

Some ways to wildlife research in a megalopolis (on the example of the city of Nizhny Novgorod)

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Abstract. The paper is aimed to characterize the abundance of wildlife species listed in the Red Data Books of Russia and the Nizhny Novgorod Oblast on the territory of the city of Nizhny Novgorod, a megalopolis located in the geographical center of European Russia, to identify particular areas as habitats of rare species, to justify the need for protection of these areas. The analysis was based on the results of the authors' surveys, published data, stock information (since the end of the XIX century), facts collected by the methods of citizen science. We have been developed the database containing 938 units of information about the registrations of 119 rare wildlife species in the city and identified 37 areas as the most important habitats of rare wildlife species, the human transformation of which should be avoided or requires special attention to the conservation of rare wildlife species and their habitats. We have proposed the matrix to estimate the degree of protection of urban habitats of rare wildlife species. Today, the habitats of a third of rare species are not protected by law. If all 37 identified natural areas are adopted as protected, more than 82% of rare urban species will be provided with territorial protection in full or at a high level.

1 Introduction

The process of urbanization is rapidly developing: more than 50% of the world's population already lives in cities occupying less than 3% of the earth's surface [1]. Modern cities are the object of comprehensive research by many specialists [2-8]. Scientists identify specific features of the urban habitat for both flora and fauna [9]. Much attention is paid to the study and protection of urban biodiversity [10, 11], however, urban ecosystems as habitats for rare wildlife species have not been sufficiently studied. In the Russian scientific literature, much attention is paid to rare plant species growing in cities [12-21], the results of an

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inventory of rare wildlife species in urban protected areas (PA) are presented [22-24], or the distribution and abundance of rare species of separate taxonomic or ecological groups are surveyed [25-31]. Our goals were to discover rare wildlife species listed in the Red Data Books of Russia [32] and the Nizhny Novgorod Oblast [33, 34] in the territory of Nizhny Novgorod and identify particular areas, which these species inhabit. Nizhny Novgorod is a megalopolis located in the geographical center of European Russia at the confluence of the Volga and the Oka, its area within the administrative boundaries is 46,000 hectares, the population is about 1.2 million people.

2 Materials and methods

The information for our analysis was the results of the authors' surveys carried out on the territory of the City of Nizhny Novgorod in 1984-2023, published records of rare species in the city, stock information (since the end of the XIX century), as well as data from citizen science [35] about rare wildlife species, listed in the Red Data Book of Russia and the Nizhny Novgorod Oblast, which were encountered on the territory of the city of Nizhny Novgorod. Lost habitats of rare species (known due to old records) and all the registrations of rare species recognized as accidental were excluded from the census. A database has been compiled containing 938 units of information about the records of 119 rare wildlife species in the city. A point GIS-theme “Registrations of rare wildlife species on the territory of the city of Nizhny Novgorod” has been developed.

Based on these data, we have identified 37 areas that are the most important as habitats for rare wildlife species. While identifying these areas, we took note of the presence or absence of protected areas on them. Thus, we have developed a polygonal GIS-theme “The most important natural areas as habitats for rare wildlife species in the city of Nizhny Novgorod”. Lists of rare species have been compiled for each identified area, and its significance for these species is shown.

We tried to estimate the degree of legal protection of urban habitats of rare wildlife species and developed the special matrix presented in Table 1.

Table 1. The matrix to estimate the degree of legal protection of urban habitats of rare wildlife species.

Score	Degree of protection	Share of protected habitats, % of the identified
1	absent	0
2	weak	1-39
3	moderate	40-69
4	high	70-99
5	full	100

3 Results

The list of 37 identified areas is presented in Table 2, the number of rare species on them is shown in Table 3. Locations of rare species records within the city, which were used to analyze and identify the most important habitats, are shown in Figure 1; locations of important habitats of rare species (with area numbers similar to those in Table 2) and their ratio to urban protected areas – in Figure 2.

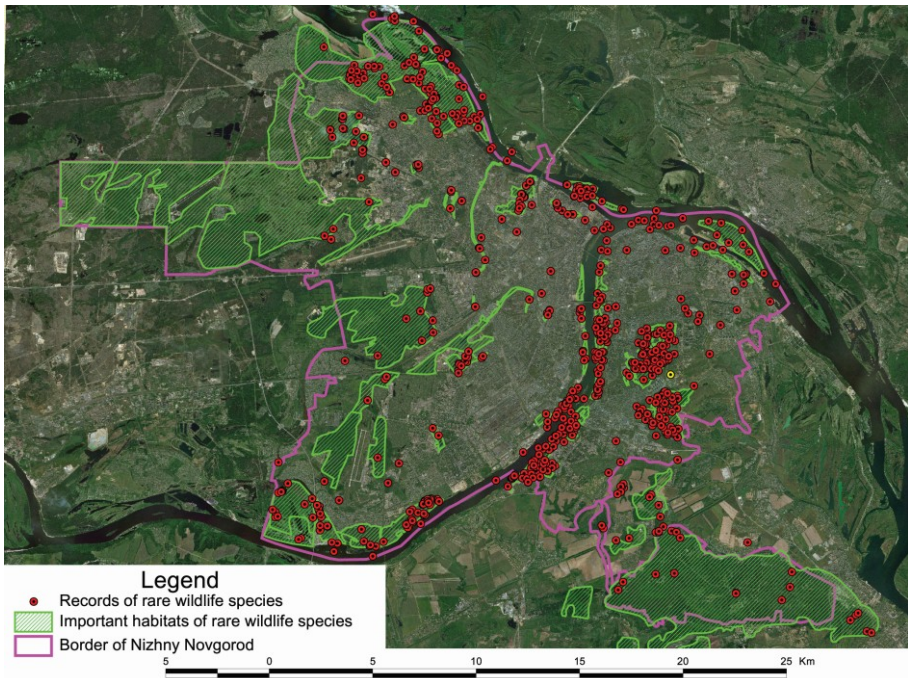


Fig. 1. Records of rare wildlife species of within the territory of the city of Nizhny Novgorod, used to identify the most important habitats of them.

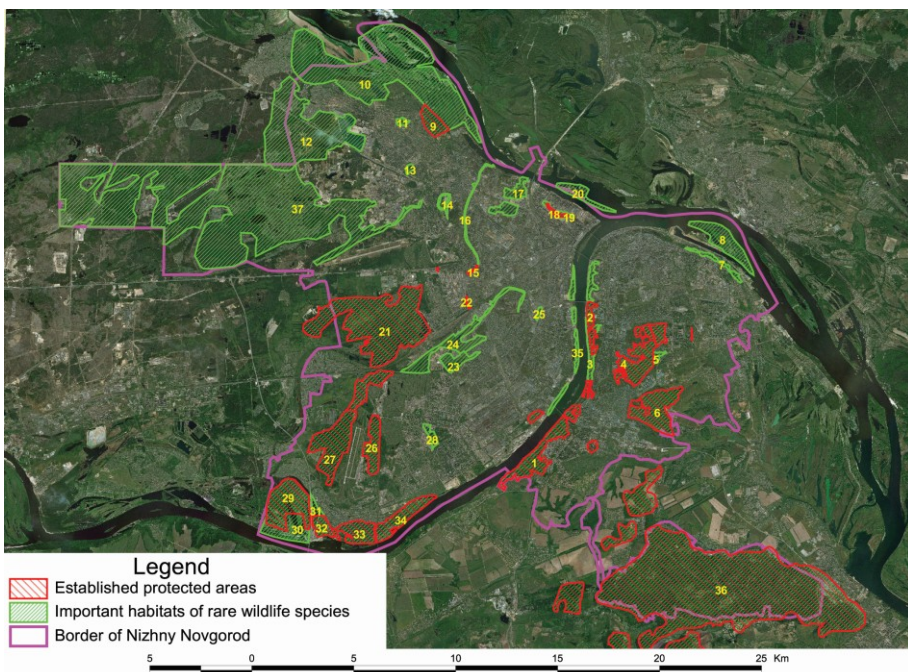


Fig. 2. Locations of important habitats of rare wildlife species within the territory of the city of Nizhny Novgorod and their overlapping with established protected areas (area numbers are similar to those shown in the Table 1 and 2).

Table 2. Nature areas within the territory of the city of Nizhny Novgorod, recognized as the most important habitats of rare wildlife species listed in the Red Data Book of Russia and the Nizhny Novgorod Oblast.

No.	Name of the area	Status of nature areas	Area, ha
1	Malinovaya Gryada Forest	nature sanctuary	295.6
2	Sluda natural boundary	nature sanctuary	78.8
3	Areas of Oka riverine slopes adjacent to the Sluda natural boundary	no	107.2
4	Schyolokovskiy Khutor Forest (including the Mariina Roscha Forest)	nature sanctuary	335.9
5	The stream valley lower of the Schyolokovskie lakes	no	17.9
6	Dubrava (Oak Forest) of Botanical Garden	nature sanctuary	315.9
7	Forests of Volga riverine slopes from the Pechersky Monastery to Podnovie	no	45.9
8	Pecherskiye Peski Island	no	231.7
9	Koposovskaya Dubrava Forest	nature sanctuary	107.2
10	Koposovskaya floodplain	no	2036.9
11	Swamps in the Koposovo village (with Beloye lake)	no	16.3
12	Lake Silicatnoe Sormovskoye and the adjacent pine forests	no	1160.2
13	Lake Svetloyarskoye	no	13.6
14	Lake Jubileynoe (in the Sormovsky Park)	no	19.3
15	Lake Bolnichnoe	nature sanctuary	5.7
16	Levinka river valley	no	33.6
17	Burnakovskaya lowland	no	123.9
18	Lake Meshcherskoe	nature sanctuary	15.4
19	Nature areas close to Lake Meshcherskoe	no	16.4
20	Islands on the Volga River opposite Lake Meshcherskoe	no	104.9
21	Zheleznodorozhnye Dachi Forest	nature sanctuary	1208.0
22	Lake near the Sortirovochny settlement	nature sanctuary	3.6
23	Lake Permyakovskoe with the surrounding area	no	87.5
24	Shuvalovskie swamps	no	258.4
25	Lake Silicatnoe (Leninsky district)	no	9.0
26	Smirnovskie Dachi Forest	nature sanctuary	305.3
27	Doskinskiye Dachi	nature sanctuary	371.0
28	Water bodies in the park of the Avtozavodsky district	no	34.5
29	Gnilitskie Dachi Forest	nature sanctuary	369.5
30	The Oka floodplain south of the Gnilitskie Dachi	no	193.1
31	Waterbody along the Gnlichka River close to the Pervomayskaya street	no	28.5
32	Talanova Roscha Forest	nature sanctuary	79.2
33	Striginskiy Bor Forest	nature sanctuary	171.1
34	Malyshevskie Grivy Forest	nature sanctuary	226.7
35	Nature areas of the Oka River left side from Myzinskiy Bridge to Metromost Bridge	no	90.1
36	Zelyony Gorod	nature sanctuary	4866.8
37	Forests of the Balakhninsky district forestry within the territory of the city of Nizhny Novgorod	no	4316.2
Total:			17700.8

Thus, 16 out of the identified important habitats already have got the status of protected areas (with a total area of 8,777.7 hectares), 21 (with a total area of 8,945.1 hectares) are not provided with legal protection.

Table 3. Number of rare wildlife species listed in the Red Data Book of Russia and Nizhny Novgorod Oblast that are registered in nature areas being the most important habitats on the territory of the city of Nizhny Novgorod (Numbers of areas are similar to those shown in the Table 2).

No. of area	Number of rare species, which			total
	the area is the most important habitat for	were recorded as regular visiting	were recorded as probable inhabiting	
1	15	2	7	24
2	18	1	2	21
3	14	1	1	16
4	14	1	5	20
5	4	1	3	8
6	9	0	9	18
7	6	0	2	8
8	2	1	3	6
9	3	3	1	7
10	13	3	6	22
11	1	0	0	1
12	7	2	1	10
13	2	2	0	4
14	2	1	0	3
15	1	1	0	2
16	2	1	0	3
17	1	2	5	8
18	1	3	0	4
19	0	3	0	3
20	2	7	0	9
21	3	1	4	8
22	1	0	0	1
23	2	2	0	4
24	0	0	1	1
25	1	2	0	3
26	2	0	1	3
27	0	0	3	3
28	1	1	0	2
29	7	4	3	14
30	0	4	1	5
31	2	2	1	5
32	5	2	1	8
33	3	0	1	4
34	12	3	2	17
35	2	6	1	9
36	12	0	2	14
37	5	0	4	9

4 Discussion

The composition of rare species in the city of Nizhny Novgorod is characterized with high taxonomic diversity. The number of rare species of different taxonomic groups is shown in Fig. 3.

The largest number of rare species in the city belongs to vascular plants (37), insects (36) and birds (26). The significant majority of 119 rare species inhabiting the city of Nizhny Novgorod, are listed only in the regional Red Data Book [27, 28], and 9 species are also listed in the Red Data Book of Russia [26].

We have discovered 88% out of 938 registrations of rare wildlife species were within 37 identified natural areas (Table 2).

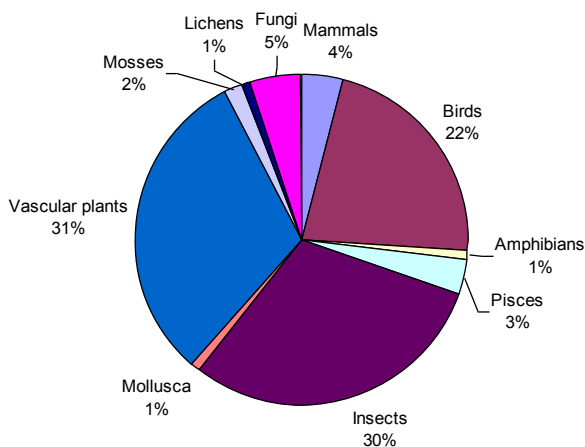


Fig. 3. Taxonomic structure of rare species registered in the city of Nizhny Novgorod (%).

The results of estimating the degree of legal protection of urban habitats of rare wildlife species are presented in Table 4.

Table 4. The degree of legal protection of urban habitats of rare species.

Score of legal protection	Share of rare species, % of the total number	
	Considering established protected areas	Considering the total protection of all the identified 37 areas
1	35.29	8.40
2	8.40	0.00
3	15.13	9.24
4	8.40	10.92
5	32.77	71.43
Total:	100.00	100.00

Today, considering the degree of legal protection of urban habitats we can declare a third (32.77%) of the urban rare wildlife species are as safe as possible, while the habitats of a slightly larger number of species (35.29%) are not legally protected at all. We evaluate the existing level of protection of rare species urban habitats as insufficient. It is necessary to provide legal protection for all 37 areas important for the conservation of urban biodiversity. In this case, more than two thirds of rare species will be under comprehensive territorial protection, and for almost 11% more species protection will reach a high level. Only 8.4% of the species will remain without any legal protection. Out of these 10 species four (*Vespertilio murinus* L., *Athene noctua* Scop., *Delichon urbicum* L., *Sphinx ligustri* L.) are synanthropic, 5 species inhabit large rivers (Oka and Volga) and one is *Meloe proscarabaeus* Pz. being insufficiently studied and difficult to identify, which was found the only time outside the large natural urban areas. Such a projected level of protection of urban habitats can be considered as satisfactory.

5 Conclusion

As a result of the analysis, we discovered the territory of the city of Nizhny Novgorod being inhabited by 119 rare wildlife species. The database developed by us contains 938

units of information about records of these species in the urban ecosystem of the city of Nizhny Novgorod.

The analysis of maps allowed us to identify 37 areas on the territory of the city – the most important habitats of rare wildlife species, the human transformation of which should be avoided or requires special attention to the conservation of rare wildlife species and their habitats.

A total of 16 areas out of the identified habitats already have the status of protected areas (with a total area of 8,777.7 hectares), 21 (with a total area of 8,945.1 hectares) are not protected. Today, the habitats of a third of rare species are not protected by law.

If all 37 identified natural areas are adopted as protected, more than 82% of rare urban species will be provided with territorial protection in full or at a high level.

Acknowledgments

The material of this research was partially prepared with the support of the Ministry of Ecology and Natural Resources of the Nizhny Novgorod Oblast, as well as within the project “Treasures of biodiversity of water bodies of the city of Nizhny Novgorod”, implemented by the Minin Nizhny Novgorod State Pedagogical University at the expense of the grant competition for environmental projects En + Group (contract BPP / GK-En-TsSPD-21-341 dated 01.06.2021)

References

1. A. S. Tretyakova, O. G. Baranova, S. A. Senator, N. N. Panasenko, A. V. Sutkin, M. Kh. Alikhadzhiyev, Studies of urban flora in Russia: current state and prospects. *Turczaninowia* **24**, **1**, 125-144 (2021) doi: 10.14258/turczaninowia.24.1.15
2. A. M. Danchenko, M. A. Danchenko, A. G. Myasnikov, Current State of Planting of Urban Forests and their Use. *Tomsk State University Journal of Biology*, **4** (**12**), 90-104 (2010)
3. A. E. Astashin, M. N. Pashkin, O.N. Pudeeva, M. M. Bad'in, A.I. Fomina, *Composition, Structure, Spatial Organization and Current Condition of the Urban Forest in a Large City (on the Example of the Beyond the River Part of Nizhny Novgorod, Russia)* IOP Conference Series: Earth and Environmental Science, **688**, 012021 (2021) doi:10.1088/1755-1315/688/1/012021
4. A. Babaeva, A. Makarova, E. Belova, A. Khamidulin, A. Latukhina, A. Krascheninnikov, *Semantic boundaries of the "city" concept*, E3S Web of Conferences, **402**, 09009 (2023) doi.org/10.1051/e3sconf/202340209009
5. G. S. Kamerilova, A. E. Astashin, N. I. Astashina, Landscape-ecological approach to the organization of scientific research activities of university students. *Vestnik of Minin University* **11** (**2**) (2023) doi: 10.26795/2307-1281-2023-11-2-3
6. E. P. Garina, S. D. Tsymbalov, S. N. Kuznetsova, N. S. Andryashina, E. G. Kislova, Formation of the Necessary Conditions for the Sustainable Development of Industrial Enterprises *Advances in Global Change Research*, **73**, 253-259 (2023)
7. K.V. Avilova, N.P. Kiyatkina, Bioeconomic Aspects of the City's Ecosystem Services on the example of the role of the Nightingale (*Luscinia luscinia*). *Byul. MOIP. Otd. boil.*, **124** (**4**), 3–9 (2019)
8. O.V. Semenyuk, K.S. Bodrov, G.V. Stoma, S.A. Yakovlev, Estimation of the Value of Ecosystem Services of the Natural Park “Bitzevsky Forest”. *Moscow University Soil Science Bulletin*, **3**, 23–30 (2019)

9. V. V. Zinovjev, S.V. Pestov, Biological Damage of Tree Leaves in Green Spaces of the City of Kirov, *Principles of the Ecology*, **4** (42), 38-48 (2021)
10. I. Kowarik, Urban biodiversity, ecosystems and the city. Insights from 50 years of the Berlin School of urban ecology. *Landscape and Urban Planning*, **240**, 104877 (2023)
11. L.B. Volkova, Urban tolerant butterfly species and conditions for their conservation in urban areas, *Animals in the city, Proceedings of the scientific and practical conference*, 71-74 (2000)
12. I.V. Sergeeva, E.V. Gulina, E. N. Shevchenko, New and rare species of urban flora of the city of Saratov, *Phytodiversity of Eastern Europe*, **17**(4) 165-170 (2023) doi: 10.24412/2072-8816-2023-17-3-165-170
13. N. A. Tremasova, Data on Records of New and Rare Alien Species in the Cities of Yaroslavl Province, *Byul. MOIP. Otd. boil.*, **127**(3) 35-39 (2022)
14. D. A. Mishagina Species of the orchid family (Orchidaceae) in the Ivanovo town, *Proceedings of the Mordovia State Nature Reserve*, **14**, 418-423 (2015)
15. O. P. Chebotareva, Y. M. Antipova, The Endemic and Protected Species in Flora of Abakan, *International Research Journal*, **11** (125), (2022) doi: <https://doi.org/10.23670/IRJ.2022.125.92>
16. A. Yu. Doronina, E. A. Volkova, V. N. Khramtsov, A. A. Belekhov, New Data on the Distribution of Rare And Protected Species of Vascular Plants In Saint Petersburg *Transactions of Karelian Research Centre of the Russian Academy of Sciences*, **1**, 94-100 (2021)
17. A. D. Krapivin, N. N. Panasenko, A. V. Matuzov, Flora of Bryansk on the iNaturalist platform. *Diversity of plant world*, **4** (15) 38-42 (2022) doi: 10.22281/2686-9713-2022-4-38-42
18. E. M. Antipova, Plants of the Krasnoyarsk Region Red Book (2022) in the Urban Flora of Krasnoyarsk. *Scientific Agronomy Journal*, **3**(122) 52-59 (2023) doi: 10.34736/FNC.2023.122.3.008.52-59
19. E. A. Borovichev, N.E. Koroleva, M.N. Kozhin, A.V. Melekhin, O.V. Petrova, Protection of Phytodiversity in a Mining Area (Khibiny Mts., Murmansk Region) *Moscow University Bulletin. Series 5, Geography*, **3**, 31-41 (2022)
20. Ya M. Golovanov, O. G. Baranova, To the question of preservation of rare species plants of urban flora in towns of the Southern industrial zone of the Bashkortostan Republic. *Bulletin of Udmurt University. Series Biology. Earth Sciences*, **1**, 026-032 (2013)
21. M. Sidorenko, I. Makeev, V. Yunina, N. Kiseleva, S. Bakka, O. Druzhkova, The conservation of some protected herbaceous plants in a wood park of Nizhni Novgorod metropolis. *E3S Web of Conferences* **480**, 02031 (2024) doi.org/10.1051/e3sconf/202448002031
22. V.V. Bobrov, The analysis of the representativeness of the protected area network of Moscow for the conservation of rare and endangered species of vertebrates (Vertebrata). *Socio-ecological technologies*, **1-2**, 55-69 (2014)
23. V.V. Korbut, Natural Complex, "Green Islands" and the Ecological Network of the Moscow Megapolis in the Context of the Ornithological Approach. *Moscow University Bulletin. Series 5, Geography*, **6**, 28-33 (2015)
24. I. S. Makeev, M. V. Sidorenko, V. P. Yunina, N. Y. Kiseleva, S.V. Bakka, Species diversity assessment of shore vegetation as a basis for environmental indication and tuning for environmental management (focused on wood park ponds cascade in a

- metropolis). IOP Conference Series: Earth and Environmental Science, **1010** (1), 012148 (2022) doi: 10.1088/1755-1315/1010/1/012148
25. N. M. Mingazova, O.Yu. Derevenskaya, O.V. Palagushkina, L.R. Pavlova, E.G. Nabeeva, N. R. Zaripova, R. I. Zamaletdinov, T. A. Kondrat'eva, Yu. I. Pavlov, E. N. Unkovskaya, M. G. Borisovich, L.Yu. Haliullina, Biodiversity of Kazan Water Objects. Scientific notes of Kazan University. Series Natural Sciences, **150** (4) 252-260 (2008)
 26. V. M. Kotkova, Aphylophoroid fungi (Basidiomycota) of the State Nature Reserve "Zapadnyy Kotlin" (St. Petersburg, Russia). News of taxonomy of lower plants, **57-2** 236-243 (2023) doi: 10.31111/nsnr/2023.57.2.F19
 27. R. I. Zamaletdinov, Development of Urbanized Areas and Herpetofauna Conservation Prospects (on an example of Kazan city). Current Studies in Herpetology, **17** (1-2), 21-27 (2017) doi: 10.18500/1814-60902017-17-1-2-21-27
 28. N. Iovchenko, Current state and problems of biodiversity and rare wader species conservation in an intensively developing megapolis (St. Petersburg). Environmental protection and conservation, **1**, 37-44 (2023)
 29. E. M. Pervushina, Community and spatial distribution of bats (Chiroptera, Vespertilionidae) in the industrial city Yekaterinburg, Tomsk State University Journal of Biology **57**, 89-108 (2022) doi: 10.17223/19988591/57/5
 30. N. A. Sobolev, L. B. Volkova, Representativeness of the List of Insects in the Red Book of the city of Moscow, Use and Protection of Natural Resources of Russia, **3** (163) 54–61 (2020)
 31. T.V. Levchenko, To the fauna of bees (Hymenoptera: Apoidea) of the “Krylatskie Kholmy” landscape reserve (Moscow), Mordovia University Bulletin **19** (1), 39–40 (2009).
 32. The Red Book of the Russian Federation, Vol. “Animals”. 2nd ed. (FGBU "VNII Ecology", Moscow, 2021)
 33. Red Data Book of the Nizhny Novgorod Oblast. Vol. 1. Animals. (DEKOM, Nizhny Novgorod, 2014)
 34. The Red Book of the Nizhny Novgorod Oblast. 2nd ed. revision and add. Volume 2 - Vascular plants, mosses, algae, lichens, fungi. (ROST-DOAFK, Kaliningrad, 2017)
 35. Biodiversity of the districts of Nizhny Novgorod,
https://www.inaturalist.org/observations?project_id=158191