Bibliography
Zagorodniuk I. V. Indicators of steppe ecosystem biodiversity as criteria of natural core value. In: Ecological aspects of the Luhanschyna in context of sustainable development (Annual of scientific works). Luhansk: LNAU Publ. House, 2009. — P. 120–125.

Бібліографія
Загороднюк І. В. Індикатори біорізноманіття степових екосистем як критерій цінності природних ядер // Екологічні аспекти Луганщини в контексті сталого розвитку (Щорічна збірка наукових праць). — Луганськ: Вид-во ЛНАУ, 2009. — С. 120–125.

English translation by author August 12, 2010
Original text (Ukrainian): http://terioshkola.org.ua/library/zag/zag-2009-steppe-indicators.pdf

Indicators of steppe ecosystem biodiversity as criteria of natural core value

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Indicators of steppe ecosystem biodiversity as criteria of natural core value. — Idea of using of biodiversity indicators for selection of the high conservation value ecosystems (HCVE) is considered. Seven key criteria of HCVE based on biotic components were established: 1) absolute indexes of species richness of biota in a whole and separate indicator groups, 2) the number and portion of alien species, 3) the amount of lost or undercount species diversity, 4) the number and portion of rare species, 5) presence of typical zonal communities and key habitat forming species, 6) the absolute sizes of ecosystems in viewpoint of minimal size of indicator species populations, 7) capacity of trophic pyramid base and the length of trophic chains. Despite the absolute value of rare species as indicators of environment state as well as criteria of values of natural systems, this their role can be addresed to other species, that have the same (or similar) indicator properties and are also indicators of the existence (or possible existence) of rare species. Seven criteria for selection of indicator species (genera) are formulated, and examples of indicators from the Steppe Fauna Core (SFC) are shown. Analysis of the indicators is a tool for rapid and effective selection of HVCE for inclusion them in the network of natural reserve fund and for the detection of natural cores of Econet, and it is a basis for analyse the current state and changes in habitats of rare and endangered species.

Introduction

Modern degree of anthropogenic transformation of ecosystems, including their direct violations by man's economic activity as well as consequential changes as a result of violation of structure of relations inside ecosystem conduce to the inevitable losses of biodiversity (Zagorodnyuk, 1997; Lebedeva, Krivolutsky, 2002). Since these processes are not point and reached global scales, the only way to diversity protection is the support of integrity of ecosystems, an effective mechanism of this was not recognized the protection of separate species or some remnants of natural ecosystems, but restoring the integrity of natural landscapes and pattern of biotic communities (Sutherland, 2004).

Generally accepted tool for restoration of ecological framework and its involvement in the structure of the most valuable for conservation area (or waters) became the Econet, which central element is natural cores as centers of existance of full-complex communities and centers of floristic and faunistic cores, characteristic of certain types of natural systems. Such natural systems are the biogeographical units of appropriate level of integration, at least at the level of district (Baquero, Tellería, 2000).

This idea is complicated by the fact that the vast majority of populations in the traditional sense of the concept actually exists in the form of “metapopulations” as system of interacting or mutually interchangeable local populations. Actually metapopulation pattern of species defines their long-term opportunities of their existance in the structure of certain communities. Two key requirements arising from the last Econet: 1) defining the minimum allowable size of natural cores and 2) opportunities to interaction between them. However, the idea of natural cores are essentially remain anthropocentric, because remnants of natural ecosystems have acquired the characteristics of island communities as result of development of urbanization centers and infrastructure of civilization.

In any case, the practice of nature protection should take into account the availability of urban and anthropogenic landscapes, on the one hand, and on the other hand, should be based essentially on the inability to maintain the existing (and especially recover the original ones) structure of ecosystems, both in terms of environmental practices and economic realities. So, the key task is to identify the network of highly valuable for conservation ecosystems as well as ensuring their interactions (Vtorov, Vtorova, 1983).

Obviously, the nubbers of criteria for this are not less than numbers of experts, and sometime not less than the number of of flora and fauna species and their assemblies. However, this problem can not be rejected even in the knowledge of this, and it requires solution. Thus, the criteria values territories (not always the "ecosystem" in the true sense of the term) should be chosen only those among them, that allow to carry out a rapid assessment of areas selected for analysis, and moreover without long-term and difficult studies, the results of which may be a late indication of the high values of such areas or ecosystems.

General criteria of natural ecosystem high values

The value of remains of natural ecosystems can be established using a few criteria (groups of criteria) including:

1) absolute sizes and configuration of sites
2) degree of insularization of territory
3) connection with other similar areas
4) degree of safety of the initial state
5) distance from the sources of instability
6) presence of rare species and communities
7) presence of indicators of biodiversity.

One of the main criteria of high vavue of some area is the existence of species which may be satisfactory indicators of biodiversity in a whole and its zonal features in particular (Niemi et al., 1997). So, our search should be directed to the criteria of evaluation of the biotic component of the High Conservation Value Ecosystems (HCVE).

Criteria for evaluation biotic component of HCVE

Important component of estimates by biotic constituents of HCVE are:

1) absolute indexes of species richness of flora and fauna in a whole or separate indicator groups;

2) absolute amount and portion of alien species;

3) volume of lost or undercount (in relation to the list of expected species) of species riches of local (aborigines) species;

4) an absolute amount and portion of rare species estimated for all groups of the rarity (Zagorodniuk, 2008);

5) presence of typical zonal communities and key habitat forming groups of species (e.g., representatives of steppe faunal core or large herbivores);

6) absolute sizes of ecosystems, taking into account the minimal spatial necessities of metapopulations of key indicator species;

7) capacity of trophic pyramid base and the number of effectively operating trophic levels and types of co-operations (incl. length of trophic chains).

Evaluation of all these criteria of high values is quite complex and time-consuming task that requires large amounts of research and considerable time, and availability of appropriate levels of professional training. By such criteria, the individual model communities and ecosystems can be assessed, but not large amounts of territories. The key problem is the possibility of relevant census of flora and fauna. This approach becomes particularly difficult to implement when we attempt to ground the Econet pattern or its natural cores. Thus, an important task in assessing the degree of safety and values of natural areas are not the data on the general volume or composition of biota in a whole, but the presence and state of populations of separate species and species groups that may be indicators of general state of communities and ecosystems (Stoyko, 2004, this work).

Role of such indicators can perform the various groups such as systematic and ecological, biogeographical or functional. For example, evaluation can be conducted using data on insects or birds, producers or entomophages, hydrobionts or xylobionts, sedentary or migratory species, single species or their guilds, species with high or low habitat forming activity, species that inhabit certain landscapes (for example, step) or microlandscapes (eg epilites) and some components of unique synusia, high rarity or common species, etc.

Analysis of all this diversity of objects and experience towards finding the indicators showed that certain animal groups within the above mentioned are extremely difficult to analyze existing data and, despite their high value, are often not sufficient or available for investigate large areas, or it requires extraordinary expenses and unjustified involvement of specialists with too high-level skills.

In particular, collecting data on rare species which are the basis of rare fauna, is very important, but it is unnecessarily time-consuming process for assessment of large territories (Prendergast et al., 1993). In addition, there are many risks to obtaine formally high estimations due to "grey biota", including alien biota (Swarts et al., 1995; Kerr, 1997).

Criteria of selection of key indicators

At forming of lists of key indicators of biodiversity, among criterias of great values of different animal or plant groups there can be the following:

1) possibility to identify of species by their direct observations or by traces of their life activity, including opportunities of photodocumentation, lifetime and distant diagnostics, identification using indirect data or without time-consuming methods of identification;

2) relatively high frequency of occurring, which can identify the species at the simplest accounting schemes for appropriated systematic or ecological groups. Such schemes is not good for the most of rarity species. Examples of minimum accounting schemes (MAS) were described in separate work (Zagorodniuk et al., 2002). Species should be

identified in typical accounting cycle (eg, 10-km route, 100 trap/nights, one day of observations, etc. in appropriate habitats and at the right time or season);

3) indicators should be selected among the groups with known metapopulation pattern. This pattern allows to estimate not only the presence of species (ie presence of some specimens, but not stable local populations), but some spatial and demographic structure, which is typical for the species in studied locality (for example, a single settlement, colony, nested pairs, reproductive nucleus, hibernated cluster, etc.);

4) presence of expressive and obvious mutualistic relationships and other types of ecological interactions with other groups of high valuable for conservation species, including the value of habitat forming elements of communities and ecosystems, their role in ensuring the existence of ecologically closed species, etc.;

5) high value of species or species groups in forming the structure of communities at the level of guilds (ie, within one ecomorphological type or trophic level), and at the level of food webs (ie relationships between trophic level);

6) "zonal value" of species, determined by its high preference to typical zonal biotopes and habitats (ecosystems) in general. Examples of calculations the indices of biotope preference can be found in special publications (Pesenko, 1982; Naglov, Zagorodniuk, 2006). In many cases, important criteria is not only high biotope preference of species to some type of habitats, but its belonging to one or another zonal biotic complex, for example the Steppe Fauna Core (Zagorodniuk, 1999);

7) The overall umbrella effect that can be estimated by point scale as the value of the fact of presence of species (supraspecies, family, etc.) to assess the status of populations of related species, guilds and indices of values and virginity (= integrity) of ecosystems (Fleishman et al., 2000).

Examples and TOP-10

Will point three examples of mammals from composition of steppe faunistic core, which can be considered in quality of indicator-species of high value for conservation steppe ecosystems (all three species are from the group of digging rodents which are the konsuments of the 1st degree).

Marmot *(Marmota bobak):* corresponds to all 7 criteria, incl. easy identication, obvious habitat forming function and connection with other mutual species (for example, long-eared hedgehog, steppe fox, ruddy shelduck, isabelline wheatear etc.), leading role in forming of trophic chains, and umbrella effect.

Suslik *(permophilus sp.):* also meets all seven criteria. This species took place a leadership role in forming of the trophic base of many carnivores and birds of pray. It forms the stable settlement only when presence (but moderate) of grazing pressure, i.e. the presence of large herbivores. Vulnerable to fragmentation factor.

Mole-rat *(Spalax microphthalmus):* this species also meets all seven criteria. One of the key species of burrowing steppe mammals which digging activity supports a certain level of structure of zoogenis soils.

Among representatives of higher terrestrial vertebrates (Amniota), the followings taxa can be considered (listed in alphabetical order at the level of generic rank) to the list («TOP-10») of key indicators of highly valuable for a prorection steppe ecosystems:

mammals (Mammalia):
marmot (*Marmota*), molerat (*Spalax*), suslik (*Spermophilus*);

birds (Aves):
eagle (*Aquilla*), falcon (*Falco*), bustard (*Otis*), wheatear (*Oenanthe*);

reptiles (Reptilia):
wall lizard (*Eremias*), ratsnake (*Elaphe*), viper (*Vipera*).

Data on such species are generally available, most these species (or genera) is easily identified in field conditions, their abundance is sufficient to their registering in the most valuable areas for conservation (and also to speak about significant role of these animals in the functioning of natural ecosystems). So, the next step is to clarify and expand to other taxonomic groups the list of indicator species as well as development of a criterion to assess their presence in selected monitoring sites.

Prospects

Steppe ecosystems are one of most vulnerable and most mastered (transformed) by man, and our next nature protection steps must be directed exactly on development of steppe segment of econet. Thus it should always remember, that at least the third of present indicator-species as well as communities which include them is closely related to the bayrak [gully] forests inherent for eastern (in scale of Ukraine) steppes. Maintenance of spatial structure of their populations, the completion of life cycles and foraging strategy, seasonal migrations, wintering [hybernate] shelters *etc.* of many representatives of steppe faunistic core are closely related to the bayrak forests, and considerable part of territory of steppe area according to forestry zoning belongs to the zone of the «northern (bayrak) forests» (Gensiruk, 2002).

In the same time, intensive development of pine plantations on plakor [highland] steppe areas, which takes place in our time, is the unjustified mean of proceeding in the portion of areas covered with forest. A tendency to the discussion of theme of development of steppe segment of econet through planning of natural cores only along the system of the former and saved until now the bayrak forests is incorrect.

Taking into account unfitness of most such lands for economic activity, the simplest is to move up into the fund of econet, however it is important to remember that steppe is not only a type of communities but also landscape which must be stretched out on tens of kilometres along and on the tops of basic watersheds, certainly, taking the bayrak-beam systems. Actually, on such full-scale plots the maintainance of stable [viable] population of steppe species of plants and animals is possible (Parnikoza, 2008).

Awareness of this is the important component of strategy for development of the protected business, otherwise all other our motions in direction of nature protection will be useful only for satisfaction of current economic problems of nature protection institutions as well as nature protectors, not for rarity part of biota which is now cut adrift.

References

Gensiruk S. A. Forests of Ukraine. Lviv, 2002. 496 pp. (In Ukrainian).

Baquero R. A., Tellería J. L. Species richness, rarity and endemicity of European mammals: a biogeographical approach // Biodiversity and Conservation. — 2001. — Vol. 10, N 1. — P. 29–44.

Fleishman E., Murphy D. D., Brussard P. F. A new method for selection of umbrella species for conservation planning // Ecological Applications. — 2000. — Vol. 10. — P. 569–579.

Kerr J. T. Species richness, endemism, and the choice of areas for conservation // Conservation Biology. — 1997. — Vol. 11, N 5. — P. 1094–1100.

Lebedeva, Krivolutski, 2002. Лебедева Н. В., Криволуцкий Д. А. Биологическое разнообразие и методы его оценки // География и мониторинг биоразнообразия. — Москва: Изд-во НУМЦ, 2002. — С. 8–75.

Naglov V., Zagorodniuk I. Statistical analysis of species biotope preferences and community pattern // Mammal fauna of Eastern Ukraine. Luhansk, 2006, p. 291–300. (Series: Proceedings of the Theriological School, volume 7). (In Russian, with summary in English).

Niemi G. J., Hanowski J. M., Lima A. R. et al. A critical analysis of the use of indicator species in management // Journal of Wildlife management. — 1997. — Vol. 61. — P. 1240–1251.

Parnikoza I. Conservation of Ukrainian steppes: what can be done today? // Rarity mammal fauna and its protection / Edited by I. Zagorodniuk. — Luhansk, 2008. — P. 53–62. — (Series: Proceedings of the Theriological School, volume 9). — (In Ukrainian with summary in English).

Pesenko, 1982. Песенко Ю. Н. Принципы и методы количественного анализа в фаунистических исследованиях. — Москва: Наука, 1982. — 287 с.

Prendergast J. R., Quinn R. M., Lawton J. H. et al. Rare species, the coincidence of diversity hotspots and conservation strategies // Nature. — 1993. — Vol. 365. — P. 335–337.

Stojko, 2004. Стойко С. М. Критерії оцінки раритетності (рідкісності) видів. Фітосозологічні критерії // Раритетний фітогенофонд західних регіонів України. — Львів: Ліга-Прес, 2004. — С. 57–65.

Sutherland W. J. Setting conservation priorities // Sutherland W. J. The conservation handbook: research, management and policy. — Oxford: Blackwell Science Ltd., 2000. — P. 21–35.

Swarts E. A., Pushkaryov S. V., Krever V. G., Ostrovsky M. A. Geography of mammal diversity and searching for ways to predict global changes in biodiversity // Journal of Biogeography. — 1995. — Vol. 22. — P. 907–914.

Vtorov, Vtorova, 1983. Второв П. П., Второва В. Н. Эталоны природы (Проблемы выбора и охраны). — Москва: Мысль, 1983. — 207 с.

Zagorodniuk I. Concept of "hot territories" and biodiversity protection // T. Gardashuk (ed.). Convention on biological diversity: public awareness and participation. (Proceedings of International Conference). — Kyiv, Stylos, 1997. — P. 59–68 (in Ukrainian, with English summary; summary: 146–147).

Zagorodniuk, 1999. Загороднюк І. В. Степове фауністичне ядро Східної Європи: його структура та перспективи збереження // Доповіді НАН України. — 1999. — № 5. — С. 203–210.

Zagorodniuk I. Rare and valuable fauna and criteria of species rarity // Rarity mammal fauna and its protection / Edited by I. Zagorodniuk. — Luhansk, 2008. — P. 7–20. — (Series: Proceedings of the Theriological School, volume 9). — (In Ukrainian with summary in English).

Zagorodniuk I., Kysselyuk O., Polischuk I., Zenina I. Units of measure of population abundance and the minimal scheme for census of mammals // Visnyk of the Lviv Univ. (Biology Series). — 2002. — № 30. — P. 8–17. (in Ukrainian, with English summary).