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## **Ecological assessment of the territory of the projected State Nature Reserve ‘Bokeyorda’ in West Kazakhstan region**

**Abstract.** Presented paper deals with the environmental protection problems on the example of the project of the State Natural Reserve ‘Bokeyorda’ in West Kazakhstan region. During the development and implementation of the project the main goal was to assess the impact of natural and anthropogenic factors on the unique natural ecosystems and their biological diversity. The natural conditions were investigated and the key plant and animal species were identified, their current status and the human impact were evaluated as well as recommendations for the conservation of species and their habitats were made. Based on the ecosystem analysis and GIS technology the most important areas for biodiversity conservation were revealed, the Reserve boundaries were defined, zoning of functional areas were performed and maps were prepared.

**Key words:** ecological assessment, ecosystem, protected areas, state natural reserve, steppe, flora and fauna.

### **Introduction**

The territory of Kazakhstan has a unique variety of landscapes – from deserts to high mountains and marine ecosystems. As tempo of the natural resources use is rapidly increasing in such economically developing country as Kazakhstan, the more urgent is the question of further improving of the system of the Nature protection areas, effective for biodiversity conservation.

A large part of the world natural steppe areas, more than 120 million ha, is located in Kazakhstan, which steppe ecosystems are the habitat of the unique steppe vegetation and the globally endangered species of steppe fauna. Kazakhstan steppe ecosystems are the most significant for the more than 2000 plant species, including about 30 endemics.

Steppes are the least protected ecosystems in Kazakhstan, and highly under-represented in the system of strictly protected areas (SPA). This is due to low volume of humus horizon of soils and scarcity of biological productivity of vegetation.

Currently, the system of SPA in the West Kazakhstan region is represented by three protected areas of national significance and seven protected areas of regional significance. The total area is of 188.7 thousands ha, or 1% of the total area of the region. No protected areas with a strict regime of protection

and with the status of a legal entity are present in this region (1-25).

One of the reasons of creation of strictly protected area at West Kazakhstan Region is that it is the habitat of the Ural population of saiga antelope (*Saiga tatarica*). Not so long ago, the mass death of this animal from pasteurellosis has occurred. 12 thousand individuals deceased in May 2010, and more than 400 individuals – in May 2011. As a result, the number of the Ural population of saiga antelope has declined from 39 thousand to 27 thousand individuals (27).

The purpose of this study was to evaluate the ecological state of ecosystems in the area between the rivers Volga and Ural, to provide the scientific justification for the creation of the State Natural reserve ‘Bokeyorda’ of West Kazakhstan region, that is necessary for the conservation of habitats of rare plant and animal endemic species, including the Ural saiga antelope population *Saiga tatarica*, as well as the conservation of the whole region biodiversity.

### **Materials and Methods**

Geobotanical, soil, floral, faunistic and ecosystem researches in the project area were performed with the use of commonly accepted methods (4, 6, 8, 11, 12, 14, 15, 21, 23, 24, 28-31). The monitoring

areas were distinguished to fix the data in the system of GPS. We mapped areas of distribution of plant and animal key species and evaluated the impact of negative factors on biological diversity (10).

Distinguishing the valuable sites for SPA, we used the ecosystem approach, based on a complex assessment of the ecological state of the natural components, dominating biogeocoenoses and zoocoenoses of steppe environment, using remote sensing data and GIS technology. It will allow to assess the quality potential of biodiversity, based on the existing correlation between the ecotope (type of habitat), the type of vegetation and animal population. Ecological potential of habitats and the potential diversity of biota were determined on the base of gradation of ecosystem components (relief, soil, vegetation and associated animal population) (7).

## Results and Discussion

The project area has a complex composition of land users. According to preliminary data of 'Scientific-Production Centre of Land Cadastre', the 74 land users are located on the total area of 78 796.2 ha. Based on the need of preserving the unique natural complexes and taking into consideration the interests of the local population as well as the perspectives of the agriculture development in this region, it has been proposed to include in the reserve only the southern part of the project area, with lake Aralsor and adjacent territory (Fig. 1). This is due to the fact that the northern and north-eastern parts of the project area within the boundaries of Borsy and Zhaksybay rural districts, and Koshankol and Karaoba rural districts, were previously seen as a promising area for the development of animal husbandry.

The project area is located in the northwestern part of the Caspian lowland in the West Kazakhstan region within the territory of Zhanibek, Bokeyorda, Kaztalovka raion districts. The total area of the studied region is 690.929 thousand ha, or about 4.5% of the region area (Fig. 1). The nature of its relief is almost a hollow, flat and slightly rolling plain with slight slope to the south. This plain is represented by places of depressions, clayish salt marshes and ancient channels of temporary streams.

The hydrographic network on the territory of the nature reserve is very weakly developed. The river Aschyozek flows on the east of the project area, with several tributaries – the largest of them are the right-bank tributaries Sherembetsay, Tatkensay, Zhaman-say, Astausalgan arroyo, Bersharal, and the left-bank tributaries Koldybaysay and Tereksay, flowing into

the large lake Aralsor. Due to the frequent alternation of soil conditions, soils are inhomogenic and have different structure. However, within the individual parts of the territory of the future nature reserve in the watershed areas, the zonal types of soils prevail – kastanozems, light-kastanozems and brown earth (5).

The flora of the project area is very diverse and poorly investigated. We have identified 537 species of vascular plants from 66 families and 265 genus. However, this is not complete species composition. In the overall flora of the West Kazakhstan region it constitutes 42.7% of total number of species (537), 54.4% (265) of total number of genera and 56.4% (66) of total number of families. The representatives of 3 families are the most numerous in the studied area – *Asteraceae*, *Poaceae* and *Chenopodiaceae*. *Asteraceae* is represented by 95 (17.3%) species, *Poaceae* – by 54 species (9.8%) and *Chenopodiaceae* – by 42 species (7.6%) (9, 16).

The project area 'Bokeyorda' belong to two natural zones – the steppe zone (subzone of *Gemifructis-gramen-poaceae* desertified steppes on light-kastanozems) and the semi-desert zone (northern subzone of *Artemisia* and long-term *Salsola* semideserts on brown earth). According to the system of phyto-geographical zoning, the project area is represented by the Eurasian steppe and the Afro-Asian desert areas. Steppe is represented by its most arid subzone – Zavalzhye-Kazakhstan *Gemifructis-gramen-poaceae* desertified steppes, which includes the northern part of territories. Desert is represented by the least arid north-western outskirts of the Caspian province – the North Turan steppe desert, which include the large part of the Caspian depression (17-18). 7 types of vegetation are well represented in the project area: steppe, desert, forest, shrub, meadow, swamp, submergед-water (20).

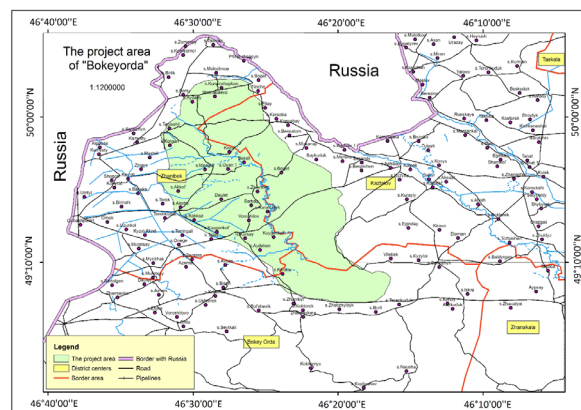
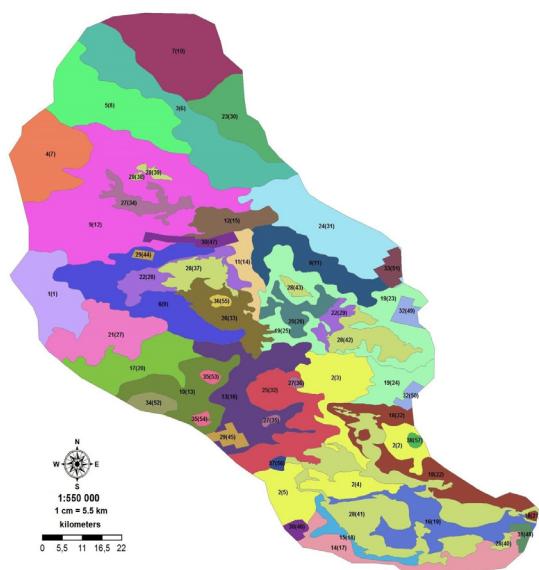


Figure 1 – Map of the projected State Natural Reserve 'Bokeyorda' in West Kazakhstan region

Animals of the project area are represented by steppe and desert zone species. Among rodents are little souslik *Spermophilus pygmaeus*, several species of hamsters (*Cricetidae*), dipodids (*Dipodidae*), gerbils (*Gerbillidae*), voles (*Microtidae*), mice (*Muridae*). Carnivores are represented by wolf *Canis lupus*, red fox *Vulpes vulpes*, korsak *Vulpes corsac*, steppe polecat *Mustela eversmanni*, stoat *Mustela erminea*, badger *Meles meles*, common weasel *Mustela nivalis*, and others. Among even-toed ungulates are two species: saiga antelope *S. tatarica* and wild boar *Sus scrofa*. The very characteristic for the studied territory are such birds as larks (*Melanocorypha*), swallows (*Hirundinidae*), little bustard *Tetrax tetrax*, demoiselle crane *Anthropoides virgo*, and others. Among the small birds of prey are kestrel *Falco tinnunculus* and red-footed falcon *Falco vespertinus*, and among the large ones are common buzzard *Buteo buteo*, hen harrier *Circus cyaneus* and steppe eagle *Aquila nipalensis*, which is rarely observed. The waterbodies are very rich in various waterfowl species. Among reptiles, steppe-runner *Eremias arguta*, sand lizard *Lacerta agilis* and steppe viper *Vipera ursinii* are ordinary to the desert.

We identified 57 individual ecosystems within the planned State Nature Reserve 'Bokeyorda', which were arranged in a hierarchical classification by their typological groups, structural and genetic classification. This classification was the basis of the legend displayed on the map (Fig. 2). This map shows classification of ecosystem ranks (Legend in Fig. 2).



**Figure 2** – Map of ecosystems of the projected State Natural Reserve 'Bokeyorda' in the West Kazakhstan region

LEGEND OF MAP FOR ECOSYSTEMS IN PROJECT-ED STATE NATURAL RESERVE «BOKEYORDA» IN THE WEST KAZAKHSTAN REGION

GROUND AUTOMORPHIC

- Desert-steppe ecosystems on light-kastanozems soils  
*Gramen-poaceae* of flat plains
- 1(1) – With the predominance of *Poaceae-filipéndula*, *Artemisia-roaceae-festuca*, *Tanacétum-festuca* associations
- 2(2-5) – With the predominance *Variherbetum-poaceae-agropyron* associations
- 3(6) – With the predominance of *Poaceae-festuca*, *Artemisia-festuca* associations in combination with *Variherbetum-gramen-poaceae* in depressions  
*Gramen-poaceae* of sloping plains dissected by erosion
- 4(7) – With the predominance of *Poaceae-filipéndula*, *Artemisia-roaceae-festuca*, *Tanacétum-festuca* associations
- 5(8) – With the prevalence of *Artemisia-poaceae-stipa* associations with a predominance of *Filipéndula*
- 6(9) – With the prevalence of *Artemisia-poaceae-festuca* associations with a predominance of *Filipéndula* in conjunction with the cultivated lands
- 7(10) – With the prevalence of *Artemisia-poaceae-stipa* dominated communities *Filipéndula* in conjunction with *Sálsola-artemisia pauciflora*, and cultivated lands
- 8(11) – With the predominance of *Poaceae-festuca* with in conjunction with *Sálsola-artemisia pauciflora*
- 9(12) – With the prevalence of *Artemisia-poaceae-festuca* dominated communities *Filipéndula* in conjunction with the *Sálsola*  
*Artemisia* of flat complicated by suffusion slides plains
- 10(13) – With the prevalence of *Poa praténsis-artemisia pauciflora* sometimes with *Poaceae* and *Sálsola* together with representatives of the *Sálsola-artemisia pauciflora*
- 11(14) – With the prevalence of *Gramen-poaceae-artemisia pauciflora*, sometimes with *Poaceae* and *Sálsola* together with representatives of the *Sálsola-artemisia pauciflora*
- 12(15) – With the prevalence of *Artemisia-roaceae-festuca* dominated communities *Filipéndula* in conjunction with the cultivated lands  
*Artemisia* of sloping plains dissected by erosion
- 13(16) – With the prevalence of *Gramen-poaceae-artemisia pauciflora* in combination with the black *Sálsola-artemisia pauciflora*
- Desert-steppe ecosystems on brown earth soils  
*Artemisia* of sloping plains dissected by erosion
- 14(17) – With the prevalence of *Artemisia lerchiana* and bluegrass during *Poa praténsis-artemisia lerchiana* community *Sálsola* in depressions and depressions
- 15(18) – With the predominance of *Variherbetum-poaceae-euphórbia* communities with a predominance of *Artemisia* and *Filipéndula*
- 16(19) – With the prevalence of *Artemisia pauciflora-limonium*, *Poaceae-artemisia lerchiana* and *Artemisia-ruccinelli* communities

Halophytes-artemisia ecosystems on solonetz  
*Artemisia* of flat complicated by suffusion slides plains  
 17(20) – With the predominance of *Salsola-artemisia pauciflora* complex with *Festuca-roaceae-artemisia* communities with a predominance of *Filipéndula*  
*Artemisia* of sloping plains dissected by erosion  
 18(21-22) – With the predominance of *Artemisia pauciflora*, *Salsola* in complex with *Artemisia-roaceae-agropyron* communities  
 19(23-25) – With the predominance of *Salsola-artemisia pauciflora* in the complex, *Ephemerae-proaceae-artemisia lerchiana* communities  
 20(26) – With the predominance of *Salsola-artemisia pauciflora* in conjunction *festuca-roaceae-artemisia* communities with a predominance of *Filipéndula*  
*Salsola* of flat complicated by suffusion slides plains  
 21(27) – With the predominance *Petrosimonia sibirica* (*Pall*) *Bge Ahab Rev* in a complex of *Salsola-artemisia pauciflora* and *Proaceae-filipéndula* communities  
*Salsola* of gently rolling plains dissected by erosion  
 22(28-29) – With the predominance of *Artemisia-salsola-limonium* communities  
 SEMIHYDROMORPHIC  
 Meadow-desert ecosystems on meadow-light kastanozems soils  
*Poaceae* of sloping plains dissected by erosion  
 23(30) – With the prevalence of *Leymus poaceae* communities  
*Gramen-poaceae* of flat complicated by suffusion slides  
 Plains  
 24(31) – With the prevalence of *Gramen-poaceae-artemisia-variherbetum* communities  
 Meadow-desert ecosystems in the meadow solonetz  
*Artemisia* in depressions  
 25(32) – With the predominance of *Salsola-artemisia pauciflora* communities in a complex *Artemisia pauciflora-suaeda* and *Artemisia-roaceae*  
*Salsola* in depressions  
 26(33) – With the prevalence of *Puccinelli-halimione-artemisia* communities  
 HYDROMORPHOUS  
 Meadow-desert ecosystems in the meadow soils  
*Variherbetum-poaceae* in depressions  
 27(34-36) – with a predominance of *Variherbetum-poaceae* communities sometimes with *Carex*  
 The hyper halophytic ecosystems of depression  
 Sors in depressions and in the saline depressions  
 28(37-43) – Sors, salt marshes with sparse *Salsola* vegetation  
 GROUND ANTHROPOGENICALLY DISTURBED  
 ECOSYSTEMS AGRO-ECOSYSTEMS  
 Anthropogenically transformed ecosystems on light-kastanozems soils  
 Parturition of arable and cultivated land  
 29(44-45) – Arable land and cultivated land on the site of *Tanacetum-festuca-stipa* communities  
 30(46-47) – Arable land and cultivated land on the site of *Variherbetum-stipa* communities  
 Anthropogenically transformed ecosystems on brown earth soils  
 Parturition of arable and cultivated land

31(48) – Arable land and cultivated land on the site of *Festuca-artemisia pauciflora*, *Festuca-linosyris* communities  
 Anthropogenically transformed ecosystems on solonetz  
 Parturition of arable and cultivated land  
 32(49-50) – Arable land and cultivated land on the site of *Tanacetum-festuca-stipa* communities  
 Anthropogenically transformed ecosystems on meadow light-kastanozems soils  
 Parturition of arable and cultivated land  
 33(51) – Arable land and cultivated land on the site of *Tanacetum-festuca-stipa* communities  
 DEGRADED  
 Anthropogenically disturbed ecosystem on eroded light-kastanozems soils  
 Parturition of pasture failures around residential housing  
 34(52) – *Ephemera-ceratocarpus* overgrazing or anthropogenic disturbances  
 35(53) – *Artemisia lerchiana-ephemeral*  
 36(54) – *Artemisia procera*. Ruderal thickets  
 Anthropogenically disturbed ecosystem on eroded solonetz  
 Parturition of pasture failures around residential housing  
 37(55) – *Ephemerae-egetorugit*  
 38(56) – *Artemisia pauciflora-salsola* thickets

Note: 1. The first number has specified number of a type of an ecosystem according to the table of a legend

2. The second number (in brackets) has specified serial number of an ecosystem according to the table of a legend

The project area includes the habitat of the Ural population of the saiga antelope *S. tatarica*. Saiga antelope of the Azgir-Urda grouping usually lives here in the spring and autumn periods. In the winter they leave the territory of Atyrau region. The main areas of its habitat are neighborhood of the Sors Khaki, river Aschyozek, lake Aralsor. In some years it rises to the north to the settlements Kaztalovka and Borsy (13, 20).

Areas of the main habitat of the saiga antelope, including wintering, summering and mass calving, currently occupy the neighbourhood of the north-western part of the Volga-Ural interfluvium. Basically, these territories are less affected by economic activity and are remote from major population centers. Obviously, the saiga antelope prefer to feed here. In the Volga-Ural interfluvium, the most part of saiga antelope population is concentrated now in Aralsor solonchak- lake structural basin, where a desert-solonchak complex of vegetation is predominant, with the most preferred by saiga antelope (*S. tatarica*) plant of the families *Asteraceae*, *Chenopodioideae*, *Cruciferae* and *Rosaceae* (1-3). These are not only such plant species as *Chenopodium album*, *Kochia*

*prostrata*, *Potentilla* sp., *Crinitaria tatarica*, *Polygonum patulum* and others, that are usually preferable by herbivorous mammals, but also many weeds and poisonous plants, such as *Lactuca serriola*, *L. tatarica*, *Artemisia austriaca*, *Thlaspi arwense* and others, which other ungulates do not eat by *S. tatarica* (19).

The Volga-Ural interfluvium is now a place for mass saiga antelope calving. Now, it is located more to the north than in the past: to the east and north of the lake Aralsor and even in the village Borsy – the most north-western part of the interfluvium. The change of the range of mass calving, occurring in recent years, is, no doubt, due to the increase of anthropogenic load on the previous areas of calving. The territories located to the south now include agricultural land, covering an area of 12 785.000 ha, of which arable land – 769,8 ha (6.0%), hayfields – 1.010 mln ha (7.9%) and pastures – 10.106 mln ha (79.0%). The main economic activities in the region of the planned reserve are the sheep farming, cattle husbandry and herd horse breeding. This factor should be taken into account in the development of this project.

Local authorities planned to provide to large farmers the agricultural areas of land for the needs of pasture animal husbandry. With this in mind, it has been recommended to create two types of SPA on the project area – the State Nature Reserve and the State Natural Zakaznik (the complex one). Possible boundaries of these SPA are shown on the map of the Reserve ‘Bokeyorda’ (Fig. 1.) The area of the Reserve is 239 242 ha, and its protected area is 81 513 ha, Zakaznik – 299 218 ha.

During the development of the project, it was necessary to take into account the recommendations for the conservation of biological diversity of the region. Rare and endangered species with important economic, scientific and aesthetic value were included in The Red Book of Kazakhstan (26, 32).

Our investigation of plant communities showed that the flora of the project area ‘Bokeyorda’ consists of 104 species of fodder plants. We noted the presence of at least 4 unique and significant plant communities, which represent a kind of original botanical-geographic phenomenon and have an important environmental, water regulation, water protection, soil protection, and other roles. Despite of widespread plowing, the small natural sites of zonal steppe complexes were fragmentary preserved. These are the Sherembetsay tract, Tegishshyl complex steppe, steppe Aralsor steppe, Karaoba *Festuca* steppe.

In the studied area of the planned reserve we also found 21 rare, endemic and relict, species of plants,

which occur with various level of abundance and play different roles in the vegetation. They constitute 5.1% of the total flora. Following species are listed in the Red Book: *Calophaca wolgarica*, *Adonis vernalis*, *Centaurea talievii*, *Tulipa schrenkii*, *Tulipa biebersteiniana*, *Tulipa biflora*, *Ornithogalum fischerianum*.

The studied territory is also important for the conservation of habitats of steppe animal species. We revealed 37 species of mammals, 71 species of birds and 7 species of reptiles. 5 species are listed in the Red Book – demoiselle crane *Anthropoides virgo*, little bustard *Tetrax tetrax*, eagle-owl *Bubo bubo*, golden eagle *Aquila chrysaetos* and steppe eagle *Aquila nipalensis*.

### Conclusions

The territory of the future State Nature Reserve ‘Bokeyorda’ has the highest potential as the habitat of *Saiga antelope* and *S. tatarica*. This is due to preserved special conditions with rich biodiversity, necessary for large endemic mammals of steppe and semi-desert areas.

The studied territory is a refuge for many endangered plant and animal species and is very important for migratory species. Here, the significant natural fodder plant resources preserved, they dominate in the pastures and hayfields and are very diverse in its stern properties and seasonal use. Fodder plant communities are the source of highly nutrient food for animals throughout the year.

On the basis of created cartographic materials we tried to define the significance of ecosystems for biodiversity conservation. For that purpose, we revealed key plant and animal species for each ecosystem. Furthermore, for the assessment of environmental significance of the project area we used the richness of species. We also revealed the degree of disturbance of ecosystems in the studied area in connection with anthropogenic load and its impact on natural systems.

The existing natural potential, and, in particular, ecological conditions, allow to particular representatives of flora and fauna to pass all the stages of the biological cycle in the territory of Reserve, including the breeding stage. However, the impact of external factors, both natural and anthropogenic, to the representatives of wildlife fauna, continues to grow due to the intensity of the economic development of the territory. Now, it is necessary to take additional and more effective activities for the conservation of species and their habitats.

No strictly protected area is created in the West Kazakhstan region at the present time. Organisation of a new environmental institutions not only will fully ensure the preservation and restoration of steppe biodiversity of the region, but also will improve the socio-economic conditions, the development of ecotourism, etc. Analysis of ecological state of the project area, as well as the study of the habitat of *Saiga antelope S. tatarica*, will contribute to the creation of the large State Natural Reserve 'Bokeyorda' in the west of the West Kazakhstan region.

### Acknowledgements

Research was carried out in the framework of the project of the Government of Kazakhstan and the Global Environment Facility, United Nations Development Programme (UNDP) 'Conservation and sustainable management of steppe ecosystems', aimed at increasing the steppe ecosystems. Contract No 62761

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