**Трансформация экосистем**
**Ecosystem Transformation**

ISSN 2619-094X Print
ISSN 2619-0931 Online
www.ecosysttrans.com

*Review*

# Faunistic and ecological features of the order Lagomorpha in the Vologda Region, Russia

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Received: 18.11.2021
Revised: 23.11.2021
Accepted: 24.11.2021
Published online: 16.02.2022

DOI: 10.23859/estr-211118
UDC 591, 599, 908

Translated by D.M. Martynova

*Abstract.* Two species of the order Lagomorpha inhabit the territory of the Vologda Region (Russia), mountain hare *Lepus timidus* L., 1758 (common species) and brown hare *Lepus europaeus* Pallas, 1778 (rare species), as well as their hybrid ("tumak" hare). The morphological and ecological characteristics of the species have been analyzed. A complete bibliographic review of the order Lagomorpha of the Vologda Region is presented.

*Keywords*: *Lepus timidus* L., *Lepus europaeus* Pallas, protection.

*To cite this article.* Kolesova, N.S., Shabunov, A.A., 2022. Faunistic and ecological features of the order Lagomorpha in the Vologda Region, Russia. *Ecosystem Transformation* **5** (1), 59–71. https://doi.org/10.23859/estr-211118

## Introduction

The Vologda Region is one of the largest regions in the European part of Russia; its area covers 144500 km$^2$, locating in the middle and southern taiga subzones. Its large size is accompanied by many landscapes and biotopes, which promotes high species and ecological diversity. The range of terrestrial habitats noted on the territory of the region includes spruce forests, pine forests, small-leaved forests, swamps, meadows, and settlements. In terms of the, The Vologda Region has the greatest area of peat bogs comparing to other regions of the North-West of Russia; they occupy about 20230 km$^2$ (14% of territory). In this region, meadows are of secondary origin, except the floodplains.

The Vologda Region is inhabited by representatives of 14–15 thousand species of invertebrates and vertebrates belonging to 14 phyla and 33 classes; 421 vertebrate species are registered here. Mammals are represented by 66 species. The order Lagomorpha and the Leporidae family include mountain hare (*Lepus timidus* L., 1758) and brown hare (*Lepus europaeus* Pallas, 1778). Their hybrids ("tumak" hare, local common name) are also found in the region; however, they are found here very rarely (Shabunov et al., 2021).

A hybrid of mountain hare and brown hare ("tumak", *Lepus europaeus* × *timidus*) has an ambiguous taxonomic position as suggested by European and Russian taxonomists: *Lepus timidus* var. *tumak* Tichomirov and Korchagin, 1889 (Bock, 2020); *Lepus europaeus tumak* (Chapman and Flux, 1990); pro *L. tumac* Eversmann, 1850 nom. nud (Bock, 2020). When working on "The Animal Kingdom of the Vologda Region" (2021), the authors had to take into account the main audience to which the publication was directed, therefore, the existence of the "tumak" was written in passing, without information about its taxonomy. Within the framework of this article, we consider it appropriate to indicate more detailed information about the nomenclature of this hybrid.

Hares have always been an important hunting resource on the territory of the region, as evidenced by the first descriptions of the Vologda Province (Frize, 1806; Nadezhdin, 1838; Zasetsky, 1782; Zyablovsky, 1810, etc.).

The study aims to assess morphological and ecological features, as well as to characterize the

status of species of the order Lagomorpha inhabiting the Vologda Region.

## Materials and methods

The paper analyzes information from literary sources and monitoring data of hunting resources, the last were collected by the Department for the Protection, Control and Regulation of the Use of Fauna Objects in the Vologda Region. The primary data of winter route counts of the abundance of the mountain hare on the territory of the Russian North National Park for 2013–2021 are presented (Svodnye..., 2021). The work presents photographs by A.A. Krasilnikov, posted in the public domain on Internet resources (VKontakte) (Appendix, Figs. S1–S9). The names of taxa are given in accordance to the Fauna Europaea resource (https://fauna-eu.org) and the guidebook "Wild Animals of Russia" (Pavlinov, 2019).

## Results

### *Morphological characteristics*

Mountain hare has a body length of 45–80 cm, feet length of 12.5–19.0 cm, auricle length of 12–14 cm, and body mass of 3–5 kg; the characteristics of the brown hare are, respectively, 57–68 cm, 13.6–18.5 cm, 10.2–14.0 cm, and 5–6 kg (Gromov and Erbaeva, 1995; Konovalov, 2005).

The mountain hare has a gray-brown-ocher summer color with small ripples; it whitens completely for the winter, except the black tips of the ears; in summer, the ears have a white border. The mountain hare has four pairs of nipples. In total, sixteen subspecies of the mountain hare are known currently; *Lepus timidus* subsp. *timidus* L., 1758 inhabits the Vologda Region, its summer pelage is brownish-gray with an admixture of pale-gray and blackish. The anterior-inner edge of the auricle is black-brown with faint yellow-reddish ripples (Gromov and Erbaeva, 1995; Fauna Europaea).

The brown hare has an ocher-gray, dark brown, brown, ocher-red, or olive-brown color of various shades, with a large variegated pattern formed by black or black-brown undercoat hairs ends protruding between the guard fur (Gromov and Erbaeva, 1995). The pelage in summer is painted in a yellowish-fawn color with pronounced large ripples; in winter, it turns white on the sides of the body and hind limbs. The brown hare has three pairs of nipples. In addition, the brown hare differs from the mountain hare by the presence of a black spot (stripe) on the dorsal surface of the tail, as well as longer ears, legs and tail. The "tumak" hare inherits the coloring of *Lepus timidus* and *L. europaeus*, having wider paws than those of the brown hare. In winter, "tumak" whitens more and has a reddish shade of pelage on the head (Konovalov, 2005; Savinov and Lobanov, 1958; Savinov and Voropanova, 1957).

### *Species status in the Vologda Region*

*Lepus timidus* is a common species with a high abundance in the Vologda Region. *Lepus europaeus* is a rare species, included in the list of species requiring biological control (supervision) of their condition on the territory of the region[1]. This species is recommended to be included in the updated list of protected species, also in the rank of requiring biological control. It is known that at the beginning of the XX century, brown hare was also rare in the Kirillovsky District of the Vologda Province (Region). V.N. Shchegolev (1925) testified to the fact that mostly mountain hares were hunted, but brown hares, only in small numbers.

### *Distribution*

V.N. Shchegolev (1925) noted that both species were distributed throughout the territory of the Cherepovets Province (nowadays, Kirillovsky District of the Vologda Region), but the abundance of the brown hare was decreasing on its northern border. Mountain hare is currently widespread in the study area, while the distribution of the brown hare is mosaic. At the beginning of the XX century, the northern border of the range of the brown hare has shifted slightly northwards the line "Vytegra – Lipin Bor – Ustye-Kubenskoye – Nikol'sk". By the end of the 1950s, this species settled further north, and since the 1970s, its range margin shifted southwards (Shabunov et al., 2007). In the 1980s, the brown hare was more widespread in the western and central areas, where the forest cover was noticeably lower (about 40%) compared to the northern and eastern regions (about 80%) (Kiselev, 1984). At present, the mountain hare is found in all 26 administrative districts of the region, being a common species. The brown hare is recorded in nine districts: in Vologodsky, Gryazovetsky, Ustyuzhensky, Cherepovetsky, Sheksninsky, it has the status of common species, in Kaduysky, Kirillovsky, Sokolsky, and Ust-Kubinsky, status of rare species.

"Tumak" hares appear where the brown hare and the mountain hare are equally common, and in the years when the breeding periods of these two species coincide. There is a known case of mating of a male brown hare and a female mountain hare kept in the same cage in the Vologda Zoo in 1929, after which a hybrid hare appeared, but it was killed by one of the adult hares a day later (Savinov and Lobanov, 1958).

### *Population dynamics*

V.N. Shchegolev (1925) recorded a significant decrease in the number of hares in 1919–1920 as

[1] Decree of the Government of the Vologda Region dated 19.12.2006 No. 1274 "On approval of the list of animals listed in the Red Book of the Vologda Region".

a result of an infectious disease. In 1923–1925, an increase in the hare abundance was noted, probably associated with an increase in the number of clearings and burnt areas, as well as with a decrease in the number of hunters and foxes (Shchegolev, 1925). Since the 1970s, the number of the brown hare is stably decreasing (Shabunov et al., 2007), including due to poisoning with pesticides and fertilizers lying on the soil surface observed since the late 1970s–early 1980s (Kiselev, 1984). Both parasites and predators regulate the hare abundance, as well as hunting by humans using traps and loops. Trichostrongyloidosis, caused by nematodes, is the most usual zoonotic disease in the hare populations (Gruzdev, 1974; Naumov, 1947). In the Verkhovazhsky District, a positive correlation was revealed between the decrease in the number of mountain hare and lynx (Karbasnikov et al., 2021).

The number of mountain hares in the Russian Federation in 2020 amounted to about 3.4 million individuals, which is 4.3% or 138 thousand individuals more than in 2019 (Kharakteristika..., 2021). In 2000–2004, according to the data of winter route surveys, an increase in the number of this species was noted throughout the territory of Russia, after which a gradual decrease was recorded. In 2010–2020, the lowest abundance was recorded by counts performed in 2011 (2.8 million individuals), then the abundance was slowly recovering; since 2015, it is estimated at 3.2–3.4 million individuals. In the North-West of Russia, Volga and Ural federal districts, the total number is 1.1 million individuals (33% of the number of snow hares in the Russian Federation). In the Northwestern Federal District, the number of mountain hare has been decreasing since 2002, its minimum value, as in Russia as a whole, was recorded in 2011 (336.7 thousand individuals), then an increase began and in 2013 it amounted to 585.5 thousand individuals, which is close to the estimates obtained in 2008 (Zayats-belyak..., 2021; Kharacteristika..., 2021; Chislennost..., 2021).

The number of brown hares in the Russian Federation in 2010–2020 was 800–900 thousand individuals, in 2020, it amounted to 911.4 thousand individuals, which was 2.2% lower comparing to 2019 (Kharacteristika..., 2021). In 2008, the number of brown hare was 825.1 thousand individuals, in 2009, 847, in 2010, 838.6, in 2011, 853.2, in 2012, 866.3, and in 2013, 793.6 thousand individuals. Therefore, in 2013, the abundance of this species has decreased by 8.4% compared to 2012 and by 3.8 compared to 2008 (Sostoyanie.., 2021).

In the Vologda Region, there is a decrease in the number of both species of hares. In 1995–2005, there were 100–150 thousand individuals of mountain hare, 99975 individuals in 2008, 71,151 in 2017, 73293 in 2018 (as of 01.04), 73293 in 2019, and 70800 individuals in 2020. Brown hare had much lower abundance: about 5 thousand individuals in the early 1970s, 253 individuals in 2008, and only 49 individuals in 2018 (as of 01.04) (Publichnyi..., 2021; Shabunov et al., 2021).

## Biotope preferences

Brown hare and mountain hare are representatives of different ecological groups. Mountain hare is a eurytopic species inhabiting different types of habitats (meadows, especially bushy meadows, forest edges, sparse forests, swamps; it avoids dense tall coniferous forests). Brown hare is a species preferring open space (meadows, fields, and forest edges). In winter, the last one is often found in small settlements (in vegetable gardens, in orchards, and near haystacks). The preference of open spaces by the hare is explained by the forest-steppe range of the species and narrower paws of the hind limbs comparing to that in mountain hare, which makes it difficult to move on the snow cover. “Tumak” hare is equally adapted to life in the forest and in open spaces (Konovalov, 2005; Savinov and Lobanov, 1958; Savinov and Voropanova, 1957; Shabunov et al., 2007).

## Feeding peculiarities

Hares find food in the lower grassy layer (Savinov and Lobanov, 1958). The food spectrm of *Lepus timidus* includes over 60 plant species. In the snowless period, it feeds on grassy plants, in winter, on the bark and young shoots of trees and shrubs, as well as on winter grasses, which it gets from under the snow at a depth of no more than 15 cm. Mountain hare prefers such grassy plants as clover, cereals, bedstraw, dandelion, wormwood, and yarrow, and some arboreal and shrubs (aspen, willow, birch, oak, apple), less often, alder, black alder, elder, and young spruce.

The feeding activity of hares is the highest at dusk, at night, and before dawn. *Lepus europaeus* feeds on grassy vegetation, preferring cereals and legumes, moreover, even in winter, getting greens (wintercrop) or dry grasses from under the snow, like “tumak” hare does. It also eats cabbage stumps in the gardens and gets into barns with hay. Only when a solid snow crust is formed, which does not allow reaching the herbaceous vegetation, the hare feeds on bark and young tree branches (Konovalov, 2005; Savinov and Lobanov, 1958; Savinov and Voropanova, 1957; Shabunov et al., 2007).

## Life cycle, lifestyle, and activity

Both species of hares are active throughout the year, molt in spring and autumn, and have behavioral adaptations to protect themselves from predators: they entangle their tracks before lying down to rest (in the summer, in the depressions of the relief, in the winter, in the snow). They lead a solitary lifestyle; however, at feeding grounds, brown hares sometimes form large groups.

Mountain hare breeds at least 2–3 times a year: in the second half of March and early May. During these periods, several males chase the female, the fastest one mates. Pregnancy lasts about 50 days; 2–5 hares appear in the first litter, up to 6, in the second. Cubs of mountain hares are born sighted, covered with pelage, and active. The female hare does not build a nest for the cubs and feeds them with milk for the first time immediately after birth, then, every 3–4 days. The cubs spend the entire period between feedings without a mother and can do without food. Newborn cubs scatter on the grass, with which they merge in color and hide. On the 8–10$^{th}$ day, they independently eat the grass around them, on the 13$^{th}$ day, they can run quickly and make sharp jumps to the side, and at 10 months, young individuals are already able to reproduce.

Brown hare breeds at least 2 times a year: in April and after a while again. Three to eight rather developed cubs are born, able to feed on their own at the age of two weeks, reaching maturity a year later. A nest for the offspring is set up in the form of a shallow pit (Konovalov, 2005; Savinov and Lobanov, 1958; Savinov and Voropanova, 1957; Shabunov et al., 2007).

## *Biocoenotic role (as elements of the food web)*

Hares are the food for the birds of prey (northern goshawk *Accipiter gentilis* (L., 1758), western marsh harrier *Circus aeruginosus* (L., 1758), pale harrier *C. macrourus* (S.G. Gmelin, 1771), Montagu's harrier *C. pygargus* (L., 1758), large owls) and animals (red fox *Vulpes vulpes* (L., 1758), gray wolf *Canis lupus* (L., 1758), dog, Eurasian lynx *Lynx lynx* (L., 1758), European pine marten *Martes martes* (L., 1758), and European polecat *Mustela putorius* L., 1758) (Shchegolev, 1925). Stoat (*Mustela erminea* L., 1758) can feed on young hares. In addition, on the territory of the National Park "Russky Sever", mountain hare was noted as a part of the diet of the Eurasian eagle-owl *Bubo bubo* (L., 1758) among other large species, such as the muskrat *Ondatra zibethicus* (L., 1766) and the European water vole *Arvicola terrestris* (L., 1758) (Kaletskaya, 1973; Sharikov et al., 2016).

## *Commercial value*

Both species of hares are included in the list of the hunting resources of the Vologda Region, despite the low abundance of the brown hare. Mountain hare is one of the most important game animals (pelage and meat are used). In 2010–2011, in the Vologda Region, 3108 individuals of mountain hare were hunted during the hunting season, in 2011–2012, this number reached 4067 (Chislennost..., 2021). In the 1920s, in the Cherepovets Province, both hare species were dominant or sub-dominant (following the red squirrel) hunting objects (Belizin, 1929). In 1922–1923, 110472 hares were hunted in the province, total income after they were sold was 16570.8 Russian rubles (Shchegolev, 1925). In 1925–1926, 20167 hares and 74002 squirrels were hunted, in 1926–1927, 70451 and 46046 ind., and in 1927–1928, 22,688 and 34304 ind., respectively (Belizin, 1929).

Both species can harm plants: mountain hare damages bark and young branches of shrubs, brown hare damages gardens, forest plantations, and winter crops (Konovalov, 2005; Savinov and Voropanova, 1957; Savinov and Lobanov, 1958; Shabunov et al., 2007).

Hares are involved in the circulation of pathogens of some natural focal infections common or possible in the region: brucellosis, tularemia, hemorrhagic fever, intestinal yersiniosis, toxoplasmosis, and plague (Iersinioses…, 2014; Moskalev et al., 2016; Pokrovsky et al., 2007; Radchenko, 2007).

The negative role of hares was noted by A.A. Silantyev (1918) for entire European part of Russia, including Arkhangelsk and Vologda provinces. He referred to a significant grazng of young trunks of forest plantations, sometimes fruit trees, in winter or early spring. At the same time, there was no negative economic effect of hare activity in the fields and vegetable gardens.

## *Protection of species*

According to the data of the Department for the Protection, Control and Regulation of the Use of Fauna Objects in the Vologda Region, the abundance of brown hare is low, so it is necessary to limit hunting on this species. Hares, as well as foxes and common raccoon dogs, are hunted from September 15 to February 28 (29) at the permissible rate of one individual per hunting day. At the end of the hunting season, security raids are carried out, the cases of hunting identified are considered poaching (Departament..., 2021).

At the moment, brown hare is not observed at the territory of the National Park "Russky Sever", while an increase in the abundance of the mountain hare has been revealed (Fig. 1).

In the Darwin Reserve, the number of mountain hare is currently low, and brown hare only occasionally comes from neighboring agricultural lands (Darvinsky..., 1957, 2021). The abundance of both species has decreased since establishing of the Rybinsk Reservoir. This is due to the increased water level, so all thickets of shrubs and deciduous forests, which served as the main feeding grounds for hares, were flooded in the former floodplain, In the Darwin State Natural Biosphere Reserve, mountain hares stay on the hills, going out to feed on the outskirts of bogs, clearings, and burnt-out areas, covered with overgrowths of birch, aspen, and willow. At the beginning of winter, they visit low forested islands,

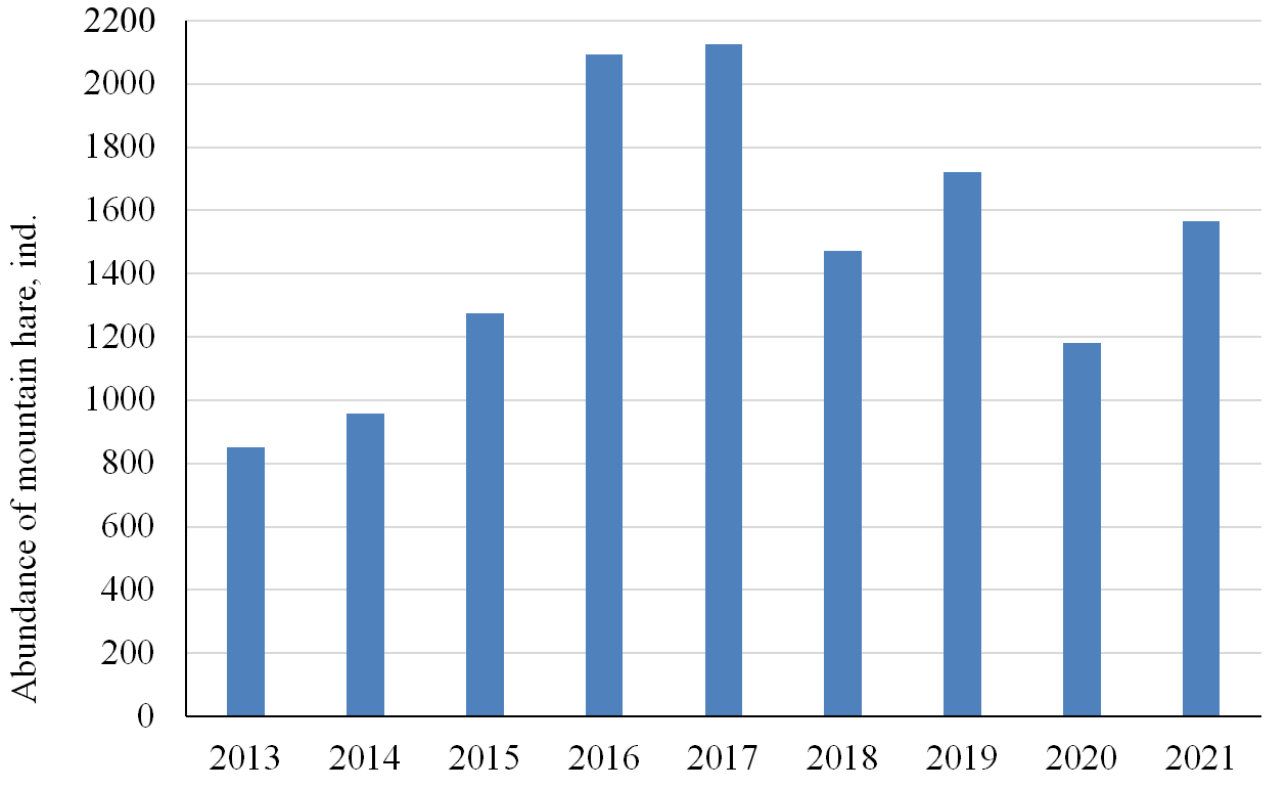


**Fig. 1.** The abundance of mountain hare on the territory of the National Park "Russky Sever" assessed by the primary data of winter route counts in 2013–2021.

where they extract fresh greens from under the snow in dry shallow waters, these greens develops here in the fall after being freed from the water at the end of summer.

## Conclusions

On the territory of the Vologda Region, two species of the order Lagomorpha live; their hybrid ("tumak" hare) has been noted as well. *Lepus timidus* is a common eurytopic species with a high abundance in all districts of the region; *Lepus europaeus* is a rare species, biotopically confined to open spaces and included in the list of species requiring biological control and conservation. Both species play an important biocenotic role, participating in food webs; they are also of epidemiological significance, they may be used as a food resource for locals, and they can harm agriculture and forestry. Currently, there is a downward trend in the number of both species.

## Acknowledgments

The authors are grateful to A.B. Chkhobadze for a discussion of the key provisions of the article and to A.A. Krasilnikov for the photographs provided. Special thanks go to National Park "Russky Sever", especially to L.V. Kuznetsova, for the courtesy of the primary data of winter route counts of the mountain hare population, and to Z.S. Elizar'eva for the photo editing.

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## APPENDIX

**Fig. S1.** Mountain hare. Russia, Vologda Region, Ust-Kubinsky District, 5 km northwards Ust'e settlement, May 25, 2017. Photo by A.A. Krasilnikov.

**Fig. S2.** Mountain hare. Russia, Vologda Region, Ust-Kubinsky District, 5 km northwards Ust'e settlement, May 29, 2021. Photo by A.A. Krasilnikov.

**Fig. S3.** Mountain hare. Russia, Vologda Region, Ust-Kubinsky District, 5 km northwards Ust'e settlement, May 29, 2021. Photo by A.A. Krasilnikov.

**Fig. S4.** Mountain hare. Russia, Vologda Region, Ust-Kubinsky District, 6 km northwestwards Ust'e settlement, May 29, 2021. Photo by A.A. Krasilnikov.

**Fig. S5.** Mountain hare. Russia, Vologda Region, Ust-Kubinsky District, 6 km northwestwards Ust'e settlement, May 29, 2021. Photo by A.A. Krasilnikov.

**Fig. S6.** Mountain hare. Russia, Vologda Region, Ust-Kubinsky District, 6 km northwestwards Ust'e settlement, May 29, 2021. Photo by A.A. Krasilnikov.

**Fig. S7.** Mountain hare. Russia, Vologda Region, Ust-Kubinsky District, 6 km northwestwards Ust'e settlement, May 29, 2021. Photo by A.A. Krasilnikov.

**Fig. S8.** Mountain hare. Russia, Vologda Region, Ust-Kubinsky District, 6 km northwestwards Ust'e settlement, May 29, 2021. Photo by A.A. Krasilnikov.

**Fig. S9.** Mountain hare. Russia, Vologda Region, Ust-Kubinsky District, 6 km northwestwards Ust'e settlement, May 29, 2021. Photo by A.A. Krasilnikov.