УДК 574 + 504.73

Dubrovsky Y.V., Scientist
Megapolis ecomonitoring and biodiversity research centre of the NASU, Ukraine

Conference participant, National championship in scientific analytics, Open European and Asian research analytics championship

SCIENTIFIC AND NATURE PROTECTION SIGNIFICANCE OF MODEL SITUATIONS IN THE DEVELOPMENT OF ECOSYSTEMS

Model situations that arise due to disturbances of the structure of the living cover and dynamics of ecosystem succession, are often unique ecological experiments. The paper examines the value of model situations for research and conservation. Given their specific character, a proposal is made for an addition to the existing categories for environmental protection.

Keywords: model situation, natural experiment, succession, ecosystem, living cover, nature protection.

Модельные ситуации, возникающие вследствие нарушений структуры живого покрова и сукцессионной динамики экосистем, часто представляют собой уникальные экологические эксперименты. Рассмотрено значение модельных ситуаций для научных исследований и сохранения биоразнообразия. С учётом их специфики предложено дополнение к существующей системе природоохранных категорий.

Ключевые слова: модельная ситуация, природный эксперимент, сукцессия, экосистема, живой покров, охрана природы.

Introduction. The modern system of wildlife conservation needs significant expansion. The basic (classic) approach is based on reserving certain areas (most usually structured ones) and/or natural objects. It implies the preservation of primarily formed and stable ecosystems together with the diversity of their components and the existing relationships between them.

The major drawback of this approach is the static character and space-time homogeneity of protected systems. In ordinary reserves, very little attention is paid to spontaneously occurring process of restructuring the living cover, which may be of considerable scientific and conservation interest. Therefore, the modern environmental conservation field should be supplemented with a special approach for the protection and maintenance of the natural course of environmental processes and events as part of the whole dynamics of the biosphere.

Status of the problem and purpose of the work. Traditional and new forms of wildlife conservation are based on different approaches.

Reservation, or maintaining the standards of nature in general is the most common “classic” traditional way, based on the special protection of typical and unique areas of the planet together with the diversity of represented there objects and relationships between them. An important aspect of this approach is to achieve the conservation of biodiversity in complex. The system of standards in the form of nature reserves and their derivatives, natural reserves, sanctuaries, landscape parks, etc. is the basis of a network of protected areas. In this case, the main difference between the categories of objects is the peculiar protection regime.

The role of natural standards can be fully carried out by areas which are self-sufficient in their resource potential, meaning they are suitable for the conservation and sustaining a set of species (biocenosis). Many of the protected objects do not match the specified criteria and can be preserved only by some external support. Therefore, the most important problem in the theory of reserve management is to develop algorithms for the minimum-required size of a protected area, depending on the type of habitat, the degree of spatial isolation, structures, buffer zones, etc.

Such preservation of natural systems involves non-interference (in extreme cases – compensatory intervention) into their existence. On the contrary, the idea of a partial moderate use of environmental assets (including recreational) and the biological production capacity of protected ecosystems was the basis for the creation of national parks, and later – for the conservation of biodiversity in quasi-natural ecosystems. The protection of the natural dynamics of biodiversity is based on maintaining the natural regime of changes occurring within systems and objects. This approach involves protecting not the object and/or the natural complex itself, but its associated natural dynamics, processes and corresponding phenomena. Examples include the settlement of life in places previously affected by volcanic eruption, species reaching newly formed island ecosystems and reservoirs, restoration of damaged forests, the occurrence of genetic changes in the Chernobyl Zone, etc.

The purpose of this paper is to study the feasibility and relevance of maintaining (preventing external disturbances) processes of the natural transformation of the living cover and the resulting consequences. To be practical I propose to establish a new special category of areas designated for environmental conservation, namely a “scientific monitoring range”.

Model situations in nature. The possibility of accomplishing experiments in the study of natural ecosystems is limited. Structural complexity, multi-component and non-additivity of natural ecosystems, as well as their significant spatial scale make fundamental experiments extremely expensive and lead to unpredictable consequences. Large-scale impacts on ecosystems must also be considered by modern society from an ethical standpoint. Do we have the right, for example, to remove from an area all living organisms found there?

The actual unavailability of planned experiments (in terms of the geographical scale) can be compensated by other

approaches. One is the analysis of model situations arising from natural or man-made disasters, and the interactions occurring between ecosystems [3]. Topographically these situations can be considered as unique polygons where on the Earth's surface nature accomplishes fairly accurate experiments that allow by comparing their results to study the impact of the leading factors of environmental change and to identify certain patterns. The situation can be considered a model in environmental terms, if it can be considered to be the result of a peculiar experiment in a given area the Earth's surface that has led to the change of the organization or the character of the way ecosystems are functioning. The situation must be methodically available for research and, if possible, free from uncontrollable external influences. Here, as in the classic version of an experiment, it should be possible to measure the processes, isolate the leading factors and distinguish important parameters. In all cases, the availability of reference standards is a necessity. Thus, a model situation can be considered a natural experiment, the results of which are available for a comparative analysis of data of the type of spatial or time series arising due to pronounced gradients of the leading factors.

Model situations may be the result of both natural processes and human impacts. Examples of the first group can serve the construction of artificial sandy islands and coastal areas (spits, dunes, etc.), coastal lakes – lagoons, overgrown oxbows of some rivers, some bogs, islands created by volcanic lava, lakes (as, for instance, Lake Sarez) created by blockages or failures, etc. The second group consists of portions of rivers regulated by dams, certain types of wasteland left behind by all kinds of development, such as Donetsk tailing heaps, etc.. The same, perhaps, could be said about where some forest cutting, digging and burning has occurred. Cascades of channel ponds, belts of pond vegetation, sequential water purification zones and regulated parts of watercourses under certain circumstances may also be considered as model situations.

Significance of model situations for environmental research and conservation. The analysis of model situations should be considered as the most important part of the experimental ecology. Only the initial stage of obtaining primary data is specific, because it is based on field research. The further processing of the data can be accomplished by the same approaches and methods as in the laboratory, field, garden etc. experiments.

Of great interest as a model for environmental studies are compactly arranged objects of the same type, forming a series of comparisons. A quite unique complex in this regard is the area of Shatsky National Park, which includes a number of lakes with an amazing variety of characteristics and environmental regimes. Despite the close proximity, the Shatsky lakes differ from each other in their age and origin. These lakes can be great series for comparisons considering their morphometric parameters, water exchange, trophic status, overgrowth etc.[2]. Similar to the previous are forest groves of different size and salt marshes within the steppe zone. Model situations prevail on islands of the Middle Dnieper [4]. For example, overgrowth of sandy beaches, hills and cliffs; swamping of coasts and inland waters; the emergence of unique saucer-like bog; structuring of the soil litter and silting of shallows; gradual isolation from the mainstream of bays and the gradual formation of oxbow lakes. Sometimes there are also interesting situations in terms of adaptive species-poor and structurally simplified communities of extreme habitats, including shifting sands, rocky areas, dystrophic bogs, etc.

Valuable scientific results have been obtained in the study of the extent of damage by ionizing radiation to the biota [7, 9, 10]. A unique opportunity to study the mechanisms and rates of the formation of the biocenosis had opened up on the island of Krakatoa, when the eruption of the volcano there left no sign of life, but in 50 years a young forest had appeared, the fauna consists of more than 1200 species of animals [8]. Apparently, it is advisable to keep intact several coal heaps of the area of Donbass.

Reservation of such substrates will help to maintain the species in the region of the early-pioneer communities of organisms that are usually not supported by existing environmental programs. In traditional nature conservation clear preference is given to formed ecosystems that have reached climax or are in the final stages of succession. This preserves the species richness of the main habitat, especially of a large number of specialized species. However, generalists species, prevailing at the early stages of succession, are less represented. But many of these species are characterized by intense ecological activity and can be of considerable interest to biological amelioration. Therefore, their presence in the system of protected objects is highly desirable.

Organization of scientific research ranges (in other words, polygons) as a new environmental protection approach. The preservation of model situations of scientific, educational or resource interest is an important issue. Already elaborations are going ahead for developing protection regimes for such unique objects, as the Chernobyl exclusion zone and the impacted area caused by the Tunguska meteorite fall. The preservation of model situations in nature has a certain specificity.

The classic approach to preserving natural systems or individual objects in a stable and permanent state is by complete non-interference by implementing special support measures. In contrast, the protection of model situations should provide a supporting background to environmental changes due to succession, as well as defend them of external leveling influences. That means this direction implies the reservation of not only the object itself, but as well the associated spontaneous dynamics of natural phenomena occurring within the place.

In line with this, it is necessary to protect not only the objects and systems, but also the natural course of processes and phenomena, including the gradients of causing factors. The special protection of spontaneously occurring processes makes sense once there is a possibility of monitoring them and arranging protection from noise-external influences. An important aspect of the problem here is the definition of reasonable boundaries of such protected areas.

For the practical conservation of model situations and objects that are used for research purposes, it would be advisable to develop and establish a special environmental category – "scientific

research polygon" [5]. Apparently, the number of situations that can be considered as model, in the biosphere is quite small, so unjustified losses are undesirable. The inventory of model situations under landscape and environmental studies would be very timely.

A mandatory condition for a model situation is the presence of marked and measurable gradients of environmental drivers in time and space. In the first case the model situation can be maintained given the importance of providing the natural dynamics of environmental process, while the second case of particular importance is the topographical aspect. However, the spatial and temporal dynamics are often intertwined and accompany one another, i.e. model situation can be a resultant of the two scales. Apparently, the protection of various model situations should be based on a common methodological basis, but with respective necessary variations. For example, many series of ecological succession within time will disappear. For these options temporary scientific monitoring and protection status for the site can be arranged only for the period of observation.

The protection of the natural course of succession processes is largely dependent on the improvement of the environmental legislation. Moreover, its methodological foundations are in a need of substantial improvement. In addition, the establishment of a network of protected areas underestimates the interests of science. In some countries, serious steps have been taken in this direction. For example, in the U.S. and the U.K. there are such environmental categories such as scientific and natural areas, as well as sites of special scientific interest [6]. In Ukraine, besides the existing categories, a special category should be introduced for areas in need of recovery [1]. But nevertheless to include and study the processes of the natural dynamics of the living cover this is not enough. Already has been raised the issue of special preconditions for the research of various stages of succession and of ecos0ystems [3, 5].

Conclusion. Model situations that occur within a limited area due to the transformation of the living cover according to gradients of environmental drivers, and are available for the analysis, may be of great interest to science, in the first place for purposes of environmental studies. They also have certain conservation value, particularly for the conservation of species and communities living in fragile or extreme habitats. Therefore, the issue of their special protection is becoming increasingly important.

On the other hand, the existing system of environmental categories also needs to be supplemented with the specific features taking into account the formation of ecosystems. It should include measures to ensure the protection of the natural dynamics of ecological processes.

For cases of particular interest to research and biodiversity, it makes sense to develop and establish a special environmental category – "research monitoring polygon". succession.

References:

1. Андрієнко Т.Л., Онищенко В.А., Клєстов М.Л., Прядко О.І., Арап Р.Я. Система категорій природно-заповідного фонду України та питання її оптимізації. – Київ: Фітосоціоцентр, 2001. – 60 с.

2. Дубровський Ю. Волинські водойми // Жива Україна. Екологічний бюлетень. – 1998. – № 11-12. – С. 13.

3. Дубровский Ю.В. Модельные ситуации в изучении экосистем // Фальцфейнівські читання. Міжнародна наукова конференція 25-27 квітня 2001 р. Збірник наукових праць. – Херсон: Терра. – 2001. С. – 51 – 52.

4. Дубровский Ю.В. Природоохранное и научное значение днепровских островов // Географія в інформаційному суспільстві: Збірник наукових праць у 4-х тт. – Київ: ВГЛ „Обрії", 2008. – Т. III. – С. 253 – 255.

5. Дубровский Ю.В. Сообщества в специфических биотопических условиях как объекты природно-заповедного фонда // Природно-заповідний фонд України – минуле, сьогодення, майбутнє. Матеріали міжнародної науково-практичної конференції, присвяченої 20-річчю природного заповідника „Медобори" (смт. Гримайлів, 26-28 травня 2010 р.). – Тернопіль: Підручники і посібники, 2010. – С. 47 – 50.

6. Зінько Ю., Партика Ю. Законодавче забезпечення охорони геоспадщини: національний і зарубіжний досвід // Природно-заповідний фонд України – минуле, сьогодення, майбутнє. Матеріали міжнародної науково-практичної конференції, присвяченої 20-річчю природного заповідника „Медобори" (26-28 травня 2010 р., смт. Гримайлів). Тернопіль: Підручники і посібники, 2010. – С. 51 – 56.

7. Козиненко И.И., Титар В.М., Шуваликов В.Б. Природные популяции животных в зоне отчуждения Чернобыльской АЭС: комплексный биомониторинг гомеостаза. Радиоэкологические исследования в зоне отчуждения Чернобыльской АЭС. Труды Коми научного центра УрО РАН, 2006, №180, с.48-68.

8. Фарб П. Популярная экология. – М.: Мир, 1971. – 192 с.

9. Kozinenko I.I., Tytar V.M., Shuvalikov V.B. Natural populations of animals in the Chernobyl exclusion zone: an integrated biomonitoring of homeostasis. Radiological studies in the area of the Chernobyl nuclear power plant. Proceedings of the Komi Science Center, Ural Branch of RAS, 2006, № 180, p. 48-68.

10. Whittaker R.H. and Woodwell G.M. Evolution of Natural Communities. // Ecosystem Structure and Function. (Prog. 31st Annual Biol. Colloc., 1970). – Corvallis: 1972. – P. 137 – 159.