

General Trends of Fauna Biodiversity Dynamics as a Result of the Anthropogenic Transformation of Meadow Landscapes in Belarus

M. PIKULIK

The data which have been collected within the last 25 years by the Institute of Zoology of National Academy of Sciences of Belarus are analyzed. These data characterize the influence of meadows' and other similar landscapes' anthropogenic transformation on different systematic groups of wild fauna biodiversity dynamics in Belarus.

After the Dnieper glacial period and the follow-up period of warming, glacials invaded the territory of Belarus two times radically transforming the landscapes, vegetation, and animal worlds. This happened between 220,000 and 110,000 years ago (Sozh or Moscow glacial period) and 95,000 and 10,000 years ago (Lake or Valday glacial period), respectively. Therefore, the final formation of the contemporary flora and fauna took place in the post-glacial period: the Holocene that came about between 10,000 and 8,000 years ago.

Since the last glacials did not cover the entire territory of Belarus some natural complexes in the south (Polesye) have a more ancient history of formation than complexes of the northern Belarus, the Lake District.

The territory of Belarus includes boundaries not only of the ancient glacial periods but also of the largest water sheds between the Black and Baltic Sea basins. These determining historic and geographic factors have exerted and continue to exert a huge impact on the formation, differentiation, and dynamics of biological diversity in the country.

The fauna of Belarus is characterized by the absence of endemic species, since - due to devastating glacial periods of the Pleistocene epoch - all species penetrated from the neighboring territories into the country at different times. At present, this flora represents a mixture of faunistic complexes belonging to 3 types of

endemic fauna: European, Siberian, and Mediterranean. A number of taxonomic groups have preserved a small amount of relict species.

An indicator of biological diversity of the wildlife in Belarus is the presence of 453 species of vertebrate animals and more than 30,000 species of invertebrates from different groups (protozoans, pearlwort, mollusks, worms, insects, spiders, crustaceans and other arthropods).

The geographic situation and climatic conditions of Belarus have stipulated the predominance of forest and aqueous bog-related ecosystems on its territory. As early as in the middle of 18th century, the area of forests was two times larger than today and covered more than 74 per cent of the entire area.

Meadow ecosystems occupy 3,286,100 hectares (15.8 per cent of Belarus). The structure of the vegetation cover includes about 24.4 per cent of meadows. According to their composition they are divided into river floodplain or water meadows (5.2%) and upland meadows (94.8%). According to their economic use, they are divided into hay areas (53.2 %) and pastures (46.8 %). As habitats of meadow species of vegetation, meadows are divided into rough, steppe, depleted, natural, rich wet and poor wet (peat-land), boggy, peat (open grass bogs). In the recent 35-40 years, meadow areas alongside boggy areas have been subjected to a severe transformation and their area has been reduced by almost 50 per cent.

The different forms of drainage reclamation followed by cattle pasture and agriculture are the main factors of influence on meadow landscapes.

The initial stage of the meadows' transformation is characterized by the changes of zoocenosis structure: the complete vanishing of single species, the reduc-

tion of numbers, the changing domination from one side; the appearance of new species, the increase in the number of some species and groups of animals from the other.

The landscape-geographic relationship between drainage boggy and inundation land reclamation was found. Zoocenosis of the wide inundation zones (Polesie, the South of Belarus) are more resistant than zoocenosis of narrow floodplain (Poozerje, the North of Belarus).

Naturally, Belarus' grasslands were represented by different types of marshes. However, historically, due to cutting down forests and drainage reclamation the anthropogenic types of grasslands such as dry meadows characterized by a variety of herb species and grassy fields with single species were established.

Bogs are complex natural formations that most of all have been subjected to anthropogenic transformation. Until the end of the 1950s the total area of bogs in Belarus had constituted about 4,130,000 hectares (19.9 per cent of the entire territory). It consisted of the share of open-type bogs totalling 2,080,000 hectares (50.3%), forest-covered bogs of 1,490,000 hectares (36.1%), shrub-covered bogs of 360,000 hectares (8.8%), and boggy meadows of 200,000 hectares (4.8%). According to their genesis, stratigraphy, and nature of the vegetation cover, bogs are divided into eutrophic grass and hypnum grass or low bogs (61.1 per cent of the total bog area), mesotrophic or upper sphagnum (18.2%) bogs. As a result of land reclamation, 1,775,000 hectares (42.4%) of bogs and boggy lands have been transformed into other agricultural land. Large-scale and intensive drainage of bogs and boggy land had been carried on from 1965 till 1975, later on till 1985 or even later, this process was less intensive. Today, the

Author: Prof. Mikhail M. PIKULIK, NASB Corresponding Member, The Institute of Zoology of the National Academy of Sciences of Belarus, 27, Akademichnaya Street, MINSK BY-220072, BELARUS

area of bogs and boggy land in natural condition constitutes about 2,300,000 hectares, of which only 795,500 hectares (33.5%) or 3.8 per cent of the Belarusian territory are open bogs. About 1,150,000 hectares (48.3 %) are occupied by forest bogs which constitutes about 5.5 per cent of the country's area.

Relationship between natural and anthropogenic ecosystems. At present, the ratio of areas of natural to man-transformed ecosystems is about 55 per cent to 45 per cent, respectively. It is known that the loss of 20 per cent (or even 10 per cent, depending on their ecological importance) of species leads to a disturbance of ecological equilibrium whereas preservation of 10 per cent of natural ecosystems allows preservation of about 5 per cent of species. Today, the results of scientific developments have shown that for Belarus, on condition of taking measures for providing a definite ecological optimization of extensively and especially of intensively used lands, the optimum ratio between natural, disturbed, and transformed ecosystems shall be as follows: specially protected natural territories 10 per cent, extensively used natural lands 40-45 per cent, and intensively used lands 45-50 per cent.

Priority ecosystems and communities to be protected

The main types of natural complexes that include practically the whole range of rare and anthropogenically vulnerable species as well as the main landscapes of natural origin, hence, mostly needing protection, are represented by the following complexes:

- low bogs of the Belarusian Polesye region;
- mesotrophic (transitory) bogs of Belarusian Polesye region;
- oligotrophic (upper) bogs of the Belarusian Lake District;
- moraine landscapes of the Belarusian Lake District;
- open spaces with remnants of Pontic (steppe) faunistic element;
- European broad-leaved woods;
- taiga and fir and small-leaved woods.

Of them, the priority protection should be given to ecosystems that have been least of all subjected to anthropogenic

transformation and that reflect the natural historic character as well as the relationship with biological diversity in the territory of the country.

From the point of view of preservation of diversity of wildlife, special importance shall be given to high eutrophic lakes, and medium-sized and large rivers with a high water supply plain (2.6 per cent of the total river length) that are least of all represented on the territories under protection, but that are characterized by the highest uniqueness and diversity of fauna.

Because of their biological diversity of vegetation the existing reserves and national nature parks are especially important, as well as the massive forest area "Nalibokskaya Pushcha" and the projected Svisloch-Berezina reserve in which the species composition of flora probably can be compared to that of the reserve forests of Belarus.

Under modern conditions of anthropogenic transformation of nature and their consequences it is very important to pay attention not only to the preserved ecosystems that remain in a relatively undisturbed state, but also to the most valuable, as regards the diversity of flora and fauna, territories that have been modified by human activities. At present, about 30% of species of animals registered in the Red Data Book of the Republic of Belarus have their habitats in places modified by man. More than half of them prefer such places or can be found exclusively on such territories.

Among **various types of anthropogenically transformed territories** the greatest importance for the preservation of diversity of fauna species is attributed to many artificial water reservoirs and fish-breeding ponds that are analogous to natural lakes in the most productive eutrophic stage, if we analyze the composition of fauna (mainly, that of birds); open reclaimed areas of former bogs or of previously drained shrub-covered plains or river floodplains; various, including unique, aged standing trees of natural origin, first of all large old parks of landscape types similar to natural woods that, however, have a more diverse composition and structure of vegetation and other ecological characteristics and that are habitats of original or rich

fauna complexes; agro-ecological zones representing specific and rather large territories with a traditional system of land use and other types of economic activities and with the established biotic complex that is usually rather rich, specific in nature, and often, has no analogies in the natural environment.

Main threats to biological diversity on the territory of Belarus

Natural threats

- ❶ Global changes in the environmental conditions
- ❷ Introduction, invasion (intervention), and hybridization.

Anthropogenic threats to biological diversity in various socio-economic sectors

❶ General data. The most significant adverse changes in the condition of wildlife have happened and continue to happen in Belarus as a result of a powerful anthropogenic impact both direct (hunting and extermination of animals) and indirect (liquidation or alteration of their habitat). Especially negative impact is exerted by such factors as the extensive inclusion of new natural territories into different spheres of human activities, ecologically unjustifiable drainage reclamation of boggy land and use of reclaimed facilities, failure to comply with correct use of poisonous chemicals and fertilizers, contamination of natural ecosystems by industrial waste, poaching, stress factors related to recreation, and development of the road network. Impacts exerted by the above factors are aggravated by a lack of ecological education and many economic leaders' and significant strata of the population's lack of responsibility, due to the absence of efficient legal and economic leverage stimulating environment-conservation activities.

Almost all the above factors related to wildlife have an adverse impact on the vegetation too (with the exception of poaching and stress factors). Ecologically incorrect use of vegetation resources (berries, medicinal resources, mushrooms), gathering of these resources using forbidden techniques and devices

and their failure to observe stipulated harvesting time periods may cause a significant damage to these irrecoverable resources.

② Territorial planning and town construction.

③ Transport and road construction.

④ Agriculture. Agrarian land use is considered to be one of the most important territorial factors that influences biological diversity of ecosystems. Agricultural lands occupy 8,758,300 hectares (over 40 per cent of the Belarusian territory). Besides, agrarian use of nature is one of the ancient intense kinds of economic activities that have substantially changed the spatial structure and functional features of the vegetation cover in the Republic. In general, ploughing of land, especially when accompanied by a preliminary drainage, decreases the number of natural localities for many species of plants and animals which, in the long run, results in a reduction of habitat areas and changes of their boundaries. On the other hand, the agrarian communities that are formed facilitate spreading of both indigenous and invasive species of cultured landscape as well as a change of their areas.

Above all, this is revealed in the formation of large and relatively uniform agricultural lands with homogeneous agrophytocenoses which are characterized by a low biological diversity. This circumstance is especially typical of the post-war period (after 1945) of intensification and specialization of agriculture. Enlargement of crop rotation fields, expansion of agricultural land areas through land reclamation, increase of the dose of fertilizers applied, introduction of industrial technologies of land cultivation not only have changed the spatial features of landscapes but also have brought liquidation of natural ecotones on agrarian areas. The latter have become the sole natural formations that have preserved biological diversity of the ecosystem. This phenomenon has resulted in fragmentation of landscape into large-scale land use facilities and large forests which do not allow the proper maintenance of biological diversity of ecosystems. This is especially typical of the Central and Eastern parts of Belarus where agricultural land use covers 75 per cent of the

area while the share of pasture reaches 60 per cent. Only during the last 25 years the average size of units of arable land has increased from 7.0 to 11.2 hectares, and that of agricultural lands from 4.0 to 7.2 hectares. A specially adverse impact on biological diversity on the species and ecosystem levels has been exerted by hydrotechnical land reclamation that was widely spread in Belarus in the 1960s and 1970s. The total area of drained agricultural land was 2,641,800 hectares, of which 1,140,000 hectares were covered by arable land. The largest land reclamation was carried out in the southern part of Belarus, i.e., in the Polesye Region. This led to extermination of natural ecosystems in this unique natural region. Here, we see disturbance not only of the spatial integrity of the geobotanic surface layer, but this also has resulted in its deep structural and functional transformation. This has been reflected in the spatial simplification of landscape structures, liquidation of wetland vegetation and use of bogs and low lands for agricultural purposes. One of the causes that brought about this situation was the disregard of tasks for the preservation of natural ecosystems of reclaimed areas, elements needed for the maintenance of biological diversity. Thus, in compliance with project and planning standards of land reclamation, the land use coefficient must not be less than 90 per cent. This means that after reclamation, 90 per cent of land must be compulsorily used as agricultural areas. In the long run, the lack of preservation measures has exerted an extremely adverse impact on the preservation of vegetation communities and maintenance of biological diversity in the region.

However, Belarus has territories with an optimum territorial combination of agricultural land, forests and meadows. Their mosaic has been predetermined by the natural landscape structures that still contain small areas with forests, natural meadows, and small arable areas. Examples of this can be found in some regions of the Belarusian Lake District, and in the central part of Belarus. Here, the area of natural ecosystems reaches 35-50 per cent which, in combination with meadow-oriented use of land, allows the steady maintenance of biological diversity both at the level

of species as well as at the level of the ecosystem.

Most vulnerable ecosystems and species

In the process of historic development, the main anthropogenic processes that affect the biological diversity of terrestrial animals have been: the felling of trees and changing of the structure of forests, drainage of bogs, and strong transformation of various elements of natural landscapes as a result of agricultural activities. Aquatic animals have been affected most of all by changes in hydrological conditions and contamination of water reservoirs. The area of forest habitats was reduced, to the greatest degree, in the first years after the World War II. At that time this area constituted 22 per cent of the territory, but later on it was increased to 33.7 per cent through artificial plantation of forests. The transformation of boggy habitats has turned to be more catastrophic. As a result of drainage open bogs that covered about 10 per cent of Belarus and constituted half of the entire bog areas of which two thirds were transformed into agricultural lands. Thus today, for example, about half of the birds that prefer to inhabit boggy or lowland areas have become rare and registered in the Red Data Book of the Republic of Belarus.

Relict species of the steppe complex are also under threat of complete vanishing from Belarus. It is precisely this complex that has suffered more than others from intense anthropogenic transformation of open landscapes. Parts of fauna species of this complex either have already vanished from Belarus or is under the threat of vanishing.

Among the most endangered species of fauna the predominant position is occupied by representatives of various types that live in lowland and boggy places and aged forests. For the majority of species that are under threat of vanishing in Europe and that have significant populations in Belarus the main habitats are river floodplains with abundant water flow and flooded forests. At present, the unique feature of the Belarusian territory and its importance for the preservation of biological diversity of Europe is

the availability in the Republic, mainly in its Polesye Region, of a still large area of river floodplains with strong water flows and low bogs.

The most important directions of activity for the conservation and sustainable use of biological diversity and their correspondence to local, national and international objectives are the following:

- ❶ Formation of State and international policy and further development of legislation;
- ❷ Optimisation of control, management and economic regulation of the use of biological diversity;
- ❸ Introduction of the National Red Data Book of rare and endangered species of animals and plants;
- ❹ Creation of a national network for monitoring the status of biological diversity;
- ❺ Creation of a State accounting system, and vegetation and wildlife land registers;
- ❻ Development of fundamental and applied sciences;
- ❼ Further development of network of specially protected natural territories and regions with limited antropogenic impact.

Formation of the ecological network of the Republic of Belarus

The ecological network is one of the main elements of the planning framework of the Republic. The ecological network means a unity of natural territorial complexes and ecosystems playing an important role in maintaining the ecological equilibrium and assuring a sustainable development of the territory, and the conservation of biological and landscape diversity. It is expedient to assure special nature-management regimes for the elements that constitute this ecological network.

Principal requirements to the organization of the national ecological network are defined by global and regional multilateral international conservation agreements (UN Convention on Biological Diversity, Rio-de-Janeiro, 1993; Ramsar Convention on Wetlands, 1971, as well as international and national ecological

programmes: "Declaration on Environment and Development" and "21st Century Agenda", "The National Strategy of Sustainable Development of the Republic of Belarus", Pan-European Biological and Landscape Diversity Strategy, the National Strategy and Action Plan for the Conservation of Biological Diversity). These include:

- preservation of an acceptable ratio between natural and urbanized areas;
- preservation, improvement of the status and restoration of the affected elements of the key ecosystems in the structure of the united ecological network;
- creation of conditions favorable for conservation of species and of sufficient opportunities for their spreading and migration by forming corridors or continuous transitional zones;
- creation, within the united ecological network, of specially protected natural areas and securing of ecologically safe development around such areas;
- restoration of degraded ecosystems;
- protection of the ecological network against threats, and organization and control over the formation and stable functioning of the ecological network when directions and parameters are determined for the development of urban areas, agriculture, transport, tourism and recreational, and of other economic sectors of the Republic;
- guaranteeing integration of the national ecological network into the Pan-European Ecological Network, the formation of which will allow conservation of the entire complex of ecosystems, habitats, species and their genetic diversity as well as of landscapes of European significance.

The ecological network of the Republic is at the stage of formation. In accordance with the preliminary development work, the ecological network has a complex functional and spatial structure. Its basic elements are natural complexes that have been least of all transformed by antropogenic factors and that are characterized by high indicators of biological diversity which are the nuclei of the ecological network and the interconnecting ways of migration of the genetic stocks. There should be differentiated

elements of European, international, national and local importance. It has been stipulated that the ecological network represents a special aspect of territorial planning. Its formation and development must be carried out on the basis of a system of special scientific and project documents.

The most important (key) elements that form the nuclei of the ecological network are large and well-preserved natural complexes part of which, at present, have the status of reserves and national parks (areas belonging to protection categories I and II according to the international classification) whereas another part requires the establishment of special protection regimes. Structure-forming elements of the zoological network of a lower hierarchy level include smaller natural complexes that have the status of partial reserves of republican and local importance (categories IV-V according to international classification) or need a special protection regime.

Interconnecting elements of the ecological network, i.e., ways for migratory genetic stocks of European and interstate importance, are valleys of big and medium-sized rivers. They include areas that have the status of national and local reserves as well as those that require such status. The role of migration paths of national or local importance is played, as a rule, by valleys of small rivers, forests as well as by certain parts of agricultural land and natural recreational areas.

Preliminary research data have been used as a basis for including the complexes of the Berezina Biosphere Reserve, the National Park "Belovezhskaya Pushcha" and the Pripyat Polesye with the valley of the Pripyat River.

The key components of the ecological network that are important for several states are:

- the valley of the West Dvina, the Surazh forest, the northern and central part of the Polotsk plain lands including natural complexes of Rosson and Osveya lake groups, the forest and bog complex Yelnya and Braslav Ridge;
- the valley of the Vilya River with the natural complex of the Naroch lake

groups as well as the valley of the Niemen River with Nalibokskaya and Grodno reserve forests;

- the valley of the Dnieper river.

The most important structures that constitute the ecological network of national importance are the valley of the Berezina River with Svisloch and Berezina forests, the Minsk Hills with the Logoy-sk natural complex.

Ecological optimization of activities of different social and economic sectors

Agriculture which is the dominant sector as regards impact on biological diversity of the measures on preservation of biological diversity must be developed along the following directions:

- Improvement of the ecological capacity of vast uniform agricultural territories as habitats of animals and plants by increasing their landscape diversity, changing their planning structure,

and combining annual crops with perennial crops.

- Soil cultivation methods should include only such methods that cause a minimum of destruction and erosion of soils, and reduce the transfer (washout) of the fertile layer from the cultivated land.
- It is necessary to provide special devices for agricultural machines that often cause death of animals and apply methods for stimulating farms and enterprises as well as individual workers to take measures aimed at protecting animals when mechanical operations are used.
- It is required to stimulate the limited use of chemicals hazardous to animals, observe the fertilizer introduction techniques and exclude the use of chemical treatment from aircraft.
- To assure the maximum prevention of erosion and depletion of soils, i.e., the processes that increase the area of waste land, thus, making it necessary to use new land with natural vegetation.

In conformity with the priorities mapped out in the Pan-European Strategy in the sphere of biological and landscape diversity that were emphasized during the National Seminar devoted to issues of implementation of the National Strategy and Action Plan for the Conservation and Sustainable Use of Biological Diversity in the Republic of Belarus, the main measures and actions for the solution of immediate tasks must be concentrated along the following directions:

- solution of the problem of use and conservation of biological diversity in the **agrarian sector** which exerts the greatest impact on the status and use of biological diversity;
- creation of the **National ecological network** and introduction of this network into the Pan-European Ecological Network.

These common European priorities will be integrated into the national policy and activities of all socio-economic sectors of Belarus.

