Estimation of Status and Trend of Species Diversity of Terrestrial Vertebrates and Plants of the Nizhny Novgorod Region

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Abstract. The Nizhny Novgorod region is the only region of Russia where the Strategy of biological diversity conservation has the status of a normative act. It was approved by the regional government in 2000. The article aims to assess the status and trends of species diversity of wildlife in the region after the adoption of the Strategy. Two model groups of wildlife species were used for the assessment: terrestrial vertebrates (468 species) and vascular plants (1800 species). Changes in regional lists of species belonging to the model groups are analyzed. The share of terrestrial vertebrate species requiring protection is now 41% and it is slightly higher than at the end of the XX century. As in the 1990s, about a quarter of the native flora of plants requires protection to varying degrees. For species requiring protection, both terrestrial vertebrates and plants at the present time, as at the end of the XX century, the main limiting factor remains the human disturbance of habitats. The second most important limiting factor is the direct pursuit (hunting, catching and destruction) of rare species, although the significance of this factor in the XXI century has rather decreased. Limiting factors have not been known for 21% of species of terrestrial vertebrates and 7% of plant species, which encourages studying the biology of these species. It is shown that the solution of problems concerned with the protection of biological diversity should be the most important element of regional environmental management, and the strategy of biological diversity conservation of the Nizhny Novgorod region has been generally relevant. Suggestions for editing the Strategy and developing the Action Plan for the biodiversity conservation of the Nizhny Novgorod region are presented.

1. Introduction

According to the International Convention on Biological Diversity the states that have ratified the treaty should develop national strategies for the conservation and sustainable use of biological diversity [1-5]. The Nizhny Novgorod region is the only region of Russia where the regional Strategy for the biodiversity conservation has the status of a normative act. The strategy was approved by the resolution of the administration of the Nizhny Novgorod region of 20.12.2000, No. 320. Twenty years have passed since the preparation of materials justifying this Strategy. There have been some changes in the status, degree of study and protection of the biodiversity of the region for this period. The basic level for the organization of biodiversity protection is the species one. The analysis of the species richness conditions
and diversity of wildlife organisms (on the example of model groups) on the territory of the Nizhny Novgorod region was carried out in 1997-1999 [6]. There is a need to assess the changes that have occurred and use these estimates both to update the Strategy for the biodiversity conservation and to prepare the Action Plan for the biodiversity conservation in the Nizhny Novgorod region.

To assess the status and trends of wildlife species diversity in the Nizhny Novgorod region, two model groups of organisms were used: terrestrial vertebrates and vascular plants. Basing on the analysis of published information [7-12] and data of own long-term field surveys we have estimated the changes in the degree of study, conditions and species composition for these groups in 1998-2019.

A complete list of species of terrestrial vertebrates of the Nizhny Novgorod region was compiled (including new species discovered in 1999-2019). The population trend for each species over the past 20 years is estimated, the need for legal protection (including territorial), environmental status is indicated (listed in the Red Books of the Russian Federation and the Nizhny Novgorod region, Appendix 2 to the Red Book of the Nizhny Novgorod region). Limiting factors have been identified for species listed in the Red Book of the Nizhny Novgorod region, other species requiring protection, as well as for species that have been declining in their numbers over the past 20 years. The shares of rare, vulnerable and requiring the protection species have been determined for terrestrial vertebrates in total and for each class, and their trends as well comparing with 1998-2000. Also the significance of different limiting factors for rare, vulnerable and requiring the protection species of terrestrial vertebrates and its changes have been determined comparing to 1998-2000.

Basing on the analysis of published information we have compiled the list of rare, vulnerable and requiring the protection species of vascular plants of the Nizhny Novgorod region. We have determined the share of rare, vulnerable and requiring the protection plant species (of the total number of plant species in the Nizhny Novgorod region) and its trend comparing with 1998-2000. We have estimated the necessity for territorial protection of species, determined their conservation status and limiting factors. The significance of different limiting factors for rare, vulnerable and requiring the protection plant species and its changes have been evaluated comparing with 1998-2000.

2. Results and Discussion

2.1. Current status and trend of species diversity of terrestrial vertebrates

A total of 468 species of vertebrates, including mammals – 77, birds – 304 (225 nesting and nesting), reptiles – 7, amphibians – 12, fish – 66, lampreys – 2, has been registered on the territory of the Nizhny Novgorod region. There is no complete list of invertebrate species inhabiting the territory of the Nizhny Novgorod region. The analysis of the current status of the wild fauna of the region was carried out on the example of terrestrial vertebrates, as this group is the most studied. Only breeding bird species were undertaken for the analysis.

The species composition of terrestrial vertebrates has undergone significant changes in the region for the XX century, [6-10]. It has also changed over the past 20 years, although not as significant. The species composition of mammals has been supplemented by two new species (Eurasian least shrew – Sorex minutissimus Zimm., greater mole-rat – Spalax microphthalmus Gueld), which inhabited the region earlier, but were not discovered by researchers. Alongside, 17 new species of birds have appeared in the Nizhny Novgorod region (Levant Sparrowhawk – Accipiter brevipes (Severtzov), Caspian Plover – Charadrius asiaticus Pall., Whiskered Tern – Chlidonias hybrida (Pall.), Middle Spotted Woodpecker – Dendrocopos medius (L.), Eurasian Reed Warbler – Acrocephalus scirpaceus (Herrmann), African Stonechat – Saxicola torquatus (L.), Corn Bunting – Emberiza calandra L., etc.). The vast majority of new species that have appeared as a result of natural expansion of the range is of southern and southwestern origin, as it was being noted in the XX century too. Some species of birds have changed their status in the region. For example, the Great Egret – Egretta alba (L.) has moved from the vagrant to the category of breeding species. The Imperial Eagle (Red Book of the Russian Federation) have vanished as a breeding species due to the degradation of pastoral cattle breeding. It is extremely unfavorable fact. At the same time, the Black Stork – Ciconia nigra (L.) and the Willow Ptarmigan – Lagopus lagopus (L.), which are listed in the Red Book of the Russian Federation, have recovered their breeding populations.

We have determined the shares of species with different population trends in the period 1999-2019 (figure 1). Herewith we considered the general population trends, but not its dynamics over the years.
The obtained results were compared with the data of the previous analysis [6]. In 2019, we estimated the population trends of all terrestrial vertebrate species, whilst this figure was unknown for 23% of species 20 years ago. The share of species with relatively stable and positive population trend has increased in the XXI century. The share of species with negative trend has remained almost unchanged. The share of extinct (and probably extinct) species has decreased somewhat (due to birds).

![Population trends](image)

**Figure 1.** Population trends of terrestrial vertebrates for 1998-2019.

The share of terrestrial vertebrate species requiring the legal protection (figure 2), is now 41% and is slightly higher than at the end of the XX century [6].

![Protection share](image)

**Figure 2.** The share of terrestrial vertebrate species requiring protection in 2019.

Analysis of factors of human disturbance important for rare, endangered and vulnerable species of terrestrial vertebrates (figure 3) has shown that the most part of species suffers from habitat change as a result of economic activity.
Figure 3. Factors of human disturbance important for rare terrestrial vertebrate and their trends

The value of this factor had significantly decreased for the period of 1989-1999 due to the fact that at this time there was a rapid increase in the number and square of regional protected areas, the forests were not being logged as planned, overgrazing in the steppes stopped. Later, the role of this factor has increased again for the following reasons:

- A significant part of the habitats of a number of endangered species that recovered their numbers (for example, large birds of prey) have been outside of protected areas, the square of which has ceased to increase;
- Due to the development of lease relations in the forestry sector the rates of logging of old forests outside of protected areas have again become disastrous;
- Catastrophic fires caused significant damage to habitats [13];
- After excessive reduction of livestock pasturing the process of steppe restoration gradually and naturally was replaced by their increasing degradation;
- The threat of destruction of river floodplains have been urgent due to the building of large hydroengineering (Cheboksary hydroelectric power station, Nizhny Novgorod low-pressure hydroelectric complex);
- The degradation of floodplain meadows has begun as a result of the almost complete absence of haying and grazing;
- There is a new threat to the habitats of rare species – cottage building.

The increasing threat of habitat disturbance for rare species undoubtedly requires adequate countermeasures to enlarge the scale and improve their legal protection.
The second most important factor of human disturbance is the direct destruction (hunting and catching) of rare species, although the role of this factor has significantly decreased in the XXI century. The problems of state control over the illegal catching and poaching of rare species as well as the promotion of the necessity of their protection have remained urgent. The third most important factor is currently the influence of the anxiety factor. The impact on rare types of environmental pollution has almost stopped. Introduction of new species has been still insignificant. Limiting factors have not been known for a fifth of the species of terrestrial vertebrates, that encourages studying the biology of them.

2.2. Current status and trends of plant species diversity

The flora of vascular plants in the region currently comprises at least 1,800 species. The developing of modern flora took place during the last 18,000 years after the melting of the glacier (or, according to another scientific version, after lowering the level of flooding the territory). The last 10,000 years, changes in the plant species composition occur mainly under the human impact: repeated migrations of peoples, the expansion and reduction of slash-and-burn agriculture and pastoral cattle breeding, etc. These processes were accompanied by invasion and conscious introduction of wild species, naturalization of cultivated plants as well. In this regard, it is quite difficult to draw an unambiguous border between native flora and biological pollution. Taking into account floristic changes over the past 2-3 centuries we consider 1300 species of plants to be native flora and about 500 species to be introduced, cultured, and naturalized from culture. Mininzon and Trostina recognize 225 plant species as biological pollution [14]. The flora of the Nizhny Novgorod region comprised 1137 species in 1985 [15], and it is almost annually increased by several species. Mininzon notes 1786 species only for the territory of Nizhny Novgorod [16]. However, the most part of discovered species is included in the list as a result of better knowledge of the flora, and are not actually new in the region. It is not possible to determine the number of species that have invaded the territory of the region over the past 20 years.

About a quarter of native plant species in the Nizhny Novgorod region requires the protection of different degrees (figure 4). This share has changed slightly for the past 20 years, as well as the population status of the most part of species. In 1999, due to insufficient study of the flora of the region, we did not define the category of species "probably extinct", and now about 1% of native plant species can be recognized as ones.

![Figure 4. Distribution of plant species in the Nizhny Novgorod in 2019 according to their population status](image)

In 1999, 14% of plant species were declared to require the territorial protection [6], and in 2019 – 19%. This increase is not a consequence of the deterioration of the environmental conditions, but the better investigation of the flora.

The most important factor affecting on the rare and requiring the protection plant species of the Nizhny Novgorod region at the present time, as at the end of the XX century, is the habitat disturbance (figure 5). Comparing with the level of 1999, the share of species, which suffers from it, has increased. The share of species, which limiting factors are unknown, has significantly decreased. The impact of excessive picking has been somewhat reduced.
Figure 5. Factors of human disturbance important for 319 rare, endangered and vulnerable plant species of the Nizhny Novgorod region.

The distribution of species suffering from habitat disturbance has shown according to their habitats (figure 6) and types of disturbance (figure 7). It has not rather changed for the period 1999-2019. At the same time the number and distribution of steppe species was limited by overgrazing at the end of the XX century, and now this role belongs to insufficient pasturing.

Figure 6. Distribution of plant species suffering from habitat disturbance according to their habitats

Figure 7. Distribution of plant species suffering from habitat disturbance according to type of disturbance

3. Conclusion

The analysis showed that, despite the some successes of the protection status of biodiversity in the Nizhny Novgorod region remains critical. The share of rare and requiring the protection wildlife species of different taxonomic groups is rather high. There is the threat of extinction of some species. The human
impact (habitat disturbance) has been significant, whilst the level of environmental education of the population is insufficient. The problems related to the biodiversity conservation should be mainstreamed into the planning and activities of state bodies implementing the regional environmental politics and nature protection in the region.

The strategy of the biodiversity conservation in the Nizhny Novgorod region remains generally relevant. We have developed several proposals for editing it in accordance with the changes that have taken place for the last two decades. The main issues dealt with under the biodiversity strategy should be the restoration of lost diversity, destroyed natural communities, extinct and endangered wildlife species in the region. The most important strategic principles are as follows: the scientific research should be aimed at developing the scientific basis for the wildlife protection and practical recommendations for it, which should be mandatory implemented in the management decisions on wildlife; the implementation and governmental support of economic activities that cause minimal damage to nature; the restoration of economic activities that are necessary to maintain biological diversity (haymaking in floodplains, pastoral cattle breeding, cultivating of artificial oak forests, etc).

We have developed specific proposals for the Action Plan on the biodiversity conservation in the Nizhny Novgorod region for 2020-2035. The Plan includes following activities: 1) activities on maintaining the Red Data Book of the Nizhny Novgorod region according to the requirements of the Federal and regional legislation; 2) research and monitoring of biological diversity in the Nizhny Novgorod region; 3) monitoring of species listed in the Red Data Book of the Nizhny Novgorod region and their habitats; 4) environmental awareness-raising activities aimed at promoting the biodiversity conservation and enhancing public participation in the study and protection of biodiversity; 5) identification of problems related to the biodiversity conservation in the forest, game management and agriculture and development of recommendations for their solution.

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