4.6 times higher in Rechkalovo.

*Table 3*

**Selectivity of the russet ground squirrel by micro-relief and vegetation height**

| Characteristics of micro-relief and vegetation height | Accessible sites | | Used sites | | Savage selectivity index $w_i$ |
|---|---|---|---|---|---|
| | Number | % | Number | % | |
| *Skorodumskoye settlement* | | | | | |
| Slope | 7 | 16.7 | 7 | 23.3 | 1.4 |
| No slope | 35 | 83.3 | 23 | 76.7 | 0.92 |
| Vegetation height 1* | 31 | 73.8 | 28 | 93.3 | 1.26 |
| Vegetation height 2, 3 | 11 | 26.2 | 2 | 6.7 | 0.25 |
| *Rechkalovo settlement* | | | | | |
| Slope | 13 | 19.7 | 12 | 48 | 2.44 |
| No slope | 53 | 80.3 | 13 | 52 | 0.65 |
| Vegetation height 1 | 47 | 71.21 | 23 | 92 | 1.29 |
| Vegetation height 2, 3 | 19 | 28.79 | 2 | 8 | 0.28 |

*Note:* * according to the vegetation height categories specified in the "Materials and methods" section.

We re-examined the russet souslik settlements near Skorodumskoye, Retnevo and Rechkalovo villages in 2016. It was found that souslik settlements near Retnevo and Rechkalovo villages had almost completely disappeared, and the territories of both settlements were overgrown with high grass. In contrast, the Skorodumskoye settlement almost doubled its area and occupied about 50 ha at the time of the last survey.

## Discussion

According to our study, more than half of the russet ground squirrel habitats are currently not inhabited. About half of all places where animals were found are disappearing settlements or single burrows. We were able to find only one relatively large settlement, which not only survived, but also increased its area during the period of observation. This settlement may be considered quite successful in terms of size parameters and high average density of burrows. The low density of burrows indicates a decrease in burrowing activity in medium and small settlements. Low burrowing activity seems to be associated with a decline in animal

numbers, which is indicated by the disappearance of some russet ground squirrel settlements known from literature and the predominance of small settlements over most of the species area. This is also indicated by low animal activity in 20% of settlements we found. In conditions of suitable habitat area reducing, an increasing press of predators, as well as a factor of human disturbance, can play a significant role in reducing the number of ground squirrels. The human disturbance may be critical in some cases, as most of the recent russet ground squirrel habitats are located near human settlements. We found burrows filled with plastic bottles, sticks or other debris in settlements not rare. Local people often talked about a child's play of catching ground squirrels with water.

Not less than a fifth part of all settlements found were uninhabited. Apparently, these settlements were abandoned by ground squirrels during the last 3–5 years. According to our estimates, the russet ground squirrel burrows completely had degraded within 5–8 years, and in the formation of high grasses are not found out within a year. Considering of this, the finding of an uninhabited settlement with non-living burrows suggests a relatively recent extinction of the species in this place. The number of discovered abandoned settlements and biotopes, where even uninhabited burrows can no longer be found, have increased in places with weak grazing.

The predominance of small settlements, a relatively large number of uninhabited settlements, the extinction of animals in previously inhabited areas, as well as the absence of ground squirrels on a wide territory indicate a progressing depression of this species at present. Therefore, the inclusion of the gopher in the list of agricultural pests [4] is based on outdated data related to the period of optimal habitat of the species at the beginning of the last century [23] and seems unjustified at present.

Development of high-grass plant communities as a result of a sharp drop in the intensity of grazing on territories previously used for pastures may be the cause of current condition of this species. A sharp decline in the livestock population by 5–7 times and a reduction in grazing intensity by half below the optimal one occurred from 1990 to 2010 [24]. It was resulted in vegetation demutation in steppe ecosystems. To date, this trend persists. We found everywhere near human settlements on the surveyed territory destroyed livestock buildings designed for 3 thousand or more cattle, according to the local people evidence. Instead of them, usual herds not exceeding 35 cattle in most of studied places to date. Previously, it was shown that grazing is a critical condition for the formation of a low-grass plant community [25; 26], which is necessary for the successful living of all ground squirrels [1; 27]. Absence of grazing leads to the fact that habitats previously suitable for russet ground squirrel are now high grass floodplain meadows and steppes. Our observations in most cases correspond to this view (Figure 2). Low grass is preserved mainly near country roads, on mowed roadsides of large roads and on the banks of water bodies with intensive anthropogenic pressure. This explains the presence of these landscape elements in most of studied inhabited settlements. There are also places with naturally formed low grass without grazing where russet ground squirrel could be found, which are located mainly in the south of the species range.

Our study did not show any significant impact of the projective plant coverage on the viability of russet ground squirrel settlements. Although the russet

ground squirrel prefers levelled sites to hilly relief, we have found that it tends to micro-relief elevations. This can be explained by a better view and protection against the pouring of holes during heavy rainfall and floods.

The results of our study show that stably existing and developing settlements of russet ground squirrel are characterized by large area and high density of burrow holes. At the same time, there are critically few large and actively developing settlements remaining today. However, the number of animals and associated burrowing activity in medium-sized settlements is considerably lower then in the large ones. In this case, the stability of a settlement is maintained only due to the size of the occupied area. Therefore, medium-sized settlements can be considered as category between stable and endangered settlements. Larger settlements of this category (with an area above average) may remain stable for a long time or become successful if current conditions are maintained, while smaller settlements are more likely to disappear. Our data allows to assume that the minimum area of a stable settlement should be at least 6 ha under current conditions. If the area of the settlement is smaller, the animals should be additionally protected from predator pressure and negative human impact. An example is the settlement of a russet ground squirrel on the territory of an equestrian sports complex near the Kuyanovo village (settlement 9 in Table 1).

For half of the surveyed territories, we obtained species status estimates from local people. Even though about two-thirds of our respondents reported that this species is saved at the place of interview, our observations confirmed the presence of animals only a little more than in half of cases. In contrast, reports of the disappearance of russet ground squirrels in a territory are true in most cases. This indicates a high level of inertness of observations of local people, whose memories of past meetings of ground squirrels have been preserved. Thus, a differentiated approach to data in different categories is necessary when using survey data.

## Conclusion

Our research data, as well as interview results, show a significant decrease in the number of russet ground squirrels compared to the past everywhere. Features of detected sites with preserved settlements as well as the results of analysis of habitat preferences of the russet ground squirrel show that low-grass meadow communities, currently undergoing intensive degradation, are a prerequisite for the species existence. It is obvious that on the most part of the species range the decline in the number of species is connected with the change of the vegetation cover condition caused by the human economic activity, namely, a decrease in the intensity of grazing of cattle. The observed process of reduction in number and size of settlements of russet ground squirrel coincides with the common for the majority of ground squirrels of genus *Spermophilus*.

Clearly, apart from local factors, there are one or more common reasons for this process. Global climate change may be one of them. However, regardless of the reasons for the deterioration of ground squirrels, the problem of their conservation as key species to ensure the sustainability of steppe ecosystems is becoming extremely important at present.

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