

## RESULTS OF STUDYING THE TYPOLOGIES OF HUNTING GROUNDS BY USING GIS -TECHNOLOGIES

Serikbayeva A.T.<sup>1</sup>, Akimzhanov D.Sh.<sup>2</sup>, Kaspakbayev Y.M.<sup>1</sup>, Karagoishin Zh.<sup>2</sup>,  
Shynbekov M.K.<sup>1</sup>, Iskakova Zh.A.<sup>1</sup>, Baitanayev O.A.<sup>1</sup>

<sup>1</sup>Kazakh National Agrarian Research University,  
Department of "Forest resources and hunting", Almaty, Kazakhstan  
E-mail: andiya.serikbayeva@kaznaru.edu.kz, murat.sinibekov@kaznau.kz,  
kazspakbayev@kaznau.kz, iskakova\_zhan80@mail.ru, baitanayev.ozat@kaznaru.edu.kz

<sup>2</sup> Kazakh Agrotechnical University by S.Seifullin,  
Department of "Hunting and Fisheries" Astana, Kazakhstan  
E-mail: darhan-14@mail.ru, k.zhashaiyr@mail.ru

**Abstract.** The article deals with issues of hunting grounds' typification by using GIS technologies. In the research work performed the comprehensive study of mammals' biological diversity with typology of their habitats. The study of the spatial distribution of rare animal species, including predatory mammals, by using the typology of their habitats, was based on GIS technologies in specially protected natural territories of Kazakhstan, including the Andasai State Natural (Zoological) nature reserve, and in the Ile-Alatau State Natural Park. According to the results of project and survey works, we have based the division of territories into different types of animal habitats (land) on ecological conditions, relief and soil-plant features. For the first time, materials of the hunting grounds' typology with allocation of their types, with quantitative indicators of each of them, were obtained for use in hunting planning. As a result, a division map of the Andasai Nature Reserve and the Aksai branch of the Ile-Alatau National Natural Park was made in GIS format for the land types that were not previously separated. Based on the decryption results, planning and cartographic materials with types of hunting grounds have been developed with the actual area of the natural nature reserve. These materials can be used to streamline biotechnical and hunting activities carried out in the Andasai Nature Reserve and in the Ile-Alatau State National Nature Park, including further security optimization.

**Keywords:** typology, GIS technology, biodiversity, hunting grounds, Andasai Nature Reserve, biotopes, Ile-Alatau State National Natural Park

**Introduction.** The geographic information system (GIS) is a computerized system that facilitates the input, analysis and presentation of georeferenced data [1,2]. Until recently, the methods of geobotanical, landscape or forest management data interpretation were used in hunting management design [3,4,5,6,7]. The study of the possibility of using aerospace information to assess the animals' habitats began in the 80s of the last century [8,9,10].

An electronic (digital) image of the earth's surface makes it possible to directly decipher biotopes and determine the functional purpose of individual areas [10,11,12,13,14]. The technology of using remote methods in different natural conditions is given in Figure 1 [7]. As can be seen from Figure

1, the components of the geographic information system are topographic maps, land management maps, forest management maps, satellite images, thanks to which the work is carried out to account for the number of animals, on-farm hunting management. As a result of data input, editing and combination, the following types of typology stratification are distinguished: natural zones and subzones, rivers, reservoirs, anthropogenic landscape, road network, forest plantations, landscape sections.

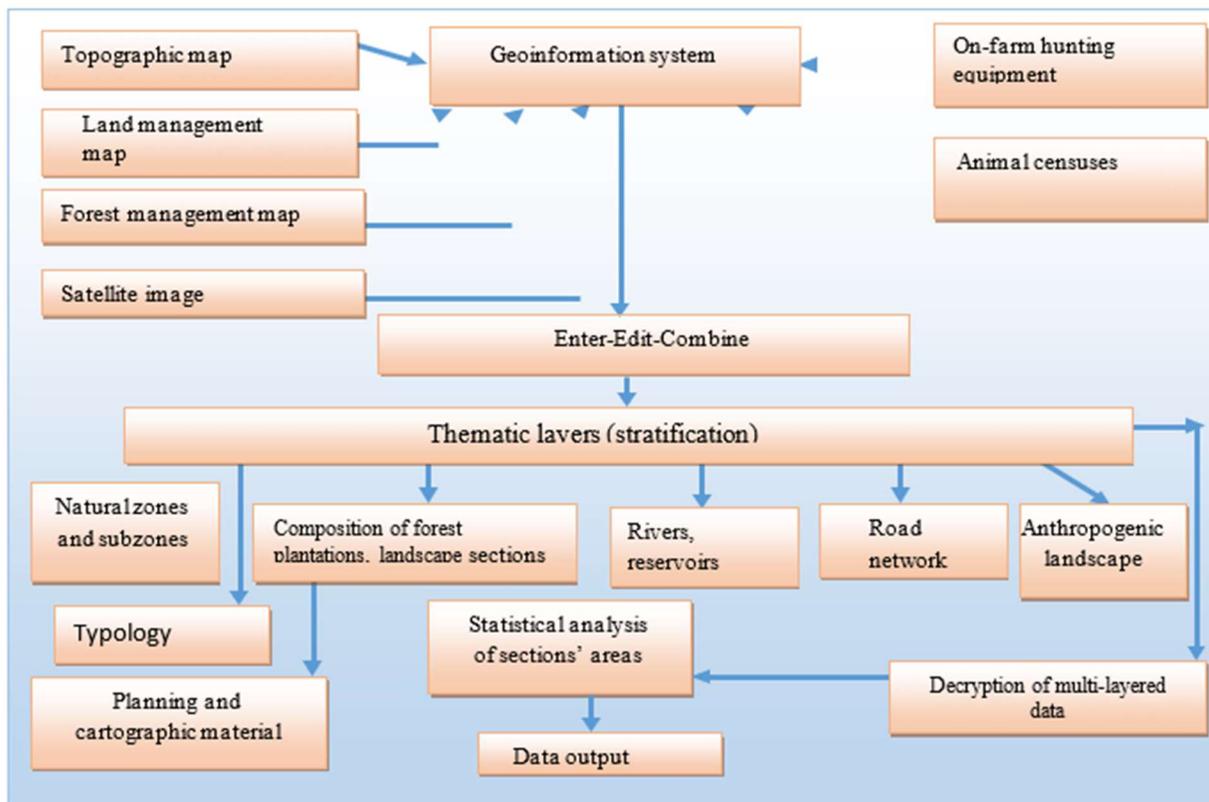


Figure 1- Block diagram of technology for typing hunting grounds in GIS format

At the present stage, GIS technologies allow for a detailed analysis of the forest fund, hunting grounds. A number of researchers for the purposes of hunting management carried out the explication and appraisal of forest hunting grounds, based on the information from collected database [15,16,17,18]. In a study by Osmolska A. (2013), GIS software was used to create thematic digital maps presenting data such as: spatial location of state lines, forestry and hunting departments, estimated roe deer abundance, habitat quality in the area, prey value of fowl, damage caused by fowl to forests, the number and structure of prey on the example of roe deer [19]. Dale M. (1995) considered the technology of cartographic support for the assessment and analysis of the ecological state of specially protected natural areas by means of geoinformation technologies that provide the interpretation of analysis results in graphical form on electronic maps [20]. The experience of using geoinformation systems in forestry is described by D. Kopetta [21], where a digital forest map standard was developed by using this system. Also, with the help of

geoinformation systems, a scheme for irrigation and development of the Hungry Steppe was developed to study the effect of forest plantations on the groundwater regime and groundwater mineralization [22].

To create types of hunting grounds, the possibilities of thematic maps developed in the GIS FORMAP 2.1 are used as described in the work of Kozorez A.I. [23]. Thus, the study of hunting grounds' typology by using a GIS database provides significant opportunities for classifying the typology of forest hunting grounds. For the purpose of modern hunting equipment, it is possible to carry out the explication and appraisal of hunting grounds using various methods and classifications on the basis of database information [24,25]. Further, without significant labor costs, it is possible to distinguish types of hunting grounds by composition, habitat of vegetation, type of forest plantations, types of game animals, numbers, density and other indicators, and these parameters can be assigned to each type of fowl animals separately. It should be noted that geoinformation mapping is regulated in the systems of interstate standards GOST R 52055-2003, GOST R 50828-95, GOST R 51353-99 [26,27,28] which operate in Kazakhstan.

#### **Materials and methods of research.**

We tested the experience of studying the hunting grounds' typology on the example of the Andasai state natural (zoological) reserve and the Ile-Alatau national park. The research used forest management materials, as well as distribution of various types of game animals. The data obtained can be used for a qualitative assessment (bonitation) of hunting grounds in the south and southeast of Kazakhstan.

A typology of hunting grounds based on GIS technologies was carried out on the territory of the protected areas of Kazakhstan, the Andasai state natural (zoological) reserve. This specially protected natural area was created by the Decree of the Council of Ministers of the Kazakh SSR dated March 29, 1966 N 220. According to the "List of specially protected natural areas" approved by the Decree of the Government of the Republic of Kazakhstan dated September 26, 2017, the reserve No. 593 has the status of republican significance with a permanent validity period [32]. It is located on the territory of Zhambyl region's Moiynkum district and it's area is 1.0 million hectares.

The reserve began to be studied quite recently. For example, in 2013, scientific papers were published on rare animal species, zoogeographic analysis of the mammalian fauna, and also in 2015 on the problems of preserving rare animal species and optimizing conservation measures in this specially protected natural area [33,34,35]. Meanwhile, the composition of habitats' types or hunting grounds of the animal world of this sanctuaru is still unknown. It is only known that it's located in Betpakdala desert, which is the main part and is a rubble-clay plateau. There are also haloxylon forests, shrub massifs, rocky lowlands, sandy areas, and wetland biotopes [36]. However, the typology of hunting grounds and the actual area occupied by them were still unknown. In this regard, the presented work is an attempt to fill this gap.

The history of the Ile-Alatau state national natural park begins in 1931. Initially, the Ile-Alatau state sanctuary was created and occupied an area of 15 thousand hectares in the valley of Malaya

Almatinka River. In 1935, after increasing the area to 40 thousand hectares, and later to 856.7 thousand hectares, it began to cover the entire range of Zailiysky Alatau.

Ile-Alatau park occupies a significant area within the Almaty region and consists of four branches: Aksai, Medeu, Talgar and Turgen. Four branches of the national park are a single whole in natural, historical, cultural and administrative terms.

In accordance with forest growth and forestry zoning, the park is included in the province of fir-spruce forests with a fruit-deciduous subbelt of Zhongarsky forest-growing and forestry region within northern spruce forests of regional Zailiysky forestry production enterprise [29, 30].

The main feature of Zhetysu Alatau relief is a stepped structure: from the central massif, about 4500 m above sea level several spurs, which are mountain ranges, are extended fan-shaped to the west. The mountain-forest-meadow-steppe zone is divided into a number of vertical soil-vegetation subzones. This is a mountain-meadow subzone of high mountains (3200–2500 m), above which it passes into the nival zone, and below it into the forest-meadow zone. The mountain-forest-meadow subzone is located within 2500–1000 m of absolute height. Coniferous forests of Schrenk spruce and Siberian fir are widely represented here, as well as deciduous plantations of aspen, birch, apple, mountain ash, etc. The mountain-steppe subzone occupies an inclined low-mountain plain at an altitude of 750–1000 m [31]. There are a variety of habitats for wild animals, and hunting fauna includes such species of ungulates as maral, Siberian roe deer, Siberian ibex and wild boar, as well as other representatives of carnivores, rodents, hares and upland game. However, until now, hunting grounds and their typology remain insufficiently studied.

Studying the typology of the hunting grounds of the Andasai State Natural (Zoological) nature reserve and the Ile-Alatau National Park was done by using GIS technology with the software product MarInfo Professional 7.5. Layers were created from a topographic map and satellite images of Google Earth in 2011, as well as partially from a forest management map. Based on the results of the interpretation, planning and cartographic materials were developed with the types of hunting grounds of animals characteristic of various species, the actual area of the allotments of the natural reserve under consideration.

### **Research results and discussion.**

A typology of hunting grounds based on GIS technologies was carried out on the territory of the protected areas of Kazakhstan's Andasai state natural (zoological) reserve.

The study of the hunting grounds' typology at Andasai Nature Reserve was done by us in 2021 using GIS technologies. The software product MarInfo Professional 7.5 was used as a result of hunting tax surveys and camera processing of the received materials. Layers were created from the topographic map and space images of Google Earth 2011 as well as partly maps of forest inventory. Based on decrypting results, planning and cartographic materials were developed with the types of hunting grounds of different animal species, within the actual area of the natural habitat's sections (Table 1).

According to the results of project and survey works, we divided the nature reserve area into various types of animal lands based on environmental conditions, relief and soil and plant features

that create optimal parameters for their habitat. A total of 10 types of habitats were identified, of which 3 are forest and 7 are non-forest.

**Table 1 – The hunting grounds’ typhology of the Andasai nature reserve**

Land type	Surface, ha	Land type	Surface, ha
Rubble-clay	694627	Rocky lowlands	91154
Plateau	39029	Salt marshes	23414
Shrubs	40043	Salt flats	2990
Haloxylon growths	4120	Wetlands	68212
Forests	32547	Other lands	6555

Analysis of table 2 shows that the forested area is 8.32%.

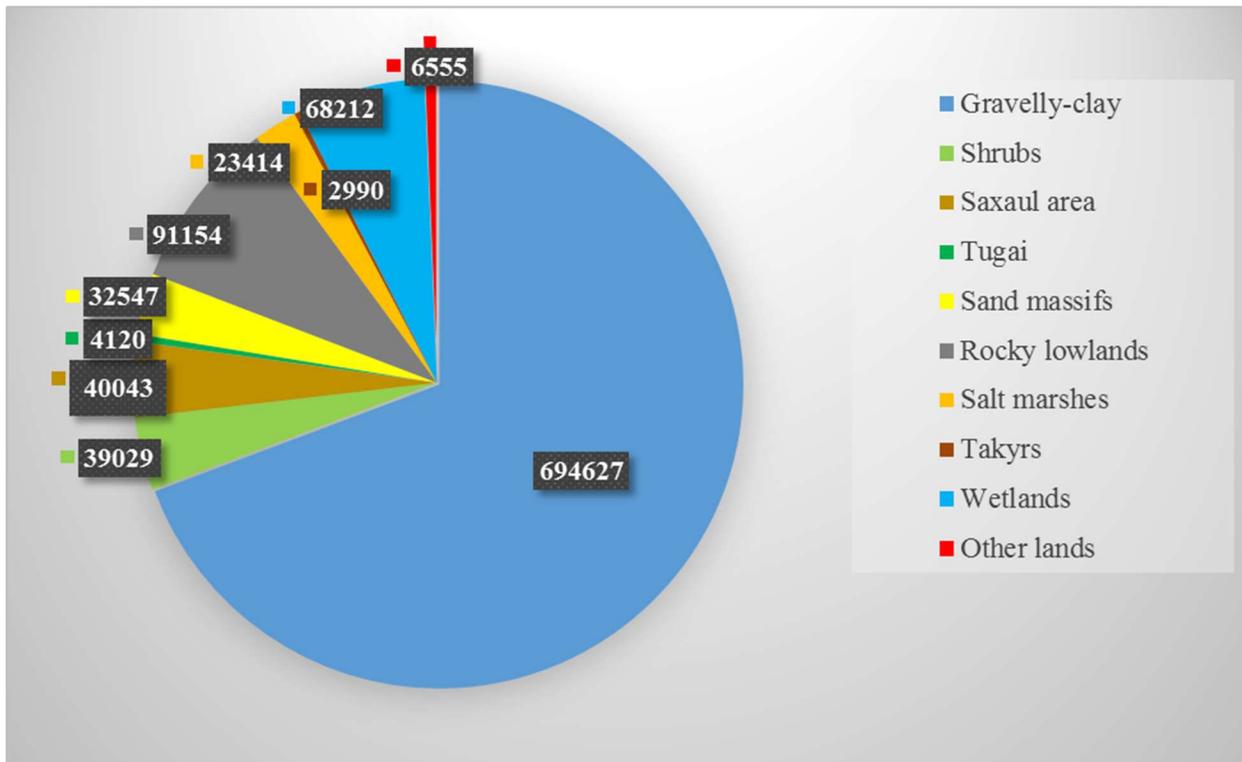


Figure 2 - The quantitative part of hunting grounds’ types at the Andasai nature reserve

The tree species are dominated by haloxylons, composed mainly of black haloxylon with a slight presence of Persian (white) haloxylon, as well as shrub thickets, consisting of caragana, shrubby willow and others. Other sections classified as open habitats are covered with saltwort, desert-wormwood and feather-grass-fescue vegetation. And in wetlands - reed and cattail with other wetland plants. The composition of other lands includes a cultural landscape: roads, arable land,

estates and settlements. Figure 3 shows a map showing the typology of biotopes (land types) of mammals in the Andasai Nature Reserve.

The nature reserve has 39 species and subspecies of vertebrates listed in the Red Book of the Republic of Kazakhstan and the Red List of the IUCN [39]. Among them, the most vulnerable species should be recognized as hoofed mammals - kulan, goitered gazelle and Tien Shan mountain sheep (argali), which are subjected to illegal hunting (poaching). Therefore, their number, despite the efforts made to protect them, does not noticeably increase. Thus, according to aerial surveys in the spring of 2009, in the southern part of Betpakdala near the mountains of Baigara, Kurmanshit and in Sekseuldala, where only 514 goitered gazelles were counted on a total area of about 990.0 thousand ha [40].

The kulan population is in great concern. Since 1986 and until 2011, 210 heads of these ungulates were brought into the reserve. Of these, 90 kulans only in the last 5 years. If we take into account the experience of reintroduction and reproduction of these ungulates in the Altyn-Emel National Park, it can be stated that over 30 years their number has increased from 32 (1982) to 2500 heads (2012), i.e. 78 times! In the Andasai Reserve, at least 7-8 thousand kulans should now live in this way. However, at present there are approximately 90 heads here. Poaching and weak protection can be considered as the main reason for limiting the number of this population [41].

Thus, with the use of GIS technologies, it was possible to obtain quantitative indicators of the areas occupied by various types of hunting grounds or habitats of desert zone representatives. These materials can be used to streamline the biotechnical and hunting activities carried out in the Andasai Nature Reserve, including further optimization of protection. For protected areas, the most important problem is conservation of rare animal species, primarily ungulates.

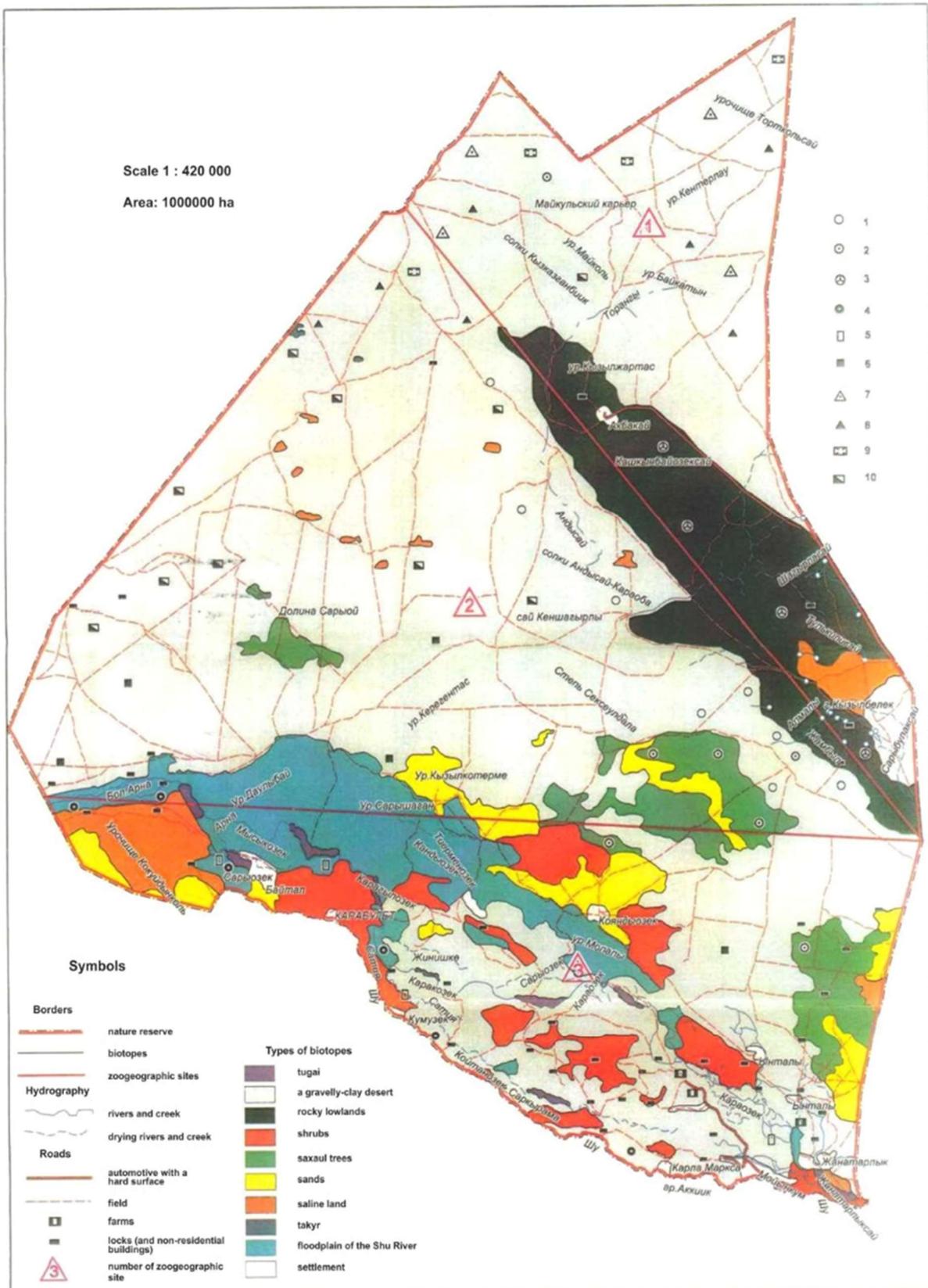


Figure 3 - Typology of mammals' biotopes (land types)

With the use of GIS technologies, the spatial distribution of rare animal species was studied by using their habitats' typology. Based on the results of project and survey work, we have based the division of the territory of the Ile-Alatau National Park into various types of animal habitats (lands) based on environmental conditions, relief and soil and plant features. A total of 12 types were identified, of which 5 are forest types: coniferous forest, deciduous forest, wild fruit forest, shrubs, juniper forests and 7 non-forest types: rock forests, mountain meadows (hayfields), mountain steppes, glaciers, wetlands, arable land, other lands (roads, estates, etc.). The shares of forest and non-forest types of animal habitats can be clearly seen in Figures 4 and 5 for four branches of the Ile-Alatau National Natural Park.

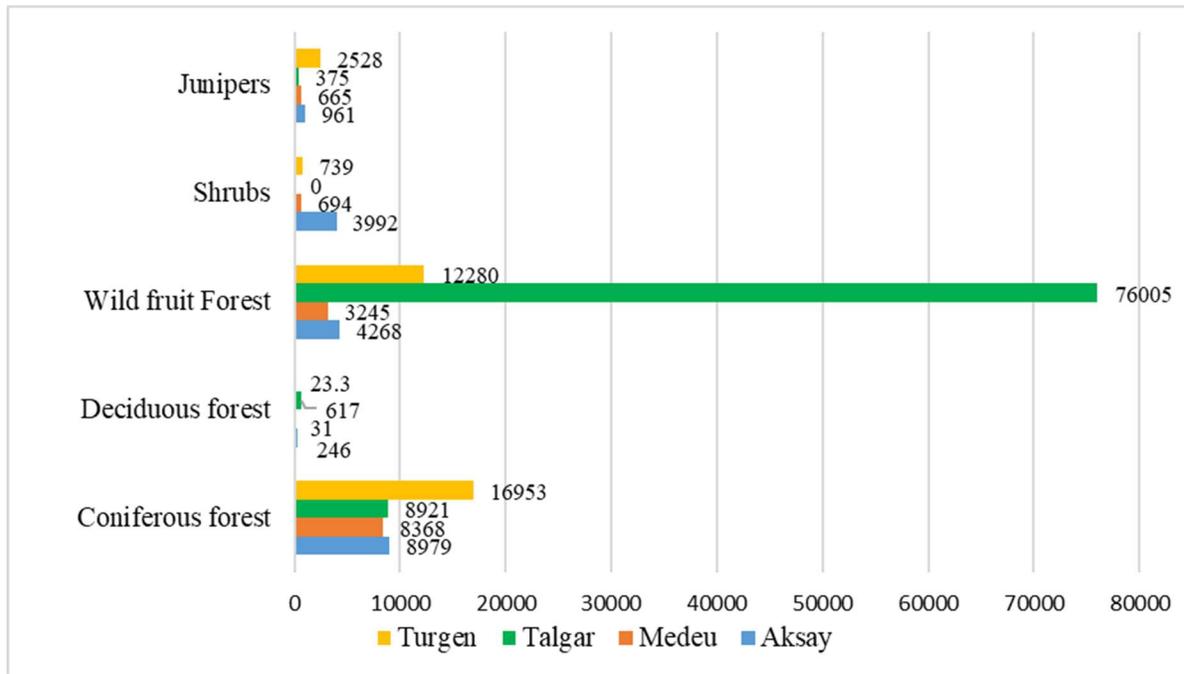


Figure 4 - Forest types of animal habitats in the Ile-Alatau Natural Park

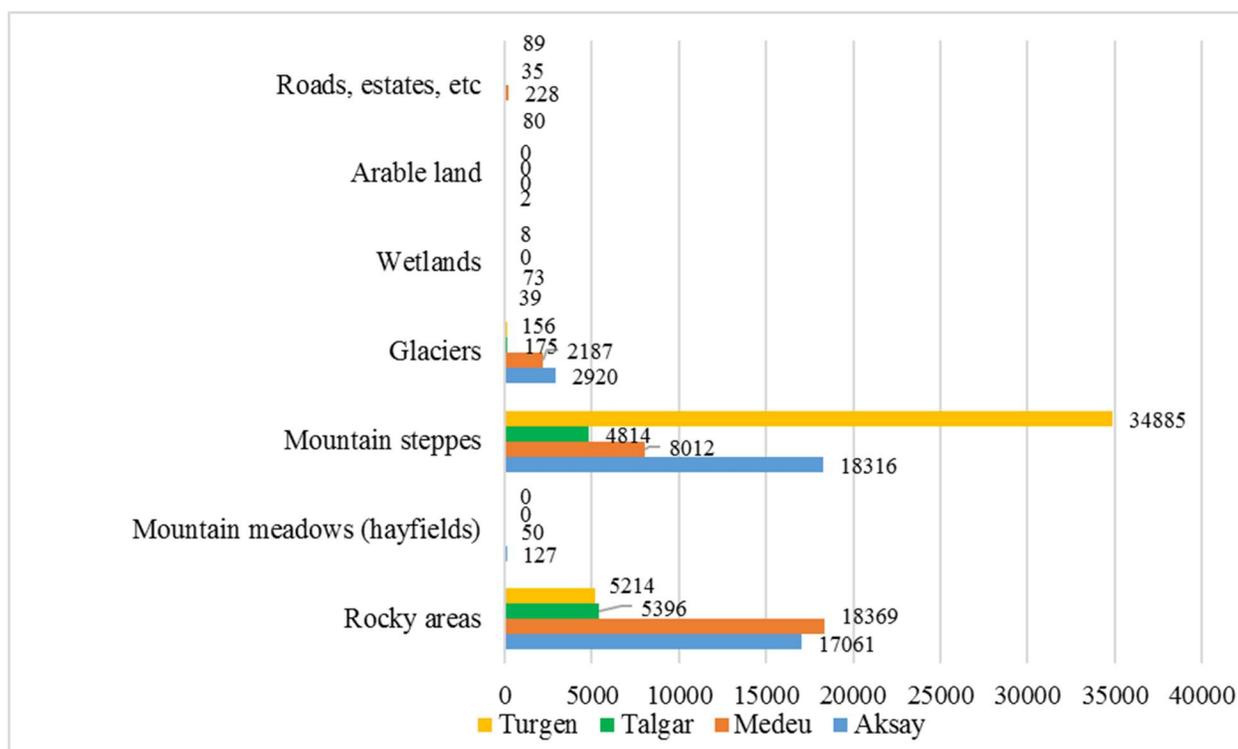


Figure 5 - Non-forest types of animal habitats in the Ile-Alatau Natural Park

According to Figure 4, the coniferous forest dominates in the Turgen branch (16953 ha), in the other branches it is almost at the same level and occupies a predominant place among other forest types of land. As for the wild fruit forest, the undoubted leader is the Talgar branch (76,005 ha), which is almost 6 times higher than similar types of land in other branches. According to Figure 5, of the non-forest land types, mountain steppes predominate in all branches, where the Turgen branch (34,885 ha) has the largest area compared to other branches. The second non-forest type, which prevails in comparison with other types, is rocky, where the leaders are the Medeu and Aksai branches, 18369 ha and 17061 ha, respectively.

The vertebrate world of the Ile-Alatau National Park includes about 270 species and subspecies of animals: 48 species of mammals, more than 200 birds, 8 reptiles, 4 amphibians and 8 fish species. Animals of the national park live in a wide variety of conditions: from foothills, forests to the alpine belt, rocks and glaciers, as well as in water bodies and on the territory of settlements [42]. Of the mammals reliably living in the park, 6 species are rare and endangered: Tien Shan brown bear, snow leopard, Turkestan lynx, Tien Shan mountain sheep, stone marten, Indian porcupine [43].

The results of studying distribution of the national park territory by types of animal habitats are shown in Table 2.

**Table 2 - Typology of animal habitats in the Ile-Alatau National Park**

Type	Area, ha/%	Among them by branches				Predator type
		Aksai	Medeu	Talgar	Turgen	
coniferous forest	43221/21,6	8979/15,8	8368/20,0	8921/31,9	16953/23,3	bear, marten, lynx
deciduous forest	894/0,4	246/0,4	31/0,07	617/2,2	23,3	bear, lynx
wild fruit forest	27398/13,7	4268/7,5	3245/7,7	76005/27,2	12280/16,9	bear,
shrubs	5425/2,7	3992/7,0	694/1,7	-	739/1,0	bear,
juniper growths	4529/2,3	961/1,7	665/1,6	375/1,3	2528/3,5	bear, lynx
mountains	46040/23,1	17061/29,9	18369/43,8	5396/19,3	5214/7,2	snow leopard, marten
mountain meadows (hayfields)	177/ 0,1	127/0,2	50/0,1	-	-	-
mountain steppes	66027/33,1	18316/32,2	8012/19,1	4814/17,2	34885/47,5	-
glaciers	5439/2,7	2920/5,1	2187/5,2	175/0,6	156/0,6	-
wetlands	120/0,06	39/0,07	73/0,2	-	8/0,001	otter
arable lands	2/0,001	2/0,003	-	-	-	-
Other lands (roads, estates, etc.)	432/0,2	80/0,4	228/0,5	35/0,1	89/0,3	-
Total:	199703/100,0	56991/100,0	41922/100,0	27938/100,0	72852/100,0	-

The Tien Shan brown bear lives in five types of land with a total area of 81,467 hectares, which is 40.8% of the park area. The Turkestan lynx inhabits three types of habitats with a total area of 48,644 ha (24.5%). The stone marten is found in two types of land, with a total area of 89261 ha (44.7%). The snow leopard lives only in the highlands in rocky habitats on an area of 46,040 ha, which is 23.1% of the national park area. And the Central Asian river otter is found from the entire network of wetlands only in the middle reaches of Shelek river in the Almaty nature reserve.

With the help of GIS technologies obtained for the first time quantitative indicators of the area occupied by various types of animal habitats in the territory of the Ile-Alatau National Park. Among tree species, Schrenk spruce forests predominate, as well as wild fruit plantations inhabited by bear, lynx and marten. In the context of branches, the largest arrays of spruce forests and wild fruit forests are noted in Turgen. Rocky massifs inhabited by the snow leopard prevail in the Medeu and Talgar branches.

The distribution of the territory of the national park by types of hunting grounds (biotopes) is presented in Table 3. Of the studied ungulates, deer, Siberian roe deer and wild boar inhabit forest lands, and Siberian ibex and argali inhabit only rocky biotopes.

**Table 3 - Distribution of the Ile-Alatau National Park are by types of hunting grounds**

Land type characteristics	Area, ha	Among them by branches			
		Aksai	Medeu	Talgar	Turgen
<p><u>Coniferous forest (1600-2600m a.s.l.)</u> Spruce plantations of Schrenk variety of rare and medium density on the slopes of northern exposures. The soils are mountain-forest dark-colored. Cover - moss, lichen, forbs, cereals; medium density. Undergrowth - wild rose, honeysuckle, barberry, mountain ash, raspberry.</p>	43221	8979	8368	8991	16953
<p><u>Deciduous forest (1200-1600m a.s.l.)</u> Aspen forests on the southern and northern slopes. Soils - mountain forest gray soils, forest. Cover - geranium, bluegrass, phlomis, cornflower; medium density. Undergrowth - honeysuckle, shrub willow, wild rose, currant; medium density.</p>	894	246	31	617	-
<p><u>Wild fruit plantations (750-1200 m a. s.l.)</u> Rare stands of apple, apricot, hawthorn, Tien Shan mountain ash, etc. Soils - mountain-forest chernozems. Cover - phleum, nettle, alopecurus.</p>	27398	4268	3245	7605	12280
<u>Shrubs (1400-2600m a. s.l.)</u>					

Thickets of wild rose, meadowsweet, shrub willow, as well as honeysuckle, currants on the southern slopes. The soil is mountain-steppe. The cover is meadow, forb.	5425	3992	694	-	739
<u>Jumipers (2600-4200m. a.s.l.)</u> Thickets of creeping juniper on rocky slopes in the alpine zone.	4529	961	665	375	2528
<u>Mountains (2800-4200m. a.s.l.)</u> Stony outcrops on steep slopes with sparse petrophytic vegetation.	46040	17061	18369	5396	5214
<u>Hayfields (up to 750m)</u> Cereal herbs in low mountains, along river valleys, upland. Soils - meadow chernozems	177	127	50	-	-
<u>Arable land (up to 750 m)</u> Agricultural crops	2	2	-	-	-
Pastures (600-1200m) Livestock grazing on the southern slopes and steppe areas with shrubs (rose hips, honeysuckle, spiraea).	66027	18316	8012	4814	34885
Wetlands Mountain rivers, lakes, swamps.	120	39	73	-	8
Glaciers (above 3400m) Alpine peaks with eternal snow and ice	5439	2920	2187	175	156
Other lands Roads, estates, settlements, cordons, settlements	432	80	228	35	89
Total:	199703	56991	41922	27938	72852

The conducted typology of ungulate lands is presented on the example of the Aksai branch of the Ile-Alatau National Park (Figure 3).

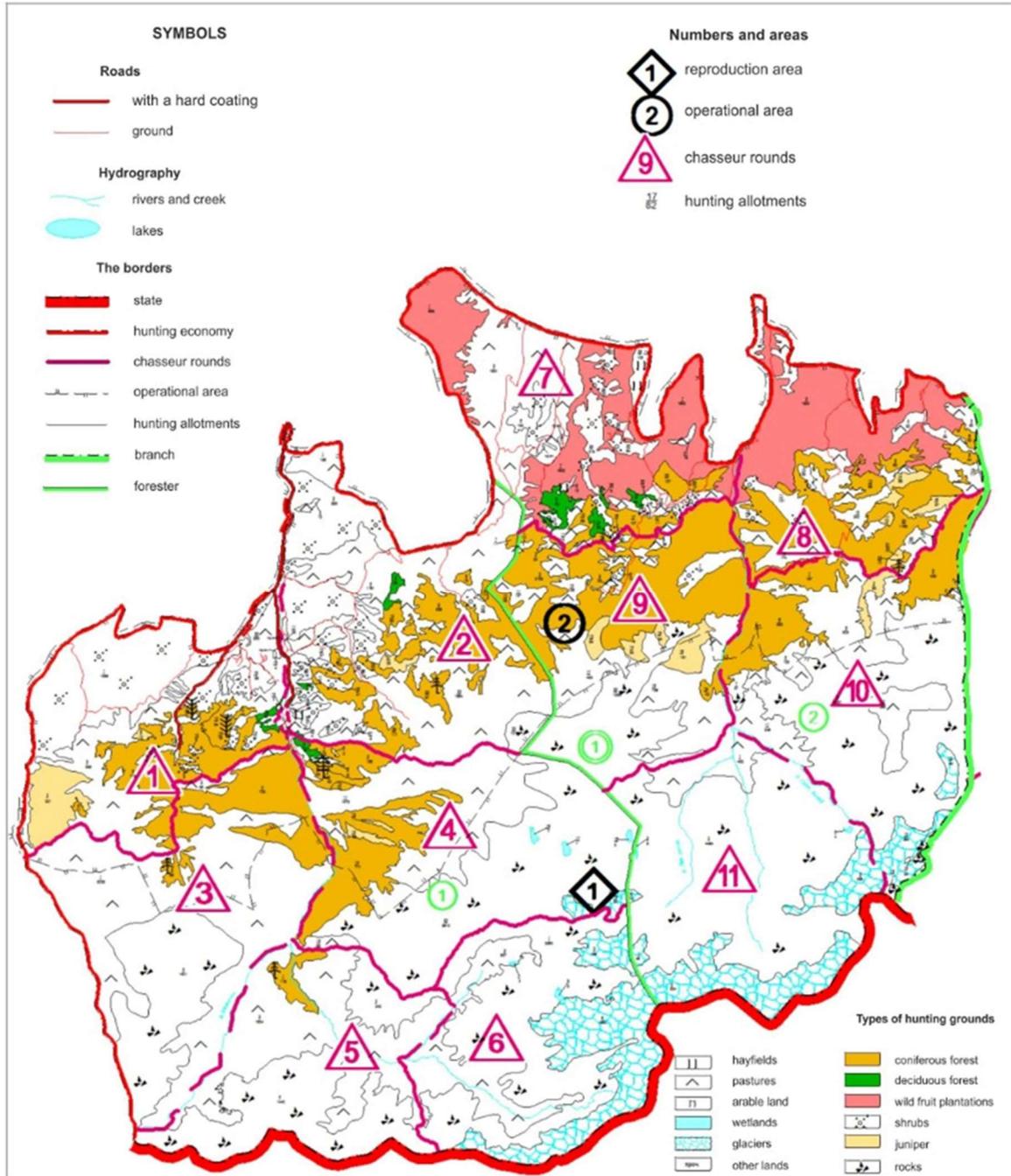


Figure 3 - Typology of the hunting grounds at the Aksai branch of the Ile-Alatau National Park

According to Figure 3, the Aksai branch of the Ile-Alatau park is dominated by coniferous forests along the perimeter in the central part. In the eastern part, coniferous forests are completely replaced by wild fruit plantations. The areas occupied by deciduous forests are negligible, juniper forests are also scattered throughout the park and are mainly concentrated in the western part.

## Conclusions.

With the help of GIS technologies, it was possible to obtain quantitative indicators of the areas occupied by various types of hunting grounds or habitats of wild animals in the desert zone. These materials can be used to streamline the biotechnical and hunting activities carried out in the Andasai Nature Reserve, including further optimization of protection.

Thus, materials for the typology of hunting grounds were obtained for use in hunting management, with allocation of their types, quantitative indicators of each of them. As a result, it should be stated that the experience of typing the hunting grounds of one of the key areas has been obtained for the first time in a GIS format. A map of the Andasai reserve and the Aksai branch of the Ile-Alatau state national park was made by dividing the territories into types of grounds, which were not previously divided. The typology of habitats of rare predatory mammals on the territory of the Ile-Alatau National Park was also studied. For the first time, a comprehensive study of the biological diversity of ungulates with a typology of their habitats was carried out by using GIS technologies.

GIS software was used to create thematic digital maps presenting data such as: spatial location of park boundaries, forestry and hunting departments, estimated ungulate abundance, habitat quality, fowl value, game damage to forests, prey abundance and patterns ungulates. GIS technology has proven to be a very useful tool to assist hunters in making natural resource management decisions, allowing for small-scale and large-scale spatial and temporal analysis and thus contribute to a more efficient and sustainable management of bioresources.

## LITERATURE

1. De By R.A. (2001) A gentle introduction to GIS. In: De By R.A. Principles of Geographic Information Systems. ITC, Enschede, 41p.
2. Campbell, Jonathan E. and Shin, Michael, "Essentials of Geographic Information Systems" (2011). Textbooks. 2. <https://digitalcommons.liberty.edu/textbooks/2>
3. A series of studyguides "Conservation of biodiversity". Scientific supervisor of the series N.S. Kasimov. Conservation and restoration of biodiversity. Section II. O.V. Smirnova, L.G. Khanina, M.V. Bobrovsky, N.A. Toropova, L.B. Zaugolnova. Field Practice Guide. Methods of collection and primary analysis of geobotanical and demographic data Coll. authors. M.: Publishing House of the Scientific and Educational Center, 2002. 286 p.
4. Jongman R.H.G., Ter Braak C.J.F., Van Tongeren O.F.R.. Data analysis in community and landscape ecology. Wageningen, 1987. 299p. 20.
5. McCune B., Mefford M.J. PC-ORD. Multivariate analysis of ecological data. Version 3.20. MjM Software Design. Gleneden Beach, Oregon, USA, 1997. 126 p
6. Русинова Н.В. Мазуркин П.М. Фадеев А.Н. Методика построения электронной тематической лесной карты / Современные наукоемкие технологии. – 2012. – № 1 – С. 35-41
7. Ermakov V.E. Forest management. Program, guidelines and control tasks for students of correspondence courses of specialty 1-75 01 01 "Forestry"

8. Elsky G.M., Shishkin A.S. Automation of the remote assessment of hunting grounds and compilation of an interactive data processing model // Earth Research from Space, 1985 No. 4. pp. 58-64.
9. Fundamentals of hunting equipment. Ed. by D.N. Danilova / Publishing House "Forest industry". Moscow. 1986, P. 258-297.
10. Worboys, M., H. Hearnshaw, and D. Maguire, Object-Oriented Data Modeling for Spatial Databases. International Journal of Geographical Information Systems 4, 4 (1990), pp. 369-383.
10. England, E. and Sparks, A. : Geostatistical Environmental Assessment Software. Las Vegas, Nevada: Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, 1992.
11. Shishkin A.S. Landscape-ecological organization of forest fowl animals' habitats in Siberia// Abstract of Doctor. diss. - Krasnoyarsk, 2006., 42p.
12. Gromtsev A. N. Fundamentals of landscape ecology of European taiga forests in Russia. Petrozavodsk. Karelian Scientific Center of the Russian Academy of Sciences. 2008., 238 p.
13. Sheviakina, Natalia & Trofymchuk, Olexandr & Zagorodnya, Snizhana & Radchuk, Igor & Tomchenko, O.V.. (2020). Remote Sensing Monitoring of Biotopes Distribution within Nature Reserve Area. Environmental Research, Engineering and Management. 76. 109-120. 10.5755/j01.arem.76.3.25204.
14. Malinnikov V.A., Stetsenko A.F., Altynov A.E., Popov S.M. Monitoring of the natural environment by aerospace means. Textbook for university students.– M.:Ed.MIIGAiK. 2008, 145 p.
15. Tomchenko O.V. (2015) Substantiation of wetland system analysis methods using remote sensing data and ground observations (in the upper Kyiv reservoir case study): Abstract. Dis. ... candidate. Sc. Science, Spec. 05.07.12 - remote aerospace research, Kyiv, Scientific Centre for Aerospace Research of the Earth National Academy of Sciences of Ukraine, 22.
16. Burger, Leslie & Burger, L.. (2006). Geospatial Technology Tools for Wildlife Management. wildlife trends. 6. 12-18.
17. Wiegand, N. and T.M. Adams, Using Object-Oriented Database Management for Feature-Based Geographic Information Systems. Journal of the Urban and Regional Information Systems Association 6, 1 (1994), pp. 21-36.
18. Dölek, İskender & avcı, Vedat. (2016). The Use of Geographical Information Systems (GIS) in the Environment and Ecology.
19. Osmólska, Anna. (2013). The Application of GIS Technology in Game Management: a Case Study of Roe Deer (*Capreolus capreolus*) Management.
20. Dale M. Lewis. Importance of GIS to Community-Based Management of Wildlife: Lessons from Zambia Ecological Applications. Vol. 5, No. 4 (Nov., 1995), pp. 861-871 (11 pages).
21. Korpetta, Dariusz & Olenderek, Heronim & Wiktor, Tracz. (2004). Geoinformation systems in forestry. Annals of Geomatics II. 20.

22. Toktasinova F. A., Abayeva K. T., Sirgebaeva S. T., Serikbayeva A. T. Choosing assortment of tree species and placing protective vegetation in concrete lining along channels International Journal Of Civil Engineering And Technology (IJCIET) (Vol.8, no. 12). P. 886-894
23. Kozorez A.I., Egorkin A.M. The use of GIS technologies in hunting management // Modern problems of nature management, hunting and fur farming. 2007. No. 1. URL: <https://cyberleninka.ru/article/n/ispolzovanie-gis-tehnologiy-v-ohotoustroystve> (date of access: 11/17/2022).
24. Danilov D.N., Rusanov Y.S., Rykovskiy A.S. Fundamentals of hunting.- M.: Forest industry, 1966.- 330 p.
25. Romanov, V. S. Classification of hunting grounds / V. S. Romanov, A. G. Lesko // Proceedings of BSTU. Series I, Forestry. - Minsk: BSTU, 2002. - Issue. X. - P. 116-125. - table.
26. GOST R 52055-2003 Geoinformation mapping. Spatial terrain models. General requirements
27. GOST R 50828-95 Geoinformation mapping. Spatial data. Digital and electronic data. General requirements
28. GOST R 51353-99 Geoinformation mapping. Metadata of electronic maps. Composition and content.
29. The main provisions of the organization and management of forestry in the Almaty region. - Almaty: Kazlesproekt, 2005. - 402 p.
30. Guidelines for conducting on-farm hunting management in the Republic of Kazakhstan. - Astana: Komlesohokhoz, 2006. - 50 p.
31. Oraikhanova A. A., Abayeva K. T., Serikbayeva A. T., Sirgebaeva S. T. Studies About variation of Morphological Characters of Pine Stands Canopy From Artificial Origin and Their Relationship With Taxation Indexes. Biosci Biotech Res Asia 2016;13(1)
32. Decree of the Government of the Republic of Kazakhstan dated September 26, 2017 No. 593 "On approval of the list of specially protected natural areas of republican significance"
33. Baitanaev O.A., Serikbaeva A.T. A method for assessing the ecological state of the territory. Patent No. 6309 for Utility Model 08/13/2021
34. Abai K.T., Baitanaev O.A., Abayeva K.T. Rare animal species of the Andasai nature reserve// Proceedings of the international scientific and practical conference of the Fund for Saving the Aral Sea.- Almaty: KazNAU Publishing House, 2013.-p. 215-218.
35. Sharipov R.Kh., Baitanaev O.A., Abayeva K.T. Zoogeographical analysis of the mammals' fauna (Vertebrata, Mammalia) of the Andasai nature reserve// Proceedings of the international scientific and practical conference of the Fund for Saving the Aral.- Almaty: KazNAU Publishing House, 2013.-p. 218-222.
36. Ismagilov M.I. Rodent ecology of Betpak-Dala and Southern Balkhash region.-Alma-Ata: Publishing House of the Academy of Sciences of KazSSR, 1961.- 366 p.
37. Serikbaeva A.T. Biological diversity of carnivorous and hoofed mammals of the fauna of Kazakhstan. - Almaty: Printhouse of the Kazakh National Agrarian University, 2020., - 160 p.

38. Serikbaeva A.T., Sharipov R.Kh., Baitanaev O.A. Typology of the hunting grounds of the Andasai nature reserve// Preservation of the diversity of animals and hunting farms in Russia. -M., 2017. - p. 196-198.
39. <https://redbook.kz/list.php?taxon=302&lang=ru>
40. Orlov S.N., Kertiev V.V., Shargenbaev M.T. Protection and reproduction of rare and endangered species of wild ungulates and saiga of the Republic of Kazakhstan // Theriofauna of Kazakhstan and adjacent territories. - Almaty, 2009. - p. 64-68.
41. Tashibaev E.S. The number and distribution of gazelles in the southern regions of Kazakhstan//Zoological and hunting studies in Kazakhstan and individual countries. - Almaty, 2012. S. 184-188.
42. Ainabekov M.S., Baitanaev O.A., Abaev O.Zh. and others. Experience in studying landscape and biological diversity (on the example of mammals using GIS technologies and camera traps in the Ile-Alatau National Park // Collection of materials of the Republican scientific and practical conference with international participation, dedicated to the 20th anniversary of Ily -Alatau SNNP.- Almaty, 2016.- p.63-71
43. <https://www.ile-alatau.kz/>