

Complex of indicators as basis for assessment of significance of different territories of Uzbekistan for conservation of faunistic diversity of mammals

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Abstract. The article proposes a set of 8 indicators allowing to compare faunal diversity, the degree of its conservation, economic importance and endemism. Through the system of indicators it is possible to assess the importance of different regions of the country for fauna conservation, to develop measures for its protection and sustainable use. The assessment of the importance of different territories of Uzbekistan for the conservation of faunal diversity of mammals is demonstrated on the example of two administrative regions of the country. It is recommended to analyse the current state of the fauna and trends in its changes using a set of indicators on a regular basis and in parallel with fauna monitoring.

1 Introduction

Biodiversity decline is one of the global challenges to environmental security and has irreversible consequences for ecosystems, compromising their integrity and reducing access to ecosystem services. To mitigate negative impacts and prevent further loss of biodiversity, planning and implementation of restoration and protection measures requires the analysis of up-to-date data. The source of such data is a monitoring system based on a set of indicators. Indicators are qualitative and quantitative characteristics that allow for comparative spatial and temporal analyses, forecast trends of changes, and develop plans for conservation and sustainable use of fauna components.

The necessity to develop and use indicators for biodiversity monitoring is reflected in the goals and objectives of the Convention on Biodiversity (1992). In order to integrate monitoring results into the biodiversity management system, indicators are developed taking into account the recommendations of the United Nations Guidelines for the Development of National Biodiversity Monitoring Systems (UN, 2023). Indicators have standard requirements: simplicity of understanding; possibility of quantitative assessments; possibility of selecting significant criteria or thresholds; scientific validity and statistical reliability; possibility of identifying spatial differences and changes over time; availability of accessible data sources and long-term observation series. The main source of such data for vertebrate fauna monitoring is inventory results.

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The experience of applying various indicators to assess biodiversity in protected areas [1, 2], in monitoring activities in the field of biodiversity resources [3] is most revealing.

2 Materials and methods

2.1 Approaches

Monitoring of vertebrate fauna in different territories and subsequent assessment of their importance for biodiversity conservation requires unification of approaches and methods. The system of indicators for Uzbekistan was developed in accordance with regional specifics and tested in two administrative regions of Uzbekistan - Syrdarya and Jizzak. Preliminarily, in 2021-2023, an original map of ecosystems and habitats was developed for these regions (Fig. 1); an inventory of all vertebrate groups was conducted and current information for such an assessment was obtained [4, 5, 6].

The proposed indicator system is based on modern fauna inventory and monitoring data, data from the Red Data Book of Uzbekistan (2019) and the Red List of the International Union for Conservation of Nature (IUCN, version 2023-2), lists of economically important species, statistical data on the system of protected areas (PAs). It allows assessing the importance of territories of administrative regions for biodiversity conservation, identifying key biodiversity areas, priority areas for long-term monitoring and protection of biodiversity. The use of a unified system of indicators also makes it possible to obtain comparable data on vertebrate diversity in different regions and to analyse them in time and space aspects.

The system of indicators characterises the fauna structure, ecosystem diversity of the study area, the presence and proportion of rare, globally threatened and hunted species in the fauna, the degree of uniqueness and naturalness of the fauna, and the condition of its protection. It should be emphasised that fauna assessment and analysis should be carried out separately for each systematic group of vertebrates - amphibians, reptiles, birds and mammals.

The set of indicators we have developed shows the following parameters.

Indicator 1. Species richness of the fauna:

The number of vertebrate species (by systematic groups) inhabiting a particular territory and their share in % of the total species diversity of the vertebrate fauna of Uzbekistan. The indicator characterises the general trend in the number of animal species caused by various factors, helps to assess the role of the study area in maintaining fauna richness, and indirectly assesses the degree of anthropogenic transformation of natural habitats.

Indicator 2: Ecosystem representation:

Representation (number) of different habitats in the study area. It allows assessing the degree of anthropogenic transformation of natural ecosystems. The standard list of habitats of Uzbekistan is used [7].

Indicator 3. Index of rare species:

Share of red-listed species of the study area (by systematic groups) in % of the total number of species in the Red Data Book of Uzbekistan. Characterises the importance of the territory for the maintenance of rare and endangered species of the country's fauna.

Indicator 4. Index of globally threatened species:

Share of globally threatened species of the study area (by systematic groups) in % of the total number of Uzbek species listed as globally threatened by IUCN. This indicator characterises the global importance of the territory for the conservation of faunal diversity.

Indicator 5. Index of hunting fauna:

The number of hunting species (by systematic groups) included in the official "List of vertebrate species subject to state registration, accounting of the volume of their use and inclusion in the state cadastre of fauna objects" of the Ministry of Ecology, Environmental Protection and Climate Change of the Republic of Uzbekistan (MinEcology, 2023), inhabiting the study area; their share in % of the total number of hunting objects in the country. Characterises the potential of the territory for sustainable use of bioresources.

Indicator 6. Level of fauna protection:

Total square of protected areas of categories I-IV in % of the total square of the study area. This indicator characterises the level of protection of the territory's biodiversity.

Indicator 7. Level of fauna endemism:

The proportion of endemic species in % in the vertebrate fauna (by systematic groups) of the study area. The presence of narrow and regional endemics indicates the uniqueness of the fauna and the importance of the study area for maintaining the biodiversity of the region.

Indicator 8. Level of fauna naturalness:

Defined as the proportion of native species in the vertebrate fauna of the study area (in %) in relation to the number of invasive species (by systematic group). Invasive (or alien) species are defined as species whose introduction is related to human activity or has occurred through random introduction or deliberate introduction. This indicator characterises the degree of preservation/disturbance of native fauna and natural habitats.

For greater clarity of analysis and comparison, we also assessed the value of each indicator on a 10-score scale. The maximum score was assigned to all indicators for Uzbekistan. For each indicator, scores are calculated as follows: for example, the mammal fauna of Uzbekistan includes 107 species and is taken as 100% or 10 scores; The mammal fauna of the Syrdarya region includes 41 species and makes up 38.3% of the country's mammal fauna, or ~4 scores (Table 2).

2.2 Research area

The territories of the Syrdarya and Jizzak region of Uzbekistan (total area 4280 km² and 21210 km² respectively) include a great diversity of landscapes and habitats (Fig. 1).

The Syrdarya region is represented by exclusively flat landscapes - the Djetyysai and Sardoba depressions and small lakes. The eastern part of the region is occupied by the Syrdarya river terraces with a total length of about 110 km. Small old lakes and reservoirs, separate massifs of riverine sands and areas of tugai forest are located here.

The plain part of both regions represents a single physiographic region, which is located on the Syr Darya River. Physiographic area called "Hungry Steppe". This vast plain with an area of more than 10,000 km² is located at the foothills of the western part of the Turkestan Range and the Nuratau Range. It was formerly a saline and clayey semi-desert. It extends north and northeast to the Syr Darya River valley. Until the 1970s, the north-western border of the Hungry Steppe was the vast Aydar solonchak and the Kyzylkum desert. At present, it is the coast of the Aidar-Arnasai lake system.

A significant northern part of Jizzak region is represented by the sandy desert Kyzylkum. The southern part of Jizzak region includes a vast belt of foothills and middle mountains of the western part of Turkestan ridge, in the west - Malguzar and Nuratau ridges.

Over the past more than a century, the natural territories of Syrdarya and Jizzak regions have undergone significant anthropogenic transformation, which affected all types of landscapes and led to the redistribution of fauna components. The Hungry Steppe was subjected to the most intensive economic impact.

these areas for maintaining faunal diversity of mammals in the country was assessed (Table 2). The description and calculations for each indicator are given below.

1. Species richness of fauna: The theriofauna of Uzbekistan includes 107 species. Within the Syrdarya province, 41 species of mammals of 6 orders and 15 families were recorded during the whole period of zoological research, which is 38.3% of the total diversity of the mammal fauna of Uzbekistan. On the territory of Jizzak region the species diversity of mammals is somewhat richer in comparison with Syrdarya region and is represented by 68 species (63.5% of the diversity of the mammal fauna of the country) of 6 orders and 19 families [5]. The fauna of this area includes representatives of 4 families that do not occur in the Syrdarya region. These are the Forest Dormouse (family Gliridae, *Dryomys nitedula*), Indian Porcupine (family Hystricidae, *Hystrix indica*), Tianshan Brown Bear (family Ursidae, *Ursus arctos isabellinus*), Bovidae - Goitered Gazelle (*Gazella subgutturosa*), Severtsov's Argali (*Ovis ammon severtzovi*) and Siberian Ibex (*Capra sibirica*). The Goitered Gazelle was formerly inhabited in the Syrdarya region [8, 9], but has now completely disappeared due to total habitat development. Other 5 species are typical inhabitants of foothill and mountain ecosystems, therefore historically absent in the fauna of Syrdarya region.

2. Ecosystem representation: In 2018, we developed a fixed two-level habitat list for Uzbekistan, consisting of 8 ecosystem types and 22 habitats [7]. The Syrdarya region is characterised by 9 and the Jizzak region by 20 habitat types (Table 1).

3. Index of rare species: The Red Book of Uzbekistan includes 32 rare and endangered species of mammals. There are 3 species of mammals listed in the national Red Data Book in Syrdarya region - Corsac Fox (family Canidae, *Vulpes corsac*), - Steppe Polecat (*Mustela eversmanii*) and Marbled Polecat (*Vormela peregusna*) of the Mustelidae family. This is 9.4 per cent of all rare mammal species in Uzbekistan. Currently, these species are rare in the region, their areal have been greatly reduced and fragmented as a result of large-scale exploration of typical habitats [4]. The various categories of rare and endangered mammals of Jizzak oblast include 12 species listed in the national Red Data Book, or 37.5% of all rare mammal species in Uzbekistan. The fauna of rare Insectivores is represented here by a naturally small species - the Long-eared Hedgehog (family Erinaceidae, *Hemiechinus hypomelas*), inhabiting mainly in the foothills of the Turkestan Range and on the northern foothill plain of the Nuratau Range. Among the rare species of bats, the Lesser Horseshoe Bat (family Rhinolophidae, *Rhinolophus hipposideros*) and the Hemprich's Long-eared Bat (family Vespertilionidae, *Otonycteris hemprichi*), known from single findings on the Nuratau Ridge [10, 11, 12, 13, 14] were recorded. The fauna of rare and threatened predatory mammals is the most diverse and is represented by 6 species. The greatest threat is experienced by the inhabitants of plain habitats and foothills - Corsac Fox, Steppe Polecat, Marbled Polecat. At present, due to intensive economic exploration of natural territories, these species are preserved in some undeveloped isolated areas of Jizzak region. The Tien Shan Brown Bear, representatives of the *Felidae* family, the Turkestan lynx (*Lynx lynx isabellinus*) and the Snow Leopard (*Panthera pardus*) inhabit the middle and high mountains of the Turkestan Range and are protected in the territory of the Zaamin State Reserve and the Zaamin National Nature Park.

Another species of this family, the Caracal (*Caracal caracal*), was listed for the first time for the territory of the region based on survey data. This fact requires confirming research. In the territory of the region on the low mountain ridge Koytash, Nuratau and Turkestansky ridges there is a representative of the family of Even-Toed Ungulates, the endemic Severtsov's Argali. Most of its habitat is located in the territory of the Nurata State Reserve. The status of the Goitered Gazelle can be assessed as rare irregular visits to the northern part of Jizzak region (Kyzylkum desert) in winter from the neighbouring territory of Kazakhstan.

Table 1. Representation of main types of ecosystems and habitats in Syrdarya (SYRD) and Jizzak (JIZ)

List of main ecosystem types (I - VIII) and habitats (1-22) of Uzbekistan	For regions	
	SYRD	JIZ
I. Deserts		
1. Sand deserts: Sand massifs of different types (barchan, ridged, hilly, etc.) are the main landscape of the Kyzylkum desert		
2. Gravel deserts: The main landscapes of the Ustyurt Plateau and part of the Kyzylkum Desert		
3. Clay deserts: Plain areas of the Kashkadarya and Syrdarya river basins - Karshi steppe and Hungry steppe		
4. Salty desert: Saline areas of depressions and drainless depressions of Kyzylkum desert, Ustyurt plateau, Amu Darya river deltas, etc.		
5. Low desert mountains: Low dry mountains of the Kyzylkum Desert and the northern end of Gissar-Alai		
6. Cliffs and chinks: Ustyurt Plateau and edges of large solonchak depressions of the Kyzylkum Desert		
II. River valleys		
7. Floodplain habitats: Areas along the Amu Darya, Syr Darya, Zaravshan, Chirchik, Ahangaran, Kashkadarya and their tributaries		
8. Sand massifs: Areas of river-bedded sands along the shores of large rivers (Dalverzinsky massif, Yazyavansky sands, etc.)		
III. Water bodies		
9. Wetlands: Reservoirs, lakes and wetlands of various origins, with riparian vegetation		
IV. Foothills		
10. Piedmont plains and adyrs: Clay foothills of the Western Tien Shan and Pamir-Alai		
V. Lower Belt of mountains		
11. Lowlands: Tree and shrub habitats and savanoids below the mountain forest belt		
VI. Mid-mountains		
12. Mountain deciduous forest and woodlands		
13. Juniper forest		
14. Mid-mountain meadows: Open grassy and meadow slopes of the mid-mountain belt		
15. Rocks and screes: Bedrock outcrops within the mid-mountain belt		
VII. Highlands		
16. Subalpine meadows: Open meadow areas above mountain forest, with tall herbaceous vegetation and juniper shrubbery		
17. Alpine meadows: Low grass meadows and upland xerophytes		
18. Nival belt: Glaciers and cliffs on the watersheds of ridges		
VIII. Anthropogenic areas		
19. Settlements: Settlements of all types and urbanised areas		
20. Arable lands: Areas under arable crops*, including rain-fed arable lands**	*	***
21. Gardens and vineyards		
22. Non-exploited land: Undeveloped land and areas along irrigation canals, boundaries between arable lands		

4. Index of globally threatened species: 22 species of mammals of Uzbekistan are listed as globally threatened by the IUCN. Of these, only one, the Marbled Polecat, occurs in Syrdarya region, which accounts for 4.5% of all globally threatened mammal species in the country. Four globally threatened species occur on the territory of Jizzak region - Marbled Polecat, Snow Leopard, Goitered Gazelle and Severtsov's Argali (18.2 per cent of all

globally threatened mammal species of the country). All these species are also listed in the national Red Data Book, which demonstrates the synergy of national and international conservation policies.

5. Index of hunting fauna: The potential for sustainable use of bioresources of the 2 regions is characterised, in particular, by the number of hunting species inhabiting the study area. «The list of vertebrate animal species subject to state registration, registration of the volume of their use and inclusion in the state cadastre of fauna objects» of the Ministry of Ecology includes 16 hunting mammal species. 9 hunting mammal species in the fauna of Syrdarya region. This is 56.2% of the hunting theriofauna of the country. 13 hunting mammal species are represented in the fauna of Jizzak region (81.2% respectively).

6. Level of fauna protection: The National Report on the State of the Environment of Uzbekistan (Ministry of Ecology, 2023) indicated that the area of the Republic's NPA is 6.321 million ha, or 14.08% of the total area of the country. Part of the natural territories of Jizzak region has a rather high significance for fauna conservation. For example, Aydar-Arnasai lake system in 2008 received the status of Ramsar. There are 4 Important Bird Areas (IBA) and 1 ornithological sanctuary (Important Bird Areas of Uzbekistan, 2008) in the study area. The eastern part of the Nuratau Ridge is a strictly protected natural area (Nuratau State Reserve) and the main habitat of the endemic Severtsov's Argali. The Turkestan Ridge is occupied by the Zaamin State Reserve and the Zaamin National Nature Park. In 2017, this territory received the status of 'Key Biodiversity Area' (KBA) according to IUCN criteria. The KBA status has an area partially located within Jizzak region - the Northern Foothill Plain of the Nuratau Range (The Mountains of Central Asia Biodiversity Hotspot Ecosystem Profile, 2017). The total area of Category I-IV protected areas located in the region is 68,702 ha, which is 3.2% of the region's area.

In Syrdarya region, in contrast to Jizzak region, there are no protected areas of I-IV categories. Together with intensive agricultural development, this has an extremely negative impact on the fauna and limits opportunities for restoration of ecosystems and habitats.

7. Level of fauna endemism: The mammals fauna of Uzbekistan includes 16 species endemic to Central Asia - 14.9% of the country's theriofauna. Only two Central Asian endemics - the Bukhara Horseshoe Bat (*Rhinolophus bocharicus*) and the Severtsov's Jerboa (family Allactagidae, *Allactaga severtzovi*) - inhabit the territory of Syrdarya region - 4.9% of the theriofauna of the region. In Jizzak region there are 6 endemic mammal species of Central Asian origin (in some cases subspecies) - 8.8% of the total number of mammal species of the region. Of these, the Severtsov's Argali is included in the Red Book of Uzbekistan. The condition of other 4 endemics - Bukhara horseshoe Bat, Severtsov's Jerboa, Afghan and Bucharian Voles (family Cricetidae, *Microtus afghanus* and *Microtus bucharensis*) does not cause concerns. The population status of another endemic inhabiting the territory of the Turkestan Range, the Red Pika (family Leporidae, *Ochotona rutila*), is currently being clarified.

8. Level of fauna naturalness: The mammals fauna of Uzbekistan contains 5 invasive or alien species - 4.7% of the total theriofauna of the country. Accordingly, the degree of its naturalness or preservation can be estimated at 95.3%. In Syrdarya and Jizzak regions there are 3 alien species of rodents: Muskrat (family Cricetidae, *Ondatra zibethicus*), Coypu (family Myocastoridae, *Myocastor coypus*) and Norway Rat (family Muridae, *Rattus norvegicus*). Thus, the conservation index of the theriofauna of Syrdarya region is 92.7% and 95.6 % in Jizzak region. Introduction of Muskrat and Coypu occurred as a result of purposeful importation of these species to Uzbekistan for breeding. The Norway Rat penetrated into the territory of Uzbekistan, in particular into Syrdarya and Jizzak regions independently, in the process of economic development of the territories [15]. It is one of the most harmful invasive synanthropic species actively expanding its range. In the mid-

1940s of the last century, the Norway Rat was introduced to Tashkent [16, 17, 18], from where it was further dispersed within Uzbekistan. With the economic development of the Hungry Steppe, with the expansion of irrigation and railway networks, the appearance of settlements, and the development of cattle breeding, favourable conditions arose for the spread of the Norway Rat to the west, including the territory of the Syr Darya and Jizzak regions. Thus, in 60-70s the species inhabited railway stations and settlements of the Hungry Steppe. Subsequently, the species reached the central part of Jizzak region [19]. The Norway Rat was recorded in the lower part of Koytash settlement, where it probably penetrated through the transport network to the former wolfram mine. The habitats of the Norway Rat in the study areas are confined to the anthropogenic landscape; it does not form stable wild populations.

Table 2. Assessment of significance of Jizzak and Syrdarya regions for conservation of mammals fauna

Indicator	Baseline indicator (Uzbekistan)			Syrdarya region			Jizzak region			
	Abs. value	%	Scores	Abs. value	%	Scores	Abs. value	%	Scores	
1. Species richness of fauna	107	100	10	41	38,3	4	68	63,5	6	
2. Ecosystem representation	22	100	10	9		4	20		9	
3. Index of rare species	32	100	10	3	9,4	1	12	37,5	4	
4. Index of globally threatened species	22	100	10	1	4,5	<1	4	18,2	2	
5. Index of hunting fauna	16	100	10	9	56,2	>5	13	81,2	8	
6. Level of fauna protection	6321 тыс.га	14,08	10	-	-	-	68,702 тыс.га	3,2	>2	
7. Level of fauna endemism	16	14,9	10	2	4,9	>3	6	8,8	>6	
8. Level of fauna naturalness	5	95,3	10	3	92,7	~10	3	95,6	~10	
Average value in scores			10				3,8			

4 Conclusion

Complex analysis of indicators (Table 2) shows that the total indicator of significance of Jizzak region for conservation of theriofauna of Uzbekistan is quite high - 6.2 scores out of 10. For Syrdarya region this indicator is much lower - 3.8 out of 10. This is due to the following reasons: low degree of ecosystem representation of this region (4 out of 10 scores); extremely high degree of its economic use; complete absence of protected areas (0 out of 10 scores). These reasons determine low indexes of rare and globally threatened species region.

The index of species richness of the theriofauna of Jizzak region is also quite high - 6 scores out of 10, which is due to its high (9 scores out of 10) ecosystem representation. Indexes of hunting utilisation of Syrdarya and Jizzak regions are also in direct correlation with species richness - 5 and 8 scores, respectively.

The level of naturalness of the theriofauna in both regions is quite high - almost 10 scores. This is due to the fact that the percentage of alien mammal species in the fauna of Uzbekistan is quite low.

There are no protected natural areas in Syrdarya region. Our studies show that natural habitats - wetlands in the south-eastern end of the Chardara reservoir, riparian habitats along the Syrdarya River, unimproved areas, coastal thickets - have been preserved here. Under conditions of intensive economic development these areas fulfil the role of refugia for preservation of faunal diversity, including rare and threatened species of mammals. The solution to the problem of preserving faunistic diversity of the Syrdarya region is to organise protection of floodplain ecosystems of the Syrdarya River.

Thus, our proposed set of indicators allows us to compare faunistic diversity, the degree of its conservation, economic importance, and endemism of fauna of different territories. Through this it is possible to assess the importance of different regions of the country for fauna conservation, to develop measures for its protection and sustainable use. Analyses of the current state of the fauna and trends in its changes using a set of indicators should be carried out regularly and in parallel with fauna monitoring.

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