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Vladimir N. Bolshakov, Nikolai S. Korytin, Yekaterinburg/Russia

Effect of Landscape Alteration on the Dynamics of Mammal Communities

Key words: Mammal communities, landscape structure, Ural mountains, Russia

Introduction

Small human-induced changes in landscape structure (like forest clearing and development of agriculture fields) are known to result with increased habitat patchness and ecotone length, and, consequently, increase in population density of many mammalian species (Leopold 1933, Yurgenson 1968, 1973, Korytin, Bolshakov, Markov, Pogodin 2002, Korytin, Markov, Pogodin 2003). Generally, moderate human-induced changes in habitat structure are favorable for wildlife. However, considerable landscape alteration results with contraction and fragmentation of geographical ranges of native species, changes in community structure, and dramatic changes in species abundances. The effect of human activity on habitat quality within the homogenous landscape could be, supposedly, simulated with Allee curve, type B (Alle, 1949, cit. by Odum, 1986), thus at early stages of habitat alteration, when the human influence is weak, the habitat quality increases, but after shifting over some threshold point the habitat quality decreases while the negative consequences are accumulated. Hence, the main problem of wildlife management is to determine the critical levels of human impact on native communities, after which the further landscape alteration would clear negative effect on ecosystem functioning.

In the given study we focused on the effect of human-induces landscape alteration of community structure of mammalian game species of Middle Ural region.

Study area

An analysis has been performed for the territory within the administrative borders of Sverdlovsk region (Sverdlovskaya oblast, eastern part of Middle Ural, between 55° and 61° n. l.). Basing on the results of cluster analysis of spatial and temporal dynamics of moose population five natural areas (NA) were described within the given region (Pogodin 1996). These natural areas significantly ($r \geq 0{,}8$, $p < 0{,}05$) overlapped the vegetation zones of Sverdlovsk region described by Kolesnikov (1974).

Particularly, north-western NA is northern and middle taiga of low and middle-height mountains of Middle Urals mountainous country; north-eastern NA covers the area of northern and middle taiga of Priobje lowlands and Trans-Ural plains; central NA is situated within the southern taiga of Trans-Urals peneplain and low mountains of Middle Urals; south-eastern NA includes the areas of mixed pine-birch-aspen forests of southern taiga and northern forest-steppe of Trans-Urals plain, and the south-

western NA includes the areas of mixed conifer-broadleaves forests and forest-steppe of western slope of Ural mountains) (Figure 1).

Method

Species under consideration were: red squirrel (*Sciurus vulgaris*), mountain hare (*Lepus timidus*), three artiodactyls species – moose (*Alces alces*), Siberian roe deer (*Capreolus pygargus*) and wild boar (*Sus scrofa*), and seven carnivores – grey wolf (*Canis lupus*), red fox (*Vulpes vulpes*), marten (*Martes martes*), stoat (*Mustela erminea*), Siberian weasel (*Mustela sibirica*), wolverine (*Gulo gulo*), and lynx (*Lynx lynx*). For each of these species data about the population density (ind/1000 ha) and abundance in 45 administrative districts of Sverdlovsk region were obtained from the results of annual winter route censuses organized by local game management authorities. For the given study we used the data for the period of 2001-2003.

To estimate the human impact on landscape structure we used the data about the squares of agriculture lands and human population density in rural areas of 45 administrative district of Sverdlovsk region.

From these data the following indexes were calculated for each of the described above natural areas (NA):

- total game species population density (TPD) as the sum of the population densities of all species under consideration;
- total population density of carnivores (CPD) as the sum of the population densities of carnivores under consideration;
- total population density of ungulates (UPD) as the sum of the population densities of artiodactyls under consideration;
- proportion of agricultural landscape (cultivated fields, hay-making areas, pastures) as a percentage of the total area of an administrative district

The relationships between these indexes were studied by means of linear and non-linear regression analysis.

Results

The NGAs differ in the shape of species-abundance curves, TPD and in CPD/UPD ratios (Table 1).

In northern taiga zone (north-western and north-eastern NA) red squirrel is the most abundant species, while in south-eastern and eastern NA (eastern slope of Ural mountains) that was mountain hare, and red squirrel occupied the second place. Moose occupies the third place in all NA, except the south-eastern one, where it was on the forth place after red squirrel, while Siberian roe deer occupied the second place after mountain hare. The last is well explained by the high proportion of open habitat and deciduous forests in the south-eastern part of Sverdlovsk region.

Among carnivores stoat is the most abundant species in the northern part of region, while in the south (south-western and central NA) the highest population density was observed for marten. In the south-eastern NA the most abundant species is red fox, and marten occupied the second place. The population density of grey wolf was very low in all NA, but the population density of wolverine in the northern areas (the southern areas lie beyond its geographical range) was even less. The population density of lynx everywhere was higher than population density of wolf (possibly because of wolf being more hunted than lynx).

An abrupt dip of the species-abundance curve was observed for the mountainous north-western NA, the smoothest dip was found for south-eastern NA. Other NAs occupy intermediate position. The other important feature of mountainous NA from the others is the highest value of TPD (Table 1). In this area total population den-

Table 1 Population density (ind/1000 ha) of carnivores and ungulates in natural areas of Sverdlovsk region.

NGA	TPD	CPD	UPD
North-western	30,24	2,4	1,76
South-western	18,83	1,54	1,62
North-eastern	13,94	1,66	1,15
Central	13,16	0,99	1,63
South-eastern	10,31	1,63	3,41

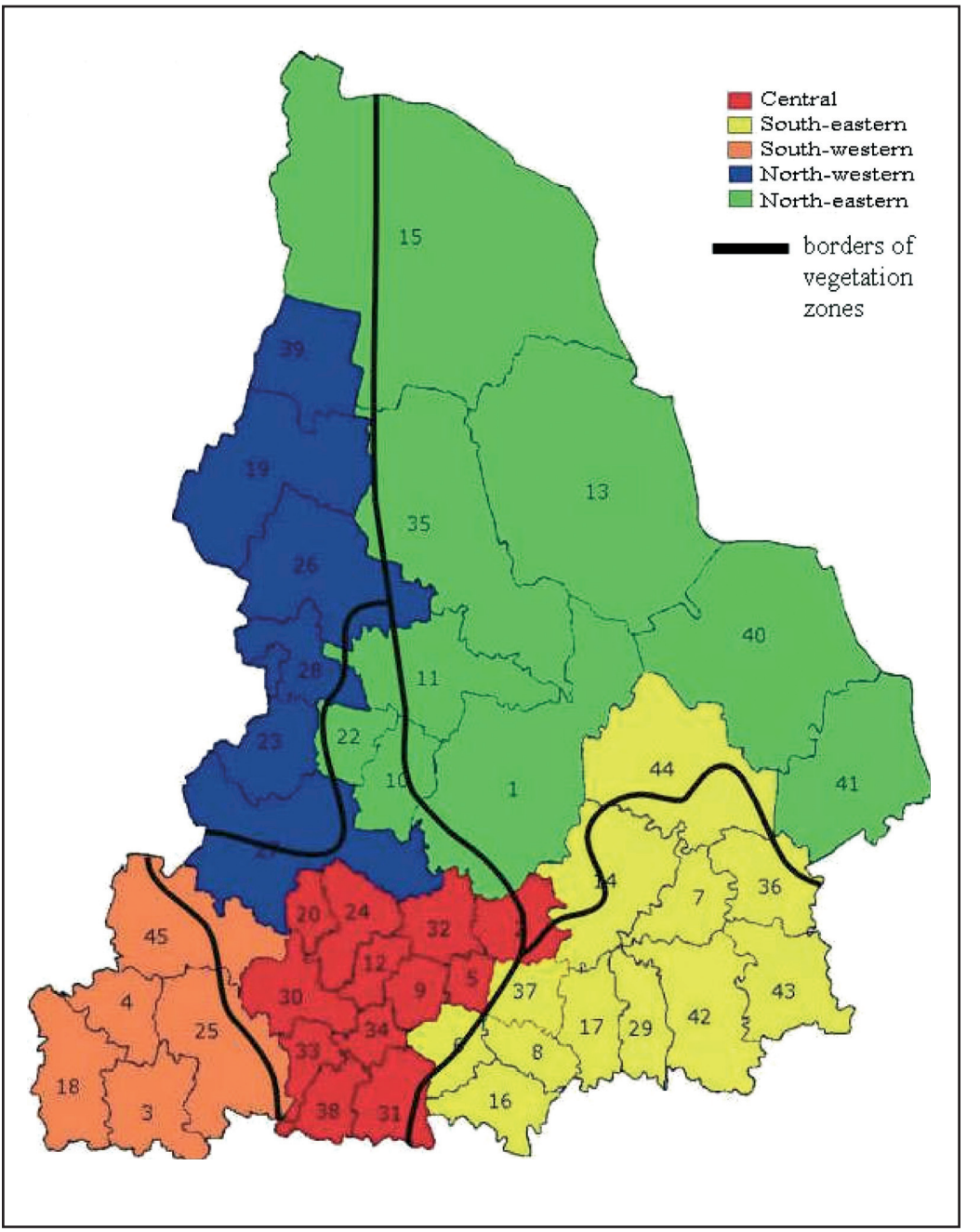

Figure 1 Natural areas extracted within Sverdlovsk region basing on analysis of moose population dynamics

sity is 30,24 ind/1000 ha, while the next value (south-western NA) is 18,83 ind/1000 ha, thus almost twice lower. Besides this, in this area the index of CPD was also the highest. The lowest value of CPD was observed for the south-eastern part of region, however, in this area we observed the highest value of UPD (Table 1).

The south-eastern NA is characterized with a highest proportion of agricultural land. In the north of region the proportion of agricultural lands does not exceed 5-6 % of total area, and in the central and south-western NAs it equals consequently 17 % and 27,5 %, but in the south-east of region the proportion of agricultural land reaches 33,6 %. This NA includes 12 administrative districts with the proportion of agricultural lands varying from 15,7 % to 56,6 %. The proportion of agricultural lands is linearly related to rural population density (Figure 2) – the growth of rural population results with increase of agricultural development.

The total number of species inhabiting given area decreases with the increase of the proportion of agricultural lands (Figure 3), particularly, big carnivores – wolverine, wolf and lynx fall out of the species list.

The increase of agricultural activity also has strong negative effect on the population density of red squirrel ($r = -0{,}87$; $p < 0{,}01$). Two

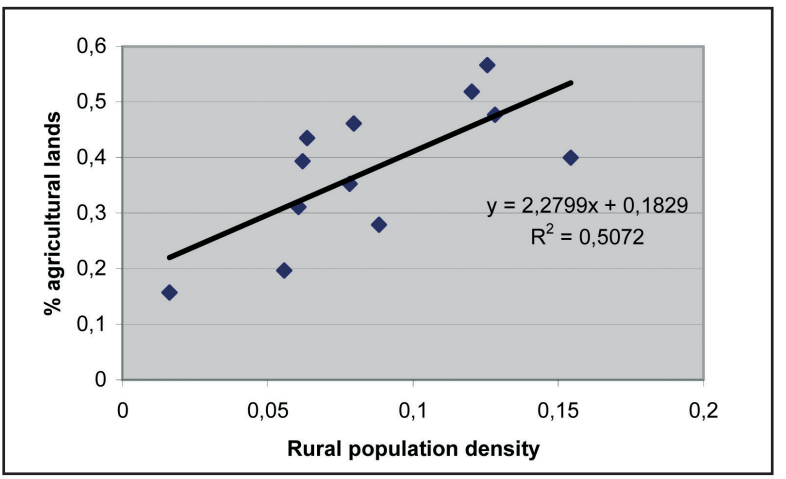

Fig. 2 Regression of the proportion of agricultural lands in administrative districts on rural population density

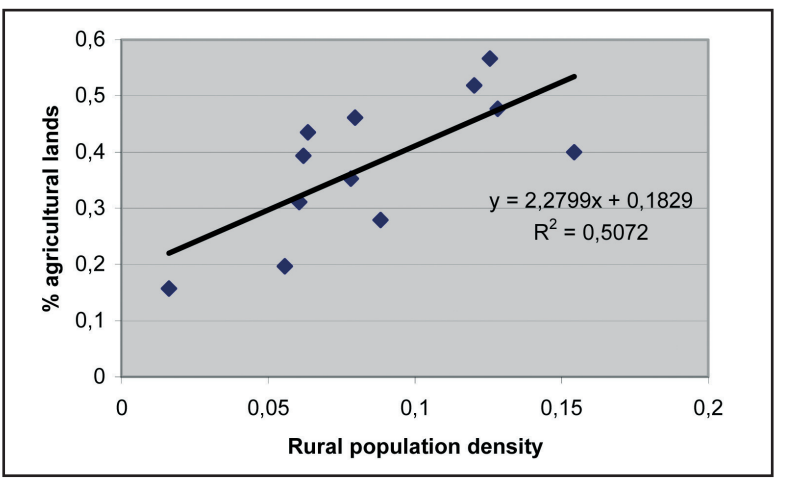

Fig. 3 Regression of the total number of game species on proportion of agricultural lands in administrative districts

of twelve species positively respond the landscape alteration associated with increase in the proportion of open habitat – that were red fox ($r = 0,77$; $p < 0,01$) and Siberian roe deer ($r = 0,85$; $p < 0,01$). The population density of both species considerably increase in the areas with high proportion of agricultural fields, this trend is especially pronounced for the roe deer (Figures 4 and 5).

Inscrease in the proportion of fields also causes an increase in population density of mountain hare ($r = 0,52$) however this correlation is not statistically significant at $\alpha = 0,05$. The abundances of all the other species decrease in highly transformed agriculture areas.

The proportion of three species – Siberian roe deer, fox and mountain hare – in the total abundance of game species in the given area reaches 80 % if the proportion of agricultural fields in this area is between 40 % – 50 %. If the proportion of fields exceed 50 % of the area, then proportion of these species in the total abundance reaches 90 %. Thus, increase in proportion of open habitat, particularly, agricultural fields results with the considerable changes in fauna of game mammals, decrease in abundance or extinction of big carnivores (wolf, wolverine, lynx), decrease in red squirrel population, and marked increase in abundances of three species – Siberian roe deer, red fox and mountain hare.

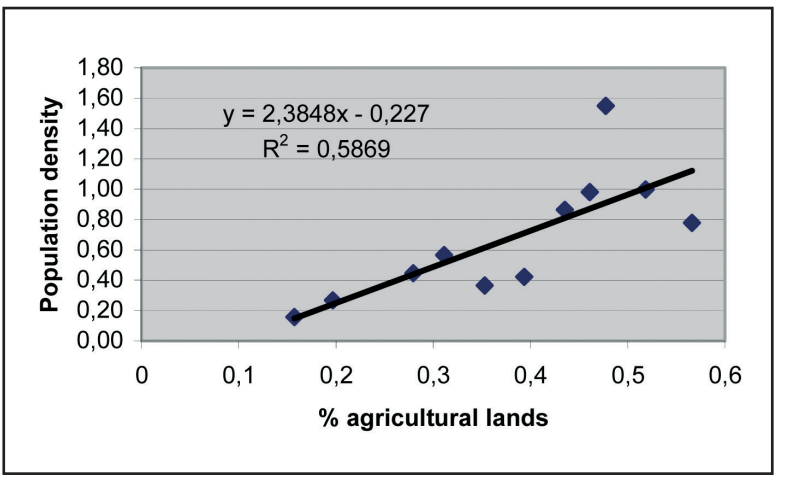

Fig. 4 Regression of red fox population density (ind/1000 ha) on the proportion of agricultural lands in administrative districts

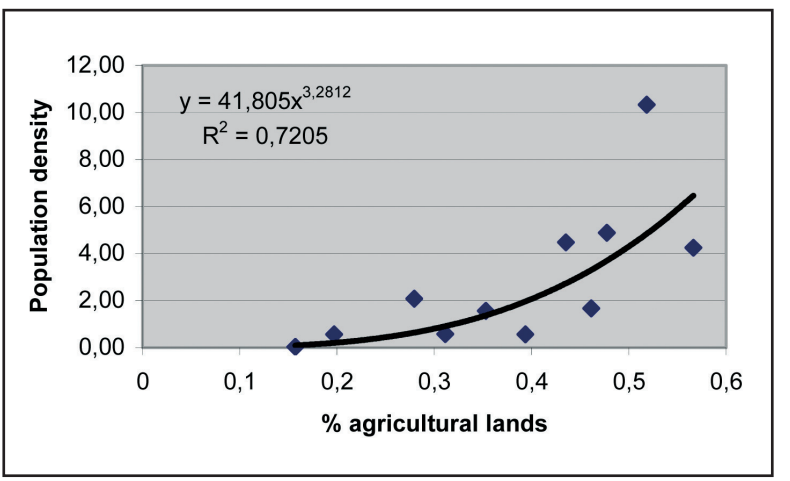

Fig. 5 Regression of Siberian roe deer population density (ind/1000 ha) on the proportion of agricultural lands in administrative districts

Summary

Effect of human-induced changes of landscape on mammal communities were studied by analyzing the relationship between the proportion of agricultural lands and rural population and abundance of game mammal species in Sverdlovskaya oblast (eastern part Middle Urals). As sampling units we used "natural areas" extracted basing on the analysis of moose population dynamics. Natural areas differed in the shape of the species-abundance curves and in the ratios of carnivores/ungulates population densities. The highest population density of carnivores was observed for northern areas, while the highest abundance of ungulates was found in the southern part of the region. Increase of the proportion of the agricultural lands causes decrease in the game species richness and abundance of big carnivores and increase of Siberian roe deer, red fox and mountain hare.

Literature

Kolesnikov, B.P. (1974): Lesorastitelniye usloviya i tipy lesov Sverdlovskoy oblasty [Forest-growing conditions and types of forest of Sverlovsk region]. – Sverdlovsk. UNC AN SSSR, 175 p.

Korytin, N.S.; Markov, N.I.; Pogodin, N.L. (2003): The effect of habitat patchness on the population density of ungulates. (Dynamics of game animals populations in Northern Europe) – Procceding of the 3rd International Symposium. 16–20 June, 2002, Sortavala, Karelia, Russia. Petrozavodsk, 119–122.

Korytin, N.S.; Bolshakov, V.N.; Markov, N.I.; Pogodin, N.L. (2002): The effect of habitat structure on the distribution and abundance of wild boar in Middle Urals. – Abstracts of IV International Wild Boar Symposium. Loisa, Portugal, September 19–22, 2002.

Leopold, A. (1933): Game management. – New York; London: C. Scribner's Sons, 481 p.

Odum E. (1986): Basic ecology. – Vol. 2. – Moscow: Mir, 704 p.

Pogodin, N.L. (1996): Otsenka stepeny skhodstva dynamiky chislennosty losya v razlichykh raionakh Sverdlovskoy oblasty. (Estimation of similarity of moose population dynamics in various districts of Sverdlovsk region). Problemy obschey I prikladnoy ekologii, Yekaterinburg, 173–183.

Yurgenson, P.B. (1973): Biologicheskiye osnovy vedeniya okhotnich'ego khozyaistva v lesakh [Biological principle of game mangament in forests]. Moscow: Lesnaya promyshlennost'. – 186 p. [In Russian].

Yurgenson, P.B. (1968): Okhotnich'y zvery I ptitsy (prikladnaya ekologiya) [Game mammals and birds (Apllied ecology)]. Moscow: Lesnaya promyshlennost'. – 308 p. [In Russian].

Anschrift der Verfasser:

Prof. Dr. V.N. Bolshakov
Prof. Dr. N.S. Korytin
Institute of Plant and Animal Ecology
Ural Division of Russian Academy of Sciences
620144 ul. 8 Marta, 202,
Yekaterinburg, Russia