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## Species composition of vascular plants of Western Karatau gorges (Mangyshlak)

Analysis of flora and identification of important plant areas in Kazakhstan is an important task for the conservation of biological diversity. On the territory of Mangistau region an important object for identification is the vegetation of the Western Karatau ridge, where a large number of species grow, including species with conservation status. Analysis of species composition of vascular plants of 8 gorges (Samal, Akmysh, Kogez, Botakan, Zhemsemsay, Karasay, Kendirli, Shybyksay) allowed to determine 60 species from 53 genera and 26 families in the summer flora. The dominant families are Asteraceae, Fabaceae, Brassicaceae, Poaceae, Polygonaceae, Chenopodiaceae, Caryophyllaceae, Lamiaceae, and Rosaceae. By life forms, perennials and small perennials dominate, by ecological groups — xerophytes and xeromesophytes. The similarity between the floras of the gorges was established on the basis of Jaccard's coefficient, which varied from 0.26 to 0.58. The minimum similarity was observed between Zhemsemsay and Shybyksay gorges, the maximum — between Samal and Kogez gorges. Growth of 7 species classified as rare and endangered plants of Mangistau region, as well as 3 species listed in the Red Book of Kazakhstan was noted. On the basis of the performed research recommendations were given for inclusion of the gorges of the Western Karatau Ridge in the list of important plant areas.

*Keywords:* important botanical area, flora, vegetation, species composition, Western Karatau.

### *Introduction*

Important plant areas (hereinafter IPAs) are natural areas of special importance for the conservation of flora and vegetation diversity [1]. A set of criteria for designating IPTs takes into account floristic richness, the number of rare and endemic species in need of protection, species listed in the Red Data Books, or species of great importance for the evolution and conservation of the biosphere [2].

Active isolation of IPT has been noted in the territory of European and CIS countries. Thus, IPAs have been described and isolated for the Murmansk and Kemerovo Regions, Altai-Sayan Range, in the Republic of Tyva, Khakassia [3–5], and IPAs in the Republic of Belarus have been well surveyed [6]. The isolation of IPAs for France and Germany has been carried out [7].

In Kazakhstan, these studies were conducted only for the territory of Almaty region [8]. Thus, 11 IPAs were identified for Zhetysu Alatau (Kapchagai Gorge; Itzhon Plateau; Karatas tract; Arkharly Pass; Ushkara tract; Lepsy River floodplain; Suleyman Creek; Seksenbai tract; Kyzkash Mountains; Arganaty Mountains; Zhanabulak, turang grove), with high floristic, mycobiotic and phytocenotic diversity. Similar studies have not been conducted in the rest of Kazakhstan.

Three main criteria are used to identify IPAs: 1) the presence of plant species listed as rare, endangered, or in the Red Books of different levels; 2) overall species richness, as IPAs are intended to identify and conserve areas with exceptional diversity of higher or lower plants; and 3) the presence of endangered habitats.

In Mangystau region (Western Kazakhstan), the gorges of the Western Karatau Range are unique areas with rich floristic diversity and a large number of rare species.

To identify sites that can be recognized as IPA, we evaluated the species composition of vascular plants in a number of gorges of the Western Karatau. The similarity of the flora was assessed using the Jaccard's coefficient.

### Experimental

Expedition research of the site was carried out by the traditional route-reconnaissance method with coverage, if possible, of the most complete variety of biotopes (landscape-ecological conditions) and phytocenoses peculiar to them.

The materials were collected in 2023-2024. The vegetation cover of the studied gorges was studied using the traditional method of geobotanical research — description of plant communities [9, 10]. In this case, special attention was paid to the study of spatial distribution (structure) of vegetation and its relationship with other landscape components (relief, soils, etc.), species diversity and assessment of vegetation condition

Identification of the collected herbarium material was carried out using fundamental summaries: “Flora of Kazakhstan” [11], “Illustrated Identifier of Plants of Kazakhstan” [12]. The species composition is given taking into account modern nomenclatural changes [13].

Populations were analyzed in 8 gorges of the West Katarau Ridge (Table 1).

Table 1

Field survey routes in the territory of the Western Karatau Ridge

Study sites	Coordinates		Height, m above sea level
	Longitude	Latitude	
Akmysh Gorge	44°13'042"	51°58'346"	275
Samal Gorge	44°12'568"	51°59'370"	274
Kogez Gorge	44°17'178"	51°39'949"	253
Shybyksay Gorge	44°13'370"	51°58'46"	268
Jemsemsay Gorge	44°17'178"	51°39'949"	253
Karasay Gorge	44°12'341"	51°53'432"	367
Kendirli Gorge	44°13'138"	51°54'552"	376
Botakan Gorge	44°13'261"	51°54'144"	243

### Results and Discussion

The Western Karatau Ridge is the highest massif of the Mangyshlak Mountains. Its altitude ranges from 380 to 480 meters above sea level. The highest point — Mount Beschoku — rises to 555 meters above sea level. The ridge stretches for 45 km with a width of about 10 km. Its summit is a penneplenized uvalist-hilly surface with ridges of dense rocks stretching parallel to each other and rising 5–10 m above the plain. Separate cone-shaped peaks rise 50–100 m above the penneplain (Djipakhchi, Beschoku and other mountains). Eastern Karatau has very steep slopes, in some places almost sheer. The slopes are strongly cut by deep ravines [14].

**Akmysh Gorge.** The area of the site is 1300x70 (30) m (Fig.). Akmysh is a stream with a small grove along its banks, fed by mountain springs, with a stream flowing through the center, which dries up in summer. The substrate is stony-rubble, sandy and clayey soils emerge at the foot of the ridge.

**Samal Gorge.** The area is 2500x100 meters. The site is a winding gorge, located on the slope of a ridge 500 m high, three kilometers from the Akmysh gorge. An abundant stream with fresh water flows along the bottom of the gorge for about a kilometer. The soils are brown, clayey, and strongly stony.

**Kogez Gorge.** Area 2000x50–100 m. Slopes are gentle, with small cluster of *Caragana grandiflora* (Bieb.) DC. bushes and wormwoods (*Artemisia austriaca*, *Artemisia santolina*). The habitat is occupied by little disturbed communities of lowland vegetation. Shrub thickets are natural undisturbed communities due to their inaccessibility. Total projective cover is 65–70 %.

**Shybyksay Gorge.** The area is 600x70 meters. The site is located in a mountain gorge with gentle rocky slopes of the ridge. The gorge is a winding form with steep slopes on all sides. The height of the slopes is not significant, up to 150 m, the slopes of the mountains are stony and rubbly, at the foot of the ridge sandy and clay soils emerge. The total projective cover formed by the community is 60–65 %. Community types are distributed in 3 tiers: woody (up to 350 cm high), formed by *Crataegus ambigua*; shrubby (120–150 cm high), formed by bushes of *Rhamnus sintenesii*, less frequently *Caragana grandiflora*, young

plants of hawthorn of doubtful, at springs single specimens of *Rubus caesius*; and herbaceous (up to 70 cm high). Due to inaccessibility and steepness of slopes, the plants are not used for livestock grazing.

**Jemsemsay Gorge.** The area is 800x100 m, the gorge is characterized by high slopes, cut through by numerous branches with very steep, stony slopes with a large number of bedrock outcrops and screes. Total projective cover is 50–60 %, hawthorn is the dominant species with abundance of sorghum<sub>2</sub>. There are 3 tiers in the communities of the gorge: Woody (up to 500–550 cm high), consisting of white willow (*Salix alba*) and adult individuals of doubtful hawthorn (*Crataegus ambigua*) (according to Figure 10); shrubby (up to 160 cm high), formed of *Convolvulus fruticosus*, *Atraphaxis herliata*, *Caragana grandiflora*, *Rhamnus sintenisii*; herbaceous (up to 60 cm high). This habitat is not used for livestock grazing.

**Karasy Gorge.** The area is 2000x30–50 m. The gorge is small in size — its length is about 2 km, its width varies from 30 to 50 m, it is slightly winding. The height of the slopes is not significant, 20–25 m, some of them are precipitous, and most of them are gentle. The slopes are clayey-stony, and in the lower part there are rubbly scree slopes. There are no side branches or promontories in the gorge. A small stream with drinking water flows along the bottom of the gorge. Due to its easy accessibility, the site is actively used for watering and grazing of livestock, which explains a certain degree of degradation of vegetation cover (about 8–12 %).

**Kendirli Gorge.** The area is 5500x30–120 meters. The gorge is a deep, strongly winding gorge divided into 2 parts. The height of the slopes is from 60 to 200 m, the northern exposure is gentle, stony-clay. The slopes of the southern exposure are steep and precipitous, rubbly. A stream with fresh water flows along the bottom of the gorge. The length of the gorge exceeds 5.5 km and its width varies from 30 to 120 meters. There are 3 vertical tiers in the gorge communities: upper woody (250 to 350 cm in height), shrub (120–220 cm in height) and herbaceous with a sub-tier of tall grasses (60–80 cm in height) and a sub-tier of stunted grasses (10–30 cm in height). Due to the inaccessibility and steepness of the slopes, the gorge is not used for livestock grazing. No degradation of vegetation cover is observed.

**Botakan Gorge.** The area is 1500x30–100 m. The height of slopes ranges from 50 to 150 m, eastern exposure — gentle, stony-clay. The slopes of the western exposure are steep and precipitous, rubbly. The gorge is up to 1.5 km long and 30 to 100 m wide. There are 3 tiers in the community: woody (up to 300–350 cm high), consisting of adult specimens of doubtful hawthorn; shrubby (up to 160 cm high), formed by *Rhamnus sintenisii*, *Atraphaxis herliata*, rarely *Caragana grandiflora*, single specimens of *Rubus caesius* at springs, young specimens of hawthorn; herbaceous (up to 60 cm high), composed of other components of the community. Due to the inaccessibility and steepness of the slopes, the gorge is not used for livestock grazing. No degradation of the vegetation cover is observed.

The cumulative analysis of taxonomic composition of communities in the gorges of the Western Karatau showed that 60 species from 53 genera and 26 families (Table 2).

Table 2

Composition of plant communities in the Western Karatau gorges

№	Gorge	Number of species, pieces	Presence of rare and endangered species for Mangystau oblast, pieces	Presence of species listed in the Red Book of Kazakhstan, pieces
1	Akmysh Gorge	60	2	2
2	Samal Gorge	55	3	3
3	Kogez Gorge	58	5	5
4	Shybyksay Gorge	35	5	2
5	Jemsemsay Gorge	53	7	2
6	Karasy Gorge	51	4	2
7	Kendirli Gorge	48	3	2
8	Botakan Gorge	39	6	2

Most species belong to the families Asteraceae, Fabaceae, Brassicaceae, Poaceae, Polygonaceae, Chenopodiaceae, Caryophyllaceae, Lamiaceae, and Rosaceae. Species from these nine leading families comprise 60.6 % of the total.

Of the rare, endangered and Red Book species, 10–21.3 % of those growing in the region were identified. *Crataegus ambigua* C.A. Mey., *Crambe edentula* Fisch., *Artemisia gurganica* (Krasch.) Filat., *Rubus caesius* L., included in the catalogue of rare and endangered plant species of Mangystau [15], are found in all

IPAs. Only in the Kogez gorge was the presence of the Red Book [16] species *Salix alba* L. and *Armeniaca vulgaris* Lam. and *Rhamnus sintonisii* Rech., *Capparis herbaceae* Sp., *Teucrium polium* L., included in the Red Book of Mangistau, revealed. Also, in the Kogez and Samal gorges, the Red Book species *Malus sieversii* (Ledeb.) M. Roem.

Analysis of life forms showed that herbaceous perennials dominate in the surveyed populations, 47.3 %; herbaceous minor perennials are in second place, 23.6 %; trees and shrubs are in third place, 18.2 % each, semi-shrubs, 5.5 %, semi-shrubs, 3.6 %, and shrubs 1.8 %.

Ecological analysis showed that a significant proportion of the flora of the studied IPAs consists of xerophytes (21 species or 35 %) and xeromesophytes (9 species or 15 %), which is associated with the severe aridity of the climate of Mangistau. The spectrum of ecological-phylogenetic groups confirmed the predominance of 501 desert and mountain-steppe species, which constitute the majority (53 %). A significant share falls to desert-steppe species (36.7 %). Meadow-steppe species make up 8 % of the total flora. Water-coastal species occupy 5.3 % of the total flora. 504 Weed species were identified, constituting 34.4 % of the total flora composition of the territory's studied areas. This indicates high anthropogenic load and cattle grazing in 506 all studied IPAs.

In the research process to assess the similarity of floras of different IPAs, the Jaccard coefficient was used, which is the ratio of the number of similar taxa for two communities to their sum for each list minus the number of common species. As we can see from the materials in Figure, the Jaccard coefficient for the Akmysh — Samal and Akmysh — Kogez, Akmysh — Karasay, Shybyksay — Zhezsemsay, Botakan — Karasay, Kendyrly — Kogez sites is almost the same, with relatively low values of 0.27–0.29. And vice versa — Samal — Kogez increases almost twice to 0.56 (56 %).

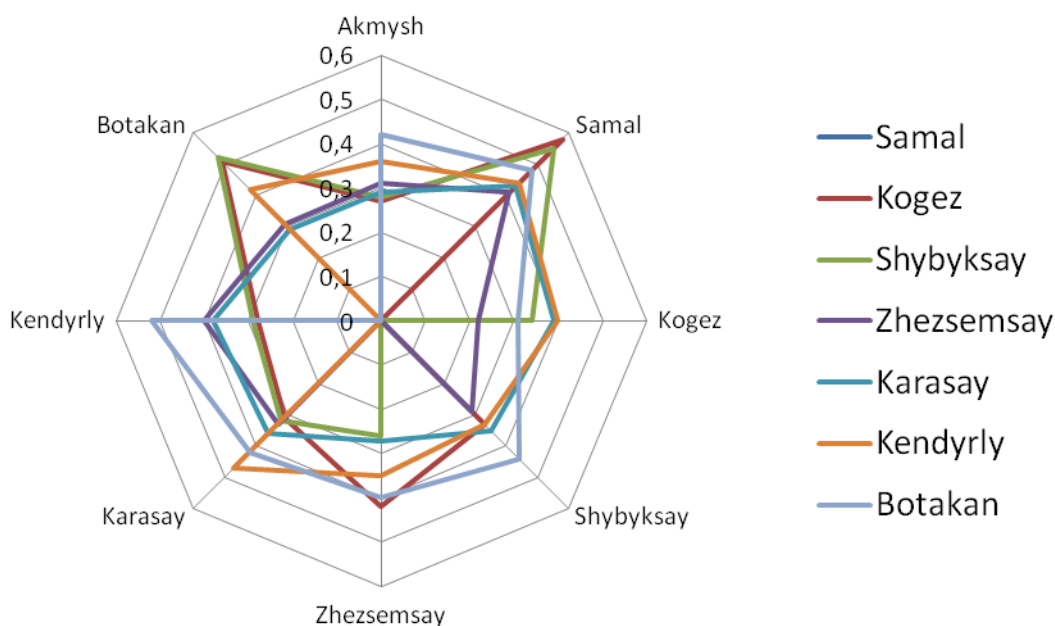


Figure. Similarity between the floras of the Western Karatau gorges based on the Jaccard index

The similarity of flora between the remaining plots ranged from 0.31 to 0.52. The differences can be explained by the presence of differences in soil conditions, anthropogenic load and moisture conditions.

It has been established that all areas are vulnerable due to a whole range of factors: location, intensive use in agriculture, increased anthropogenic load, etc. The most effective way to preserve rare plants is to maintain their natural populations. The allocation of the above areas to the category of critical botanical territories allows us to hope for the long-term existence of natural biocenoses without catastrophic changes. It is also essential to consider these areas with a high concentration of rare significant species when planning possible recreational and economic activities. Given the vulnerability of all three areas, it is proposed to use geographic data as an alternative or supplement when choosing new IPAs or specially protected natural areas.

### Conclusion

Biodiversity analysis for the important plant areas — gorges of Western Karatau in the Mangistau region showed high species diversity and the presence of rare and endangered plant species, making these areas important for conservation and monitoring.

Based on the research results, allocating the 8 gorges, to the essential plant areas category are recommended to ensure the long-term existence of natural biocenoses and the conservation of rare plant species. This will allow for the establishment of a protection regime, the regulation of recreational load, and the limitation of grazing, which are necessary measures to maintain ecosystem stability.

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### Батыс Қаратау (Маңғышлақ) шатқалындағы тамырлы өсімдіктердің түрлік құрамы

Қазақстандағы флораны талдау және негізгі ботаникалық аумақтарды анықтау биологиялық әртүрлілікті сақтаудың маңызды кепілі. Маңғыстау облысының Батыс Қаратау жотасындағы өсімдіктер бөліп көрсету үшін маңызды объект болып табылады, оның аумағында табиғатты қорғау мәртебесі бар түрлерді қоса алғанда, көптеген түрлер өседі. 8 шатқалдағы тамырлы өсімдіктердің түрлік құрамын талдау (Самал, Ақмыш, Көгез, Ботақан, Жемсемсай, Қарасай, Кеңдірлі, Шыбықсай) жазғы флора құрамында 53 тұқымдас пен 26 туыстың 60 түрін анықтауға мүмкіндік берді. Asteraceae,

Fabaceae, Brassicaceae, Poaceae, Polygonaceae, Chenopodiaceae, Caryophyllaceae, Lamiaceae және Rosaceae сияқты түрлердің басым тұқымдастары анықталды. Тіршілік формаларында көпжылдық және жас көпжылдықтар, ал экологиялық топтарда ксерофиттер мен ксеромезофиттер басым. Шатқалдардың флорасы арасындағы ұқсастық 0,26-дан 0,58-ге дейін ауытқыған Жаккар коэффициенті негізінде белгіленді. Ең аз ұқсастық Жемсемсай мен Шыбықсай шатқалдары арасында, ең жоғарысы Самал мен Көгез шатқалдары арасында байқалды. Маңғыстау өңірінің сирек кездесетін және жойылып бара жатқан өсімдіктеріне жатқызылған 7 түрдің, сондай-ақ Қазақстанның Қызыл кітабына енгізілген 3 түрінің өсуі атап өтілді. Жүргізілген зерттеулер негізінде Батыс Қаратау жотасының шатқалдарын негізгі ботаникалық аймақтардың тізіміне енгізу бойынша ұсыныстар жасалды.

*Кілт сөздер:* негізгі ботаникалық аумақтары, флорасы, өсімдіктері, түр құрамы, Батыс Қаратау.

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## Видовой состав сосудистых растений ущелий Западного Каратау (Мангышлак)

Анализ флоры и выделение ключевых ботанических территорий в Казахстане является важной задачей для сохранения биологического разнообразия. На территории Мангистауской области важным объектом для выделения является растительность хребта Западный Каратау, на территории которого произрастает большое число видов, включая виды с природоохранным статусом. Анализ видовой состава сосудистых растений 8 ущелий (Самал, Акмыш, Көгез, Ботакан, Жемсемсай, Карасай, Кендирили, Шыбықсай) позволил определить в составе летней флоры 60 видов из 53 родов и 26 семейств. Доминирующими семействами определены *Asteraceae*, *Fabaceae*, *Brassicaceae*, *Poaceae*, *Polygonaceae*, *Chenopodiaceae*, *Caryophyllaceae*, *Lamiaceae* и *Rosaceae*. По жизненным формам доминируют многолетники и малолетники, по экологическим группам — ксерофиты и ксеромезофиты. Установлено сходство между флорами ущелий на основании коэффициента Жаккара, который изменялся от 0,26 до 0,58. Минимальное сходство отмечено между ущельями Жемсемсай и Шыбықсай, максимальное — между ущельями Самал и Көгез. Отмечено произрастание 7 видов, отнесенных к редким и исчезающим растениям Магистауской области, а также 3 видов, занесенных в Красную книгу Казахстана. На основании выполненных исследований даны рекомендации для включения ущелий хребта Западный Каратау в перечень ключевых ботанических территорий.

*Ключевые слова:* ключевые ботанические территории, флора, растительность, видовой состав, Западный Каратау.

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