

В статье рассматривается применение современных подходов к гармонизации Национальной стратегии по сохранению и восстановлению самобытного растительно-флористического районирования, редких и исчезающих видов растений и грибов на территории Карабаха. Для выяснения экологических изменений, произошедших на территориях, освобожденных от оккупации в результате Великой Отечественной войны, представляется целесообразной оценка потенциала быстрого послевоенного восстановления. С этой целью для изучения закономерностей сохранения и восстановления флоры и среды обитания в современных условиях важно принимать во внимание послевоенный опыт в других странах мира, описанный в мировой научной литературе. При этом к планированию восстановления и реабилитации деградированных экосистем Карабаха следует привлечь новые инструменты и технологии, а также инновационные управленческие подходы. Последствия современных войн приводят к сокращению популяций местной флоры и фауны, к уменьшению видового разнообразия в экосистемах. Кроме того, специфичное влияние антропогенных факторов в данных условиях способно привести к полному уничтожению популяций и видов. Установлено, что разработка оптимальных стратегий восстановления и реабилитации экосистем на территориях, пострадавших в результате военных действий, зависит от характера, уязвимости и устойчивости нарушения биологической системы, а также от сроков смягчения негативных последствий. В связи с этим важное значение имеет изучение биоразнообразия и выявление прошлых и нынешних тенденций развития экосистем, прогнозирование сценариев их будущего развития в регионе с использованием аэрокосмических и геоинформационных исследований. Для реализации этой деятельности необходимо проведение полевых исследований, имеющих важное значение для определения статуса видов и степени влияния изменений на местную флору, составления списка растений, а также внесение результатов в имеющиеся базы данных. Мониторинг новых находок, изучение состояния популяций редких и исчезающих видов, создание семенного фонда с целью сохранения *in situ* и *ex situ*, разработка электронных карт ареалов распространения видов растений, разработка и внедрение цифровых технологий для оперативной оценки состояния компонентов фитоценоза – первостепенные задачи ботаников. Целенаправленная деятельность ученых является гарантом проведения успешной политики по экологической оценке разнообразия растительных ресурсов и их использованию. В статье приводятся эндемии Карабахского региона, показано распределение растительного покрова в 4-х геоботанических районах

Карабаха и дано сравнение краснокнижных видов, представленных в 1 и 2 изданиях Красной книги Азербайджана и планируемых для 3-го издания, упоминаются виды, утерянные в природе. Отдельно указываются эндемики Карабахского региона, распределение растительности по 4 геоботаническим районам Карабаха, перечислены исчезающие в природе виды. На примере других регионов Азербайджана демонстрируется возможность прогнозирования на будущий период распространения инвазивных и сохранения популяций редких видов растений.

Key words: *plant diversity, rare and endangered species, conservation, Karabakh, restoration, innovative methods*

The article discusses the application of modern approaches to the harmonization of the National Strategy for the Conservation and Restoration of unique vegetation-floristic zoning, rare and endangered species of plants and fungi on the Territory of Karabakh. To clarify the environmental changes that have occurred in the territories liberated from occupation as a result of the Great Patriotic War, it seems expedient to assess the potential for rapid post-war recovery. For this purpose, in order to study the patterns of conservation and restoration of flora and habitat in modern conditions, it is important to take into account the post-war experience in other countries of the world, described in the world scientific literature. At the same time, new tools and technologies, as well as innovative management approaches should be involved in planning the restoration and rehabilitation of degraded ecosystems in Karabakh. The consequences of modern wars lead to a decrease in the populations of local flora and fauna, to a decrease in species diversity in ecosystems. In addition, the specific influence of anthropogenic factors under these conditions can lead to the complete destruction of populations and species. It has been established that the development of optimal strategies for the restoration and rehabilitation of ecosystems in areas affected by military operations depends on the nature, vulnerability and sustainability of the violation of the biological system, as well as on the timing of mitigating the negative consequences. In this regard, it is important to study biodiversity and identify past and current trends in the development of ecosystems, predict scenarios for their future development in the region using aerospace and geoinformation research. To implement this activity, it is necessary to conduct field research, which is important for determining the status of species and the degree of influence of changes on the local flora, compiling a list of plants, as well as including the results into existing databases. Monitoring new finds, studying the state of populations of rare and endangered species, creating a seed fund for *in situ* and *ex situ* conservation, preparing electronic maps of the distribution areas of plant species, developing and implementing digital technologies for the rapid assessment of the state of phytocenosis components are the primary tasks of botanists. The purposeful activity of scientists is a guarantor of a successful policy for the environmental assessment of the diversity of plant resources and their use. The article describes the endemics of the Karabakh region, shows the distribution of vegetation cover in four geobotanical regions of Karabakh and gives a comparison of the Red Book species presented in the 1st and 2nd editions of the Red Book of Azerbaijan and the species planned for the 3rd edition, mentions species lost in nature. The endemics of the Karabakh region, the distribution of vegetation in 4 geobotanical

regions of Karabakh are indicated separately, endangered species are listed. On the example of other regions of Azerbaijan, the possibility of predicting the distribution of invasive species and preservation of populations of rare plant species for the future period is demonstrated.

Introduction.

It has been established that modern warfare is one of the main forces associated with environmental problems and the reduction of biodiversity in a number of regions (The environmental consequences of War., 2000). Military conflicts have been found to have a significant impact on the biosphere at various ecological scales (Dudley, J.P., Ginsberg, J.R., Plumptre, A.J., Hart, J.A., and Campos, L.C. 2002; Machlis, G.E., and Hanson, T. 2008). In addition to the rather obvious negative consequences of war on the human population, it significantly affects the biodiversity and ecosystem structure and function (Machlis, G.E., and Hanson, T. 2008; Pendersen, D. 2002). The problem of clarifying the ecological changes that took place in the Karabakh region of Azerbaijan as a result of the Patriotic War and assessing the potential for rapid post-war recovery with the application of modern scientific approaches is currently in the forefront. On the other hand, Azerbaijan's rich biodiversity and natural habitats are increasingly exposed to anthropogenic stresses and global climate change, the decline of the number of populations of most species, disruption of vegetation structure and fragmentation are observed. The effects of these factors can cause rare taxa to become critical or disappear in a short period of time. At the same time, the liberation of our lands from occupation laid the foundation for a new successful period of the Azerbaijani state, society and economy.

First of all, it is necessary to apply modern approaches to the coordination of the National Strategy for the original plant-floristic zoning in the territory of Karabakh, conservation and restoration of rare and endangered species of plants and fungi. As is well known, innovative approaches to the planning and management of effective multifunctional nature conservation landscapes are key (IUCN, 2021). Therefore, it is expedient to involve new tools and technologies and/or joint management approaches in the planning of restoration and rehabilitation of degraded ecosystems of Karabakh with the participation of many stakeholders.

The effects of modern warfare and chemical pollution are causing to both declining populations of local flora and fauna and species diversity in affected ecosystems (Dubey, A., and Shreni, P.D. 2008). It has been established that the development of optimal strategies for the restoration and rehabilitation of ecosystems in areas affected by hostilities depends on the nature, vulnerability and sustainability of the violation of the biological system, as well as on the timing of mitigating the negative consequences (Elisafenko, T.V., Dorogina, O.V. 2019). First of all, it is necessary to study the optimal strategies for the rehabilitation of ecosystems in the regions of both positive and negative environmental consequences of war, as well as to identify the past and present trends in the development of ecosystems such as the influence of anthropogenic factors and climate changes

(Dubey, A., and Shreni, P.D. 2008; Dudley, J.P., Ginsberg, J.R., Plumptre, A.J., Hart, J.A., and Campos, L.C. 2002). It is also considered an important tool for the study of biodiversity, which includes the joint use of aerospace and geoinformation research, in addition to predicting future development scenarios of natural ecosystems (Ali-zade, V.M., Salimov, R.A. 2018).

It is expected that this will result in the compilation of a new nomenclature list of plant species growing in Karabakh and its inclusion in the database of Azerbaijani flora; the results of monitoring of rare and endangered species will be reflected in the 3rd edition of the Red Book of the Republic of Azerbaijan. A special place is occupied by the identification of economically significant useful species (medicinal, food, fodder, decorative, etc.), a detailed study of the species composition, habitats, phytocenotic features and resources, taking into account the rich diversity of the flora of Karabakh. It is important to study invasive species due to their increased activity, leading to the loss of biodiversity. Conservation strengthening and restoring together with species risk reduction and recovery indicators are the most pressing issue of the day.

1. Plant protection strategy

Thus, it is possible to strengthen and restore conservation by species risk reduction and restoration indicators. All over the world, nature is declining at an unprecedented pace in human history. This is due to the pressure of human actions. For example, species are being lost as a result of the conversion of their natural habitat to agriculture, forestry and urban expansion, as well as their collection for hunting, fishing, local consumption and international trade. Climate change is also exacerbating the situation. Up to one million

plant and animal species are in danger of extinction, and the loss of these species threatens the ecosystem and ecosystem services on which all life depends.

A number of provisions of the Plant Protection Strategy by the International Union for Conservation of Nature (IUCN) must be taken into account in order to apply modern approaches to the coordination of the National Strategy for the original plant-floristic zoning in the territory of Karabakh, conservation and restoration of rare and endangered species of plants and fungi: plant diversity clarification and documentation; conservation of plant diversity; sustainable use of plant diversity; activation of knowledge and training on plant diversity; creating opportunities for plant conservation; application of modern approaches and innovative solutions for the conservation of biodiversity; assessment of species in accordance with the requirements of international standards.

It is clear that the Red List, which represents plants which future is in danger, shows the functional status of rare or endangered species and provides information on biodiversity violations. The Red List, as an early warning system at the species and ecosystem level, provides guidelines on the direction of their conservation efforts. At the same time, plant protection is related to the application of morphology, taxonomy, cytology, ecology, biogeography, genetics and molecular biology, mathematical modeling and a number of science fields and is solved in close cooperation.

2. Assessment of species in accordance with the requirements of international standards

The latest IUCN manual contains new methods for material processing, modern mathematical research and etc. As is well

known, innovative approaches to planning and managing effective multifunctional nature landscapes are key. Therefore, it is expedient to involve new tools and technologies in the planning of restoration and rehabilitation of degraded ecosystems of Karabakh with the participation of many stakeholders. The optimal strategy is connected primarily on the nature, sensitivity and sustainability of the disruption of the biological system, as well as the duration of mitigation of negative consequences, as well as the detection of past and present trends in the development of ecosystems in the region. This allows for a comprehensive study of biodiversity which includes the joint use of aerospace and geoinformation research, as well as forecasting future development scenarios.

Species risk reduction and recovery metrics

The new **IUCN – metric tool** – on species risk reduction and recovery promises to help assess the conservation potential of endangered biodiversity and identify targets for the scale of the area or landscape in line with the global strategy for biodiversity in the post-2020 period. *STAR quantifies the potential contribution of specific threat abatement and habitat restoration actions, or the sum contribution of multiple actions, to reducing extinction risk.* Here it is important to assess the condition of both individual species and entire ecosystems.

Currently, the restoration work in the world is carried out in two main directions: the renewal of communities and the restoration of populations. For example, in forests, tree plant populations, which are edificators, are restored primarily for the purpose of restoring the original ecosystem. At the same time, the reconstruction of the

original structure and dominant species is an imitation of the original ecosystem, but it is also important to take measures to restore the habitat.

4. International obligations

The most influential of these international conventions is arguably the Convention on Biological Diversity (CBD). Information from Red lists can be used to measure progress in at least 13 of the 20 targets, especially Target 12. National red lists can help countries measure their progress toward the CBD Targets, and can inform National Biodiversity Strategies and Action Plans.

Extensive measures are being taken on the clause 6.3.1.5. of the National Strategy for 2017-2020 “Development of best practices and management plans for the sustainable use of rare and rare species of fauna and flora in the areas that do not have special protection status but are assessed as sensitive ecosystems” on the protection and sustainable use of biological diversity of the Republic of Azerbaijan.

Hormonization of national approaches to the Red list of plant with international botanical and selection criteria for protected species is of great importance for inclusion rare and endangered species in the forthcoming 3rd edition of Red book of Azerbaijan. In this aspect, it is necessary to take into account both international obligations and the realias associated with the liberation of the occupied and mercilessly exploited territories of Karabakh and the destruction of natural ecosystems and species.

Answering the region-specific key questions offers important knowledge concerning progress toward the Aichi

Biodiversity Targets, the Sustainable Development Goals, and national policies

The Aichi Biodiversity Targets are relevant to the Sustainable Development Goals (SDGs). It is a very important tool for measuring progress on Red Lists in at least 13 of the 20 targets. Goals 14 and 15 address biodiversity and ecosystems explicitly and correspond closely with the Aichi Biodiversity Targets. Beyond Goals 14 and 15, several Sustainable Development Goals address the broader importance of biodiversity and ecosystems for human well-being. The European Union Biodiversity Strategy 2020 aims to halt biodiversity loss in the European Union, restoring ecosystems where possible, and stepping up efforts to avert global biodiversity loss. This underpins the European Union's commitment to the Convention on Biological Diversity and the Aichi Biodiversity Targets by integrating policies on the ecosystem services approach into member States' economies and planning. Non-European Union countries contribute to the implementation of the Aichi Biodiversity Targets through national strategies, plans or programmes. Most Europe and Central Asia countries have developed a national biodiversity strategy and a corresponding action plan.

Methodological recommendations for considering biodiversity when assessing the prospects for restoration of forest landscape IUCN

An approach based on the diversity of species is essential to recreate more resilient ecosystems and landscapes than other approaches. The selection of ecologically appropriate species is one of the most important steps that can be taken in forest landscape restoration. Obviously, the selection of species for restoration activities

should start with soil-dwelling species and plants. In most cases, degradation affecting landscapes begins with a decline in soil quality or erosion of the topsoil and leaching of nutrients from it. The restoration of soil condition to support vegetation growth is essential, especially the re-establishment of plant species as succession partners. At a minimum, at least some of the components of an integrated ecosystem approach shall be applied in forest landscape restoration.

To do this, practitioners must have a working knowledge of the types of ecosystems in their geographic region, as well as on known or major species. It is especially important to take into account the sources of data on biodiversity cited by IUCN (<http://www.iucnredlist.org>) in activities to restore the biological diversity of Karabakh. In some countries and regions, data on the ratio of vegetation cover and used lands (including forests and associated habitats) and the distribution of species have been recorded or observed over decades. In many cases, this information is predominantly related to living natural resources with commercial value. These archives can be useful in identifying the results of previous studies of local ecosystems, including pre-existing distributions of important species, which may form the basis for future restoration activities. Historical data on the distribution of animal species may be required in the planning process, especially if one of the goals is to recreate the landscapes that support the existence of these species. The natural return of extinct species to the restored landscape can serve as a general sign of a successful outcome. On the other hand, within the framework of an overall strategy for the restoration of landscape and biodiversity as a component of this process, it is recommended

that culturally important species and areas be considered when planning the restoration process, both in terms of the technical aspect of restoration and in terms of interaction with local communities.

5. Rare and endangered plant species of Karabakh and activity for their assessment and restoration

Along with the main drivers of the ongoing loss of biodiversity and the reduction of ecosystems (land degradation; habitat fragmentation; inefficient use of natural resources; pollution; spread of invasive alien species; climate change) in Azerbaijan, the consequences of the war in Karabakh (radioactive contamination, mining) are widespread.

Identification of priority species and habitats and information gaps, assistance in area-based conservation planning, raise of communication and awareness, collection of information on species for environmental impact assessment, assistance in resource allocation for biodiversity conservation, and support of the development legislation are part of the monitoring of the biodiversity situation in the region are tasks within the framework of monitoring of biodiversity in the region.

Thus, to implement this activity, it is necessary to conduct field research, which is important for determining the status of species and the degree of influence of changes on the local flora, compiling a list of plants, as well as including the results into existing databases.

Monitoring new finds, studying the state of populations of rare and endangered species, creating a seed fund for *in situ* and *ex situ* conservation, preparing electronic maps of the distribution areas of plant species,

developing and implementing digital technologies for the rapid assessment of the state of phytocenosis components are the primary tasks of botanists. The purposeful activity of scientists is a guarantor of a successful policy for the environmental assessment of the diversity of plant resources and their use.

Below is presented the distribution of wooden peculiar species in four geobotanical regions of Karabakh, the endemics of the Karabakh region and gives a comparison of the Red Book species presented in the 1st and 2nd editions of the Red Book of Azerbaijan and the species planned for the 3rd edition, mentions species lost in nature. From this point of view, the main trees distributed in the forest ecosystems of Karabakh are the following:

Kalbajar: bear nuts, Caucasian hornbeam, beech

Zangilan: oriental plane tree, araz oak, walnut, Caucasian hornbeam

Shusha: oak, beech, Caucasian hornbeam

Lachin: oak, Caucasian hornbeam

It is expedient to pay special attention to restoration above mentioned species and also planned to expand the number of Karabakh plants in need of protection included in the 1st and 2nd editions of the Red Book of the Republic of Azerbaijan and planned for publication in the III. It is planned to expand the number of Karabakh plants (Fig.1). Comparatively, this scheme and the list are presented below:

List of rare endemic plant species distributed in Karabakh and included in the II edition of the Red Book:

1. *Corallorrhiza trifida* - Early coralroot
2. *Iris annae* - Anna süsəni

3. *Convallaria transcaucasica* - Transcaucasian lily
4. *Salix pentandroides* - Beşerkəkcikli söyüd
5. *Alcea sachsachianica* – Sağsağan gülxətmisi
6. *Astragalus zangelanus* - Zangilan milk vetch
7. *Centaurea karabaghensis* - Karabakh knapweed
8. *Globularia vulgaris* - Common Globularia

In addition, it is recommended to include 10 species in the third edition of the Red Book:

1. *Carpinusoxycarpa* H. Winkl. - Endemic of Azerbaijan (Center of LC)
2. *Cephalantheraepipactoides* Fisch. &Mey. (South of the Lesser Caucasus - Zangilan)
3. *Crataegusszovitsii* Pojark. (Shusha, Jabrayil, Hadrut)
4. *Cytisuscaucasicus* Grossh. (center of the Lesser Caucasus, Khambag)
5. *Genista transcaucasica* (center of the Lesser Caucasus, south of the Lesser Caucasus)
6. *Liliumarmenum* (center of the Lesser Caucasus, North of the Lesser Caucasus)

7. *Padusracemosa*(Lam.) Gilib. (center of the Lesser Caucasus.)
8. *Sorbusturcica* Zins. (Around Shusha)
9. *Quercusaraxina* (Trautv.) Grossh. (*boissieri* Reut.) (Zangilan, Gubadli)
10. *Urticapilulifera* L. (Khudafarin)

On the example of other regions of Azerbaijan, the possibility of predicting the distribution of invasive species and preservation of populations of rare plant species are demonstrated for the future period (Fig.2).

Along with the ecological changes in the Karabakh region as a result of the Patriotic War, the steady decline in biodiversity threatens the quality of our lives, therefore, first of all, the acquisition of knowledge about the causes of the extinction of landscapes, ecosystems and species, using modern methods and approaches, including molecular, aerospace, mathematical, medical, etc., comes to the fore.

In this direction, it is necessary to mobilize scientists to make reliable estimates, develop models and forecast scenarios. It is obvious that the implementation of innovative investigations, the results of which can contribute to the conservation and sustainable development of biodiversity in the region, is a useful tool that meets modern challenges.

REFERENCES

- Ali-zade V.M., Salimov R.A. 2018 *Assessment of Biodiversity and Ecosystem Services in Azerbaijan. Proceedings of the Azerbaijan National Academy of Sciences (Biological and Medical Sciences) vol. 73, №2, Baku-Elm, p.140-150.*
- Dudley, J.P., Ginsberg, J.R., Plumptre, A.J., Hart, J.A., and Campos, L.C. 2002. *Effects of war and civil strife on wildlife and habitats. Conserv. Biol. 16(2): 319-329. doi:10.1046/j.1523-1739.2002.00306.x.*
- Dubey, A., and Shreni, P.D. 2008. *War and environment: an overview. J. Environ. Res. Dev. 4: 968-976.*

Elisafenko T. V., Dorogina O.V. *Revisiting Terms Used in Recovery of Natural Population, Plant Resources* , 2019 vol.55, 2, p. 284-290

The environmental consequences of War. Legal, Economic, and Scientific Perspectives, Eds. Jay E. Austin Carl E. Bruch, Washington, 2000, 683 p.

IUCN <http://www.iucnredlist.org>

Machlis, G.E., and Hanson, T. 2008. Warfare ecology. *BioScience*, 58: 729-736. doi:10.1641/B580809.

Michael J. Lawrence, Holly L.J. Stemberger, Aaron J. Zolderdo, Daniel P. Struthers, and Steven J. Cooke. *The effects of modern war and military activities on biodiversity and the environment*. *Environ. Rev.* 23:1-18 (2015) [dx.doi.org/10.1139/er-2015-0039](https://doi.org/10.1139/er-2015-0039)

Pendersen, D. 2002. Political violence, ethnic conflict, and contemporary wars: broad implications for health and social well-being. *Soc. Sci. Med.* 55: 175 - 190. doi:10.1016/S0277-9536(01)00261-1. PMID:12144134.