

Plants of residential and industrial zones of Cherepovets

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Abstract. The research was carried out in 2021-2022 in the city of Cherepovets, Vologda region. The aim of the study was to assess the species composition of plants within the administrative boundaries of Cherepovets and to propose measures to restore the biodiversity of the study area. The level of urbanization of the territory is estimated as moderate. For the first time the data on the current species composition of plants of residential and industrial zones of the city of Cherepovets were obtained. In particular, species from the Red Book list as well as those in need of biological control were identified.

1 Introduction

The global environmental problems of the 20th and 21st centuries demonstrate the spontaneous nature of the development of civilization, the inability or unwillingness of the world's political elites to explore the creative nature of everyday life, without confrontation and violence, and within the framework of strict keeping agreements and laws. At the same time, there are numerous scientific data on the state of natural ecosystems and recommendations and development of measures to regulate the relationship between human populations and natural complexes. The knowledge gained as a result of ecological research led to an understanding of the role of biodiversity as the most cost-effective tool supporting the stability of natural ecosystems and the evolutionarily developed climate of the planet. This understanding was enshrined in the "agreements" of the world community. In particular, 2010-2020 was the decade of biodiversity conservation, and 2021-2030 is the decade of biodiversity restoration. The purpose of our study is to evaluate the species composition of plants within the administrative boundaries of Cherepovets and propose measures to restore the biodiversity of the studied territory.

2 Materials and methods

The research was carried out in 2021-2022 in the city of Cherepovets, Vologda region (Fig. 1). The territory of the city (122 km²) is divided into two approximately equal zones: residential in the east and industrial in the west. On the northern and eastern borders of the

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city there are abandoned fields and fragments of secondary deciduous forests, in the south – fields, meadows, mixed forests and the Rybinsk reservoir, in the west – secondary forests and swampy forests and wastelands. The collected biological material is processed in the laboratory conditions of the ecological and analytical laboratory of the Department of Biology, using equipment Regional shared services center of Cherepovets State University. The names of plants are aligned with World Flora Online (www.worldfloraonline.org). The level of urbanization of the territory was estimated according to the indicators proposed by O.A. Balabeikina and E.L. Faibusovich [1]: the ratio of the area of the urban territory to the total area of the region (0.16%), the ratio of the population of the first and second largest cities in the region (both cities are slightly more than 300 thousand people each) and the share of the population of cities in the population of the subject of the Russian Federation (73.1%) (based on data from the official portal of the Government of the Vologda region as of April 2023). The level of urbanization can be assessed as temperate.



Fig. 1. Map of the Cherepovets research area (<http://yandex.map>).

3 Results and Discussion

The Region is located in the boreal climate zone of the Eastern European taiga. Spruce and pine forests dominate the vegetation cover; in the southern part of the Region, the share of broad-leaved trees is noticeable. The main tree species are spruce *Picea abies* (41%), pine *Pinus sylvestris* (24%), birch *Betula* sp. (28%), and aspen *Populus* sp. (6%) [2], [3]. There are also larch *Larix decidua*, elm *Ulmus* sp., alder *Alnus* sp., and arborescent willows. The duration of the growing season is about 150 days [4]. 352 species of seed plants were identified, 238 species in the residential area, 236 species in the industrial area. The native flora is better represented in the residential part of the city – 207 species, in the industrial zone – only 156 species. Introduced species from different regions are more represented in the industrial zone, especially from the Russian Far East, which are used to create bright landscape compositions. The most numerous in the city are plants of genera *Acer*, *Alnus*, *Betula*, *Fraxinus*, *Populus*, *Rosaceae*, *Salix*, *Tilia*, *Artemisia*, *Asteraceae*, *Chenopodiaceae*, *Plantago*, *Poaceae*, *Rumex*, and *Umbelliferae*, *Urtica*. It is the pollen of these plants and *Pinus* and *Picea* that dominate the pollen spectrum in the city [5].

According to the ecological characteristics, the vegetation of the two zones has a lot in common. Light-loving plants account for 88.66% in the residential zone and 86.44% in the industrial zone; mesotrophic and eutrophic plants, respectively: 93.7% and 92.80%; mesophytes and xerophyte-mesophytes: 59.24% and 71.19%. Grass dominate among life forms: 84.3% and 60.59%. In relation to ecological and cenotic groups, plants are distributed as follows: pubescent (28.57% and 26.69%), weedy and cultivated (30.67% and 47.89%), coastal (14.29% and 5.93%), forest (9.66% and 7.63%) and marsh-marsh-meadow (10.08% and 6.35%) and meadow (5.46% and 4.66%). Plants of human significance are divided into: decorative (13.45% and 31.35%), medicinal (18.91% and 13.14%), fodder (10.5% and 8.05%), food (6.3% and 2.97%), mixed value (48.32% and 31.35%).

It would seem that why identify functional groups such as fodder and medicinal plants among the identified plants, if the plants grow in the city. Such plants cannot be harvested in a technogenic regime. But these plants can be a testing ground for the study of microevolutionary processes for the adaptation of forage and medicinal plants to new living conditions without losing their useful properties.

Plants listed in the Red Book of the Vologda Region [6], which need protection or study, were found in two zones; in the residential zone: *Acer platanoides*, *Cornus alba*, *Quercus robur*, *Tilia cordata*, *Ulmus glabra*, *Dracocephalum thymiflorum*, *Galium verum*, *Leymus arenarius*, *Saponaria officinalis*, *Swida alba*, and in the industrial zone: *Acer platanoides*, *Quercus robur*, *Tilia cordata*, *Alisma lanceolatum*, *Cotoneaster melanocarpus*, *Epipactis helleborine*, *Fraxinus excelsior*, *Medicago falcata*, *Ulmus laevis*.

It is assumed that the pool of species in any city will be a filtered subset of the regional pool and other species introduced with human assistance [7], [8]. And our data fully confirms this. In other cities, species are filtered mainly using a set of selective anthropogenic influences. In a small town in the north-west of the European part of Russia, species were selected by biological selection based on their response characteristics. And it seems that the species we found are best suited for urban conditions, will be preserved or thrive here.

Urbanization in the region is moderate, therefore, there are stable links with regional features of flora and rural landscapes, and the impact of cities on biodiversity after urbanization can be estimated as average. Invasive species have become part of the vegetation of the city and nothing can be done about it. When planning and designing urban vegetation, planners will need to take into account the role of beneficial alien (and sometimes even invasive) species in combination with biodiversity considerations.

Another feature was noted – an increase in the growing season by almost 3-4 weeks compared to the countryside of the Vologda region. This contributes to better ripening of seeds, at the same time earlier flowering and, accordingly, prolonging the timing of pollen entering the atmosphere [5] and increasing the risks for allergy sufferers.

The results obtained were satisfactory. Particularly good results were obtained for the industrial zone, where less biological diversity was expected. The presence of sites on this territory, where people practically do not visit, seems to be an opportunity to preserve plants on them, which are especially sensitive to stomping by people and plants from the list of the Red Book of the Vologda region. Due to the fact that the idea of plants as a green shield [9] is becoming widespread, the work on creating a Green Shield of PJSC Severstal – increasing the sanitary protection zone of the enterprise can further improve the condition of green spaces, which are important as air and water purifiers [10].

An approximate assessment of the condition of the plants showed that the individuals of most species found were in a good and satisfactory sector. In general, it can be argued that many plants have adapted to life in the urban ecosystem, as it is noted in other regions of the world [11, 12]. Vulnerable species, the proportion of which is small, are coastal and

swamp species, forest and meadow, therefore, the Department of Municipal Administration can be recommended to create special areas for the formation of the necessary plant communities or protected coastal areas close to the industrial zone and within the city boundaries near the historical and cultural complex Farmstead Galskych.

Urban vegetation has several positive effects on the urban environment [13]: it reduces urban runoff, reduces the number of thermal islands due to shading and transpiration cooling by tree leaves, it also reduces the energy needed to cool buildings. It is likely that urban trees can reduce CO² emissions from combustion, thereby reducing overall emissions from power plants. It is likely that urban plants can improve the quality of life of urban residents [14]. Additional research is needed to help study the role of urban plants in the urban environment and the transition to sustainable development.

Although the relevance of native plants in urban settings is often questioned [15], the use of local vegetation specific to a particular region seems to be one of the main approaches in the conservation and restoration of biodiversity. Native plants as the main elements of the landscape have the additional advantage of increasing biodiversity and creating an environment capable of providing ecosystem goods and services in an urban environment.

The local community has come to manage and preserve urban biodiversity. To develop and form a positive trend, one can use the experience of different countries [16-18] and in particular China, one of the megaverse countries, which has recently made a number of serious changes in governance, taking decisive steps towards green development and “ecological civilization” [19]. Biodiversity does not recognize borders and, given the obvious impact of broader ecological systems, it is important to adopt a regional approach in which the exchange of experience and knowledge should be encouraged and facilitated.

4 Conclusions

Thus, for the first time, data on the species composition of plants of two fundamentally different zones of the city of Cherepovets in 2020-2022 were obtained. The number of species in the residential area is 238, in the industrial area – 236, the number of common species – 122. There are three species from the list of the Red Book of the Vologda Region in each zone, the number of species in need of biological control in the residential zone is seven, in the industrial zone – 6. The predominant life form is herbaceous (mesophytes and light-loving plants). The coefficient of floral generality of Jacquard is 0.20, which is obviously due to the large proportion of cultivated plants in the urban area. Native plants as the main elements of the landscape have the additional advantage of increasing biodiversity and creating an environment capable of providing ecosystem goods and services in an urban environment. At the future stage of research, it is necessary to complete the identification of species throughout the city, assess the biological condition of plants, identify areas where it is possible to create reserves for the survival of plants and reserves for the restoration of local biodiversity, as well as provide for the possibility of cognitive recreation near or in such areas.

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