

The conditions and methods of biological diversity preservation and restoration on post-technogenic lands

Ludmila Kapelkina* and Tamara Teplyakova

St. Petersburg Research Centre of Ecological Safety of Russian Academy of Sciences, Korpusnaya 18, St. Petersburg 197110, Russia

Abstract. Oil production, as well as the transportation of oil and gas through pipeline systems, cause the destruction and man-made transformation of the natural ecosystems of Northern Eurasia, an increase in the area of disturbed lands, and a reduction in the habitats of specially protected plant species. In this regard, the most significant measures for biological diversity are the identification of conditions for the growth of populations of rare plants in man-made biotopes and the development of methods for their conservation and restoration. 12 species (*Carex sylvatica*, *Dactylorhiza baltica*, *D. fuchsii*, *D. incarnata*, *D. maculata*, *Fragaria moschata*, *Glyceria lithuanica*, *Listera ovata*, *Neottia nidus-avis*, *Ophioglossum vulgatum*, *Platanthera bifolia*, *Veratrum lobelianum*) from the Red Book of the Yaroslavl region and 1 species (*Dactylorhiza baltica*) from the Red Book of the Leningrad region were recorded in the protected area of oil pipelines. Moreover, *Dactylorhiza baltica* is listed in the Red Book of the Russian Federation. For *Dactylorhiza fuchsii*, *D. incarnata*, *D. maculata*, *Fragaria moschata*, at the risk of complete destruction of their biotopes, methods of their transplantation, repatriation and rehabilitation have been developed and transferred to the appropriate Department of the Yaroslavl region. For the restoration of biotopes on bulk sand dams of an oil field in Western Siberia, an experimental study of the wild species *Leymus arenarius* as a fixative of technogenic sands showed good results.

1 Introduction

The preservation and restoration of biodiversity is the most important task of industrialized regions. International [1], regional [2, 3] and national [4] Red Books of rare Plants requiring protection have been created. In this regard, the monitoring of vegetation cover on lands subject to technogenic disturbance is the key to the successful conservation and restoration of biological diversity.

At the same time, for the effective conservation of rare species and their biotopes, it is necessary to use a set of research methods both to describe natural populations and their growing conditions, and to recreate them in newly created habitats.

The introduction of wild-growing seeds, including specially protected species, harvested

* Corresponding author: kapelkina@mail.ru

locally and allocated for industrial development, into the sown grass mixtures will help preserve the biodiversity in the regions. The search, testing and use of plant species of local wild flora is a promising direction in the environmental and sanitary-hygienic direction of reclamation.

2 Conditions and methods

2.1 The conditions and methods of Red Book plant preservation from oil pipeline protected areas

The protected areas of oil pipelines are sections of the earth's surface with a width of 50 m (25 m on both of the pipeline axis). In order to the safety of pipeline operation, the regulations provide for periodic logging in the protected areas. The studied sections of the oil pipelines pass through the lands of different categories: coniferous-deciduous spruce-birch forests with an admixture of aspen and alder, heavily watered and swampy

Their floristic study was carried out by the route method in the summer season to identify plant populations included in the regional Red Books [2, 3] and the Red Book of the Russian Federation.[4]. The length of the routes was more than 30 km in each of the studied regions. The locations of the red book plant species were recorded through the GPS system.

The Brown-Blanke method was used to describe plant communities with the participation of rare species found [5].

The boundaries of the discovered populations of red book plants were marked along the perimeter by barriers made of signal tape, which guaranteed their preservation when clearing protected areas of pipelines from tree and shrub vegetation [6].

If there is a risk of complete destruction of populations during the work necessary for the maintenance of pipelines, it is necessary to pre-arrange the transfer of protected species to the nearest suitable biotopes outside the area of the work being carried out. A possible option is to transfer official Specially Protected Natural Territories to suitable biotopes.

For a number of red book species (including *Dactylorhiza fuchsii* (Druce) Soó, *D. incarnata* (L.) Soó, *D. maculata* (L.) Soó and *Fragaria moschata* (Duchesne) Weston), exclusive methods for transplanting, repatriating and rehabilitating were developed and submitted to the Department of Environmental Protection of Yaroslavl [7].

2.2 The conditions and methods of vegetation restoration from drilling sites

Oil production in the swamps of Western Siberia is carried out on drilling sites previously filled with imported sand.

Experiments on the selection of sand-fixing plants were laid at the Nizhnesortymkoye oil field in Western Siberia. Here, 15 years ago, the seeds of *Leymus arenarius* (L.) Hochst were planted to a depth of 3-4 cm.

The seeds were collected by us at the place of its natural growth – on the coast of the White Sea in the Murmansk region. This plant species has been used for more than 50 years on the Kola Peninsula to fix slopes composed of dusty nepheline sands, which are formed during the processing of apatite-nepheline ores. *Leymus arenarius* is able to grow on these wastes when applying a small amount of mineral fertilizers without applying a fertile layer of soil to the surface of the sands. It grows well on loose sandy sediments and is able to form new roots when submerged in the sand.

3 Results and discussion

3.1 Protected plant species (Ostern Europa)

In the Yaroslavl region, 12 out of 173 species of vascular plants of the regional Red Book [3] were identified in the studied territory: *Carex sylvatica* Huds., *Dactylorhiza baltica* (Klinge) Orlova, *D. fuchsii*, *D. incarnata*, *D. maculata*, *Fragaria moschata*, *Glyceria lithuanica* (Gorski) Gorski, *Listera ovata* (L.) R. Br., *Neottia nidus-avis* (L.) Rich., *Ophioglossum vulgatum* L., *Platanthera bifolia* (L.) Rich., *Veratrum lobelianum* Bernh. Of these, *D. baltica* is listed in the Red Book of the Russian Federation [3]. The total number of protected species found by us is hundreds of specimens. Some representatives of the family *Orchidaceae* have the largest number of specimens in the population. For example, *Dactylorhiza fuchsii* sometimes forms numerous populations (up to 50 flowering individuals). The large number of *Dactylorhiza* species growing in the protected areas of oil pipelines is due to the favorable lighting and moistening conditions of meadow and swamp-meadow biotopes, which are formed when trees and shrubs are cut down. A number of protected species were found in a single habitat (1 specimen of *Neottia nidus-avis*), in 2 habitats (1 and 3 specimens of *Dactylorhiza baltica*) and in 3 habitats (1-3 specimens of *Platanthera bifolia*) [6].

In the Leningrad region, numerous populations of *Dactylorhiza baltica* have been identified, which is included both in the regional Book [2] and in the Red Book of the Russian Federation [4].

Our studies have shown that the cutting down of tree and shrub vegetation along the pipeline protected areas favours the growth of rare species that belong to meadow and swamp-meadow plants [8]. Despite the temporary disruption of vegetation cover during logging, protected plant populations are rapidly regaining their numbers. Nevertheless, in the pipeline sections where protected plant species are marked, it is advisable to cut down tree and shrub vegetation in the autumn period after the maturation and shedding of seeds.

3.2 Experiment on fixing technogenic sands at the Nizhnesortymskoye oil field (Western Siberia)

Leymus arenarius seeds were sown in different ecotopes of the drilling site. The most favorable for its growth and development were the internal slopes of the dams (Fig.), in the places of contact of imported bulk sand and drilling waste.



Fig. *Leymus arenarius* population on the inner slope of the drilling site dam

Drilling waste according to the degree of salinity more or less corresponds to the conditions of natural biotopes of *Leymus arenarius*, which grows on lightly salted or unsalted sands of sea coasts and a number of large lakes in Northern Europe [9]. Thin greenish-blue shoots of *Leymus arenarius* appear only in the spring of the following year, regardless of the planting time.

The germination of seeds and the development of seedlings is hindered due to the low moisture capacity and water-holding capacity of the sands. Autumn rains and spring snowmelt provide increased humidity of the sands for a longer period and cause the emergence of seedlings in the spring. Over the past 15 years, there has been a significant spread of this species to other sections of internal dams. Mature seeds in the fall are carried by the wind to neighboring areas. Clumps of this cereal were found at a distance of 100 – 120 meters from the place of initial planting.

The area occupied by *Leymus arenarius* is constantly increasing, the state of its population is good. The high qualities of this plant for the reclamation of disturbed lands have long been known in Europe [10] and our experiment confirmed them for the more continental conditions of the north of Western Siberia. In this regard, it is advisable to use *Leymus arenarius* for fixing loose sandy substrates on the corresponding technogenic ecotopes in the oil-producing regions of Western Siberia.

4 Conclusion

Biotopes of industrially developed regions are exposed to significant destructive effects until their complete destruction. An important condition for the effectiveness of the preservation and restoration of biological diversity is the timeliness of monitoring studies in case of planned land disturbance. At the same time, different natural and climatic conditions, regional specifics of flora and vegetation make it impossible to find the same type of solutions for preservation and restoration.

For their success there should be a differentiated approach to each disturbed area using various methods of investigating the state of vegetation cover, especially populations of rare species. The most effective is a combination of descriptive (floristical and geobotanical) and experimental (transplanting and repatriating) methods.

We emphasize that the success of restoration works depends on the timeliness of decisions taken taking into account all identified natural and man-made conditions when using complex research methods in disturbed ecosystems.

References

1. *European Red List of vascular plants* (2011)
2. *The Red Book of the Leningrad Region* (2018)
3. *The Red Book of the Yaroslavl Region* (2015)
4. *The Red Book of Russian Federation* (2008)
5. B. M. Mirkin, L. G. Naumova, Braun-Blanquet method of vegetation classification in Russia, *Zh. Ob. Biol.*, **70**,1 (2009)
6. L. P. Kapelkina, T. E. Teplyakova, Red Book of vascular plants along oil pipelines in Yaroslavl Region, *Theor. Appl. Ecol.* **1**:54–60 (2019)
7. L. P. Kapelkina., T. E. Teplyakova, Transplantation and rehabilitation of the Red Book species of plants as a method of their conservation in conditions of technogenesis *Ecol., Indust. Ener. Saf.*, 580–582 (2017)

8. L. P. Kapelkina, T. E. Teplyakova, The Regional Aspects of Biodiversity Preservation under Oil Deposit Exploitation and Oil Transportation, IOP Conf. Ser. Ear. Env. Sc. **666** (2021)
9. E. Hulten, M. Fries, *Atlas of Northern European Vascular Plants, Northern of the Tropic of Cancer*, **1-3** (1986)
10. S. Greipsson, A. J. Davy *Responses of *Leymus arenarius* to Nutrients: Improvement of Seed Production and Seedling Establishment for Land Reclamation* J. Appl. Ecol. **34**, 5 (1997)