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SPECIES COMPOSITION OF ICHTHYOFAUNA IN THE LAKES OF THE ILI RIVER'S DELTA (BALKHASH BASIN)

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Abstract

The study of the ichthyofauna of the bodies of water of Alizhan, Ardak, and Arkar in the Balkhash district of the Almaty region was conducted to assess the species composition, ecological characteristics, and commercial potential. The analysis was carried out using data from standard fish catches using nets of different mesh sizes, as well as ecological parameters of the water (depth, mineralization, oxygen content).The article provides a general description of the ichthyofauna of the bodies of water of Alizhan, Ardak and Arkar, and also presents the results of studies of the ichthyofauna of all three bodies of water. 13 species of fish were identified, representing 10 families, including commercial species (carp, snakehead, catfish, roach, asp, crucian carp) and the rare Balkhash perch, included in the Red Book of Kazakhstan.The Shannon (2.76–2.87) and Simpson (0.81–0.83) indices confirmed the high level of biodiversity. Commercial species demonstrate good biological indicators (fatness factor 2.00–3.21), and the concentration of juveniles reaches 0.063 specimens/m³.The findings highlight the importance of rational use of water resources, conservation of rare species and adaptive management of ecosystems to ensure sustainable biodiversity and fisheries productivity.
Keywords: Balkhash basin, ichthyofauna, species composition, body of water, biodiversity, aboriginal species, young fishes, rural bodies of water.

INTRODUCTION

The Balkhash basin represents a dynamic and relatively young hydrosystem from a geological perspective. Its initial ichthyofauna was shaped by species migrating from adjacent basins, followed by prolonged isolation and adaptation to diverse abiotic conditions, leading to the emergence of endemic fish species and subspecies unique to this region [1]. This ongoing process of morphogenesis makes the Balkhash basin a valuable natural laboratory for studying evolutionary mechanisms at the population, species, and community levels. Research on the ichthyofauna of Lake Balkhash and the Ili River dates back to the early 19th century, underscoring the scientific significance of these ecosystems for understanding regional biodiversity [2].

A key feature of the basin is the Ili River Delta, Central Asia's largest wetland complex, spanning approximately 8,000 km². This delta serves as a critical refuge for biodiversity, sustaining unique habitats for numerous plant and animal species, including rare and endemic taxa. Beyond its ecological value, the delta supports vital ecosystem services, such as freshwater supply, fisheries, water filtration, climate regulation, and erosion control [3]. Recognized as a Ramsar site ("Ili River Delta and Southern Lake Balkhash"), it remains one of the few deltaic systems in the region maintaining a stable hydrological regime despite increasing anthropogenic pressures [4].

Freshwater fish communities are integral to aquatic ecosystem stability, yet their composition is highly sensitive to environmental changes, including urbanization and altered hydrological regimes [5, 6]. In the context of global biodiversity decline, systematic monitoring of aquatic ecosystems has become a priority for conservation and restoration efforts [7–9]. Reliable taxonomic inventories are essential for assessing biodiversity patterns, delineating species distributions, and guiding

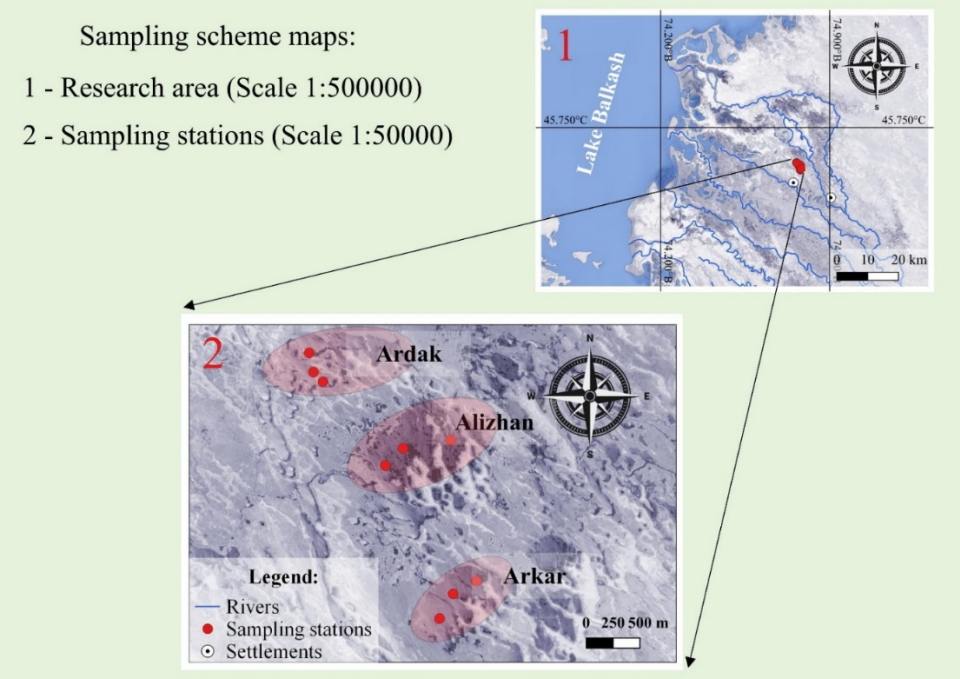
conservation strategies [10, 11].

This study aims to provide an updated inventory of ichthyofauna in the Balkhash region, combining field observations with existing scientific data. Special emphasis is placed on the role of deltaic ecosystems as biodiversity hotspots, offering critical conditions for fish reproduction and survival. By documenting species diversity and identifying conservation priorities, this research contributes to the broader understanding of freshwater ecosystem resilience in the face of environmental change.

MATERIALS AND RESEARCH METHODS

Ichthyofauna studies were conducted in 2023 in three bodies of water located in the Balkhash region (picture 1), 25 km south of the village of Karoy. The area of he bodies of water under consideration ranges from 29 to 65 hectares. Maximum depths range from 4.3 to 5.5 m. The bodies of water differ in morphological characteristics and hydrochemical composition (table 1).

Picture 1: Map of the location of sampling points in the studied bodies of water of the Balkhash region



Lakes Alijan, Arkar, and Ardak currently experience relatively low levels of human impact compared to more heavily modified ecosystems in the region. Their remote locations, smaller size, and limited economic use have helped preserve their natural hydrological and ecological characteristics.

The lakes' water regimes remain largely undisturbed, as they are not major sources for large-scale irrigation or drinking water supply. No major dams or water diversion infrastructure directly affect these lakes, allowing them to maintain natural seasonal fluctuations.

Table 1: Characteristics of the studied lakes

Bodies of water	Length, km	Width, km	Depth, m	Area, ha	Altitude	Mineralization, mg/litres	Oxygen,mg/litres
Alizhan	0,99	0,70	5,5	65	345	621,27	8,29
Arkar	0,78	0,51	5,2	29	346	624,42	10,3
Ardak	1,37	0,60	4,3	43	347	539,06	9,26

Materials on ichthyofauna were collected from reservoirs that are part of the local reservoir system of the region. When collecting the material, we used fixed nets with a mesh size of 16–80 mm, every 25 m long, and a fry seine (mesh size 3 mm). In total, more than 236 fish specimens were caught. Office processing of the material was carried out using generally accepted methods [12]. The coordinates of the stations were determined using the Garmin GPS navigation system. Identifiers were used to identify fish species. [13, 14, 15].The Latin names of most fish are consistent with Eschmeyer's Catalog of Fishes and Fish Base [16, 17]. Statistical processing of data was carried out according to the guidelines of G.F. Lakin [18] and Press W.H. et al. [19], using the computer program of Excel.

To determine the degree of fatness of fish (Fulton fatness coefficient), the following formula was used:

$$F = \frac{\mathrm{Q} * 100}{\mathrm{l}^3}$$

Where F is the fatness factor; Q is the weight of the fish, g; l is the length of the fish from the beginning of the snout to the end of the scaly cover (by ad), cm. To assess the species diversity of the studied stations, the common indices Shannon and Simpson were used [20]. The yield of young fish was calculated using the formula [21]:

$$\text{РУ}\frac{P * N}{P_1} * U, \text{thousand spec./ha}$$

Where P is the area in which the number of young fish is determined (it was always taken to be equal to 1 ha), N is the number of caught young fish, P_1 is the area of he catchment area (it was always taken to be equal to 30 m^2), U is the catchability of the fishing gear (it was always taken to be equal to 33%).

The following indices were calculated: S – total number of fish species in the community (species richness), D – Simpson diversity index, E – Simpson distribution uniformity, H – Shannon diversity index, J – Shannon distribution uniformity.

Hydrochemical water samples were collected at two points in each reservoir.To determine the mass concentration of dissolved oxygen (mg/l) and the percentage of water saturation with oxygen, the MARK-302M analyzer operating in immersion mode was used.The determination of water mineralization was carried out in accordance with the requirements of GOSTP 54316-2020 [22].

RESULTS AND DISCUSSION

Based on the analysis of net and snail catches, only 13 species belonging to 10 families were found – *Cyprinidae*, *Xenocyprididae, Gobionidae*, *Leuciscidae*, *Siluridae*, *Channiidae*, *Adrianichthyidae*, *Odontobutidae*, *Gobiidae* and *Percidae* (table 2).

Among them, 6 species of fish (carp, snakehead, catfish, roach, asp, crucian carp) are considered the main commercial species, the sharp-bellied fish is a low-value commercial fish, the remaining species have no commercial value, belong to the Chinese complex, and are introduced species.[23] The introduction of new fish species in the 20th century significantly changed the ichthyofauna of Lake Balkhash: by 1972, 98% of the commercial catch consisted of introduced species, and the proportion of native species decreased to 2% [24].

Table 2: Species composition of the ichthyofauna of the studied water bodies

Species name		Water bodies		
Latin	English	Lake Alizhan	Lake Ardak	Lake Arkar
Cyprinus carpio (Linnaeus, 1758)	Common carp	+	+	+
Carassius gibelio (Bloch, 1782)	Prussian carp	+	+	+
Hemiculter leucisculus (Basilewsky, 1855)	Sawbelly	+	+	+
Pseudorasbora parva (Temmick et Schleger, 1846)	Stone moroko	+	+	+
Rhinogobius cheni (Nicholos, 1931)	Chinese gobiid fish	+	+	+
Rutilus caspicus (Linnaeus, 1758)	Caspian roach	+	+	+
Leuciscus aspius (Linnaeus, 1758)	Asp	+	+	+
Channa argus (Cantor, 1842)	Snakehead	+	+	+
Oryzias latipes (Temminch et Schlegel, 1846)	Japanese rice fish	+	+	+
Micropercops cinctus (Dabry et Thiersant,1872)	Chinese eleotris	+	+	+
Silurus glanis (Linnaeus, 1758)	Wels catfish	+	-	-
Abbottina rivularis (Basilewski, 1855)	Chinese false gudgeon	-	+	-
Perca schrenkii (Kessler, 1874)	Balkhash perch	-	-	+
Note: "+" – the species can be found in catches, "-" – the species is absent in catches.				

The calculated indices of biological diversity indicate that, despite the significant species diversity of fish noted in all the studied water bodies, biocenoses are characterized by a simplified structure. The values of the Shannon species diversity

index vary from 2.76 to 2.87, and the Simpson species diversity index vary in a narrow range from 0.81 to 0.83, which indicates their insignificant fluctuations and a relatively stable structure of biocenoses in all studied water bodies (table 3).

The fish community analysis of Lakes Alizhan, Arkar and Ardak reveals generally similar biodiversity patterns with minor variations in ecological structure. All three waterbodies maintain relatively high diversity, as evidenced by Simpson Index values ranging between 0.81-0.83 and Shannon Index values of 2.76-2.87, indicating no single dominant species controlling these ecosystems.

Table 3: Indicators of diversity of fish communities in water bodies

Indicators	Body of water		
	Alizhan	Arkar	Ardak
Fish caught (n)	68	76	92
Species richness(S)	11	10	10
Simpson Diversity Index (D)	0,81	0,82	0,83
Simpson's Uniform Distribution (E)	0,62	0,73	0,71
Shannon Diversity Index (H, log2)	2,76	2,87	2,84
Uniformity of distribution according to Shannon (J, log2)	0,80	0,86	0,85

However, some noteworthy differences emerge in distribution patterns - Ardak demonstrated the highest catch abundance (92 specimens), while Alizhan contained the greatest species richness (11 species). The uniformity metrics suggest Arkar maintains the most balanced community structure (Simpson's E=0.73, Shannon's J=0.86), compared to Alizhan, which shows slightly higher dominance (E=0.62, J=0.80). These subtle variations in species distribution could reflect differences in habitat characteristics, resource availability, or historical factors among the lakes. The findings suggest these lakes represent relatively healthy aquatic ecosystems with well-established fish communities, though continued monitoring would be valuable to track any future changes in community structure.

The study examined various fish species across three reservoirs in the Balkhash-Ili basin: Lake Alizhan, Lake Arkar, and Lake Ardak. Fish lengths ranged from 12.8 to 57.0 cm, with weights between 33 and 2164 g. Age analysis revealed seven generations, with 3-4-year-olds being dominant across species.

Caspian roach (*Rutilus rutilus*) was the most abundant in all three lakes, though its commercial value was lower than other species. Fish sizes ranged from 12.8 to 29.6 cm and from 33 to 562 g, with an average length of 20.1 cm and weight of 177 g. The largest catches occurred in Lake Alizhan (22 individuals), followed by Lake Arkar (12), and Lake Ardak (5). The population displayed seven generations, with 3-4-year-olds being most prevalent.

Crucian carp (*Carassius gibelio*) was found in all three lakes but had limited commercial value. Fish ranged from 8.6 to 28.9 cm in length and 16.0 to 643.0 g in weight. In Lake Alizhan, specimens aged 2, 6, and 8 years were caught, with an average Fulton condition factor of 2.59. In Lake Arkar, sizes ranged from 16.5 to 29.5 cm and 141 to 685 g in weight; in Lake Ardak, from 26.2 to 30.0 cm and 520 to 780 g, with an average condition factor of 2.84.

Snakehead (*Channa argus*), found in all three lakes, showed size variation from 39.7 to 57.0 cm and weights from 690 to 2164 g. The Fulton condition factor ranged from 1.04 to 1.42, with Lake Arkar's highest at 1.26. The average size and condition indicate successful adaptation to these reservoirs, consistent with prior studies on its acclimatization in the Ili-Balkhash basin. The largest specimen, 57 cm, was from Lake Alizhan.

Common carp (*Cyprinus carpio*) was rare, with only 11 individuals caught. Sizes ranged from 22.0 to 42.5 cm, and weights from 225 to 1605 g.

Asp (*Aspius aspius*) was scarce, especially in Lake Alizhan and Lake Ardak, where young fish were common. Sizes ranged from 14.6 to 32.0 cm, and weights from 39 to 441 g. Its low presence may result from limited suitable habitats, as it prefers areas with active currents and abundant food like small fish and insects.

Wels catfish (*Silurus glanis*) was rarely recorded, with only one specimen caught in Lake Alizhan, measuring 36.0 cm and weighing 362 g. Its low body condition factor of 0.78 might indicate food shortages or competition.

These findings align with previous research on the Balkhash-Ili basin's fish populations. Caspian roach, though abundant, remains of limited commercial value, consistent with Pazylbekov et al. [25], who noted its widespread presence but low commercial worth. The size and weight distributions also mirror earlier studies, suggesting stable populations.

Despite reaching sexual maturity by 2-3 years, crucian carp showed limited commercial value, consistent with earlier reports by Tagaev [26], describing it as unpretentious but commercially insignificant. The data suggest a mostly female population, with fertility ranging from 7.7 to 83.3 thousand eggs, highlighting reproductive potential.

Snakehead has successfully adapted to all studied reservoirs, thriving in low-flow lakes with abundant vegetation, as described by Zharkenov and Dukravets [27], [28]. Size and condition variations suggest that food and habitat quality influence growth. Larger specimens in Lake Alizhan indicate beneficial environmental conditions.

Common carp remains scarce, aligning with Magauina [29], who reported low populations despite regular stocking, likely due to hydrological changes affecting breeding and survival.

The low presence of asp corroborates earlier findings, noting its preference for strong currents and rich food. The presence of young asp in Lake Alizhan and Lake Ardak suggests it is poorly adapted to the calmer, nutrient-poor environments

here.

Finally, the few wels catfish caught might be underrepresented because of the fishing methods used, as reflected by the low catch rate and condition of the singular specimen. Its low condition might also be due to competition and limited food in these ecosystems.

Table 4: Biological parameters of fish species caught in the studied lakes

Fish species	L (length), cm min-max M	Q (weight), g min-max M	Fulton min-max M	N
Lake Ardak				
Common carp	22,0-34,4 27,6	225-825 519	2,00-2,62 2,29	8
Crucian carp	26,2-30,0 27,9	520-780 616	2,54-3,21 2,84	8
Caspian roach	13,0-20,8 14,7	35-148 59	1,54-1,73 1,62	5
Snakehead	13,0-20,8 14,7	35-148 59	1,54-1,73 1,62	7
Asp	14,6	40	1,29	1
Lake Alizhan				
Common carp	28,4	548	2,39	1
Crucian carp	8,6-28,9 17,4	16,0-643,0 249,0	2,41-2,87 2,59	7
Caspian roach	12,8-29,6 21,9	33,0-562,0 227,0	1,50-2,19 1,85	22
Snakehead	39,7-57,0 48,2	690-2164 1367	1,04-1,24 1,15	8
Wels catfish	36,0	362	0,78	1
Asp	14,9	39	1,18	1
Lake Arkar				
Common carp	38,2-42,5 40,3	1064-1605 1334	1,91-2,09 2,0	2
Crucian carp	16,5-29,5 22,9	141-685 328	2,56-3,14 2,89	10
Caspian roach	20,2-27,5 23,7	120-377 246	1,43-2,17 1,77	12
Snakehead	33,4-53,0 43,4	468-1790 1096	1,01-1,42 1,26	9
Asp	32,0	441	1,35	1

Note: M –medium value

The ichthyofauna of the coastal shallow water zone of the studied reservoirs was characterized by moderate species diversity and a certain specificity of dominance of individual fish species.

Five species of juvenile fish were found in the Alizhan reservoir: the sharp-bellied goby, the stone moroko, the eleotris, the Japanese rice fish, and the Chinese gobiid fish. The average concentration of juvenile fish in catches was 0.018 specimens/m³. The greatest number was demonstrated by the stone moroko, the concentration of which reached 0.05 specimens/m³, which allowed it to occupy a dominant position in the ichthyofauna of this reservoir.

The ichthyofauna of the Ardak reservoir turned out to be more diverse and was represented by 7 species of young fish: river abotina, crucian carp, sharp-bellied goby, Chinese gobiid fish, stone moroko, eleotris and Japanese rice fish. The average concentration of young fish was 0.024 specimens/m³, which exceeds the indicators of the lake Alijan. The largest share of the catches was made up of stone moroko with a concentration of 0.10 specimens/m³, confirming its leading role in the structure of the ichthyofauna of the coastal zone of the reservoir.

The highest density of young fish was noted in the Arkar reservoir, where 6 species were registered: Stone moroko, Japanese rice fish, Balkhash perch, sharp-bellied goby, Chinese gobiid fish and eleotris. Among them, the Balkhash perch is a species included in the Red Book of the Republic of Kazakhstan, therefore, during the analysis, the fish was not dissected and was returned to the reservoir. According to E.B. Kozhabaeva (2019), the Balkhash perch is an endemic species of the Balkhash basin. The native species inhabited various ecotopes, with the exception of mountain reservoirs. However, as a result of acclimatization measures in the basin, its range has significantly decreased. The Balkhash perch is a commercial species and is listed in the Red

Book of the Republic of Kazakhstan and the International Union for Conservation of Nature (IUCN)[30]. The average concentration of juveniles was 0.063 specimens/m³, which is the maximum value among the studied reservoirs. The catches were dominated by stone moroko, which together demonstrated a concentration of 0.30 specimens/m³, which emphasizes their importance in the coastal ecosystem of this reservoir (table 5).

Table 5: Biological parameters and concentration of juvenile fish in the studied water bodies

Fish species	Indicators				
	L, mm min-max M	Q, g min-max M	yield, species/m³	n	proportion, %
Lake Alizhan					
Sawbelly	53,0	2,15	0,003	1	3,6
Japanese rice fish	20,0	0,03	0,003	1	3,6
Stonemoroko	20,0-27,0 23,4	0,03-0,45 0,18	0,05	15	53,6
Eleotris	31,0	0,68	0,003	1	3,6
Chinese gobiid fish	27,0-46,0 38,6	0,34-2,04 1,26	0,03	10	35,7
Total			0,018	28	100,0
Lake Ardak					
Chinese false gudgeon	66,0	0,162	0,004	1	2,4
Sawbelly	32,0-37,0 34,0	0,016-0,020 0,017	0,01	3	7,1
Japanese rice fish	15,0-17,0 16,3	0,001-0,001 0,001	0,01	3	7,1
Stone moroko	20,0-31,0 23,8	0,004-0,014 0,008	0,10	25	59,5
Crucian carp	39,0-42,0 40,7	0,08-0,10 0,09	0,01	3	7,1
Eleotris	24,0	0,01	0,004	1	2,4
Chinese gobiid fish	22,0-51,0 35,0	0,01-0,11 0,04	0,03	6	14,3
Total			0,024	42	100,0
Lake Arkar					
Balkhash perch[*]	60,0	0,15	0,01	1	1,6
Japanese rice fish	16,0-27,0 19,6	0,001-0,01 0,004	0,15	25	40,3
Stone moroko	19,0-30,0 23,6	0,001-0,014 0,006	0,15	25	40,3
Sawbelly	34,0-66,0 50,0	0,02-0,12 0,07	0,01	2	3,2
Eleotris	19,0-22,0 20,3	0,004-0,01 0,01	0,02	3	4,8
Chinese gobiid fish	18,0-43,0 29,3	0,002-0,05 0,02	0,04	6	9,7
Total			0,063	63	100,0

Note: [*] species listed in the Red Book of the Republic of Kazakhstan

CONCLUSION

The study of the ichthyofauna of the Alizhan, Ardak and Arkhar reservoirs made it possible to obtain comprehensive data on the biodiversity, ecology and commercial potential of the Balkhash ecosystems, which is important for developing strategies for the rational management of fish resources. 13 species of fish from 10 families were identified, including key commercial species (carp, snakehead, catfish, roach, asp, crucian carp) and rare species (Balkhash perch), which emphasizes the ecological and economic value of the reservoirs. High biodiversity indices (Shannon 2.76–2.87; Simpson 0.81–0.83) indicate the stability of ecosystems. The ichthyofauna demonstrate good biometric indicators (body condition coefficient up to 3.21), and the high concentration of juveniles (up to 0.063 specimens/m³ in the Arkar reservoir) reflects their productivity.The results obtained highlight the importance of rational management of fisheries resources and conservation of rare species, which

requires the integration of data on biodiversity, chemical parameters of the environment and anthropogenic impact to ensure sustainable use of these ecosystems.

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ІЛЕ ӨЗЕНІНІҢ АТЫРАУЫ КӨЛДЕРІНДЕГІ ИХТИОФАУНАНЫҢ ТҮРЛІК ҚҰРАМЫ (БАЛҚАШ БАССЕЙНІ)

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Аннотация

Түрлік құрамын, экологиялық ерекшеліктерін және кәсіптік әлеуетін бағалау үшін Алматы облысы Балқаш ауданындағы Алижан, Ардақ және Арқар су қоймаларының ихтиофаунасына зерттеу жүргізілді. Талдау үшін біз стандартты балық аулау деректерін пайдаландық, әртүрлі ұяшықтары бар торларды, сондай-ақ қоршаған ортаның судың көрсеткіштерін (тереңдігі, тұздылығы, оттегі мөлшері) пайдаландық. Мақалада Алижан, Ардақ және Арқар су қоймаларының ихтиофаунасына жалпы сипаттамасы, сонымен қатар барлық үш су қоймасының ихтиофаунасын зерттеу нәтижелері берілген. Балықтың 13 түрі анықталды, олар 10 тұқымдастың өкілі болып табылады, оның ішінде кәсіптік түрлері (сазан, жыланбас балық, жайын, тыран, ақмарқа, мөңке) және Қазақстанның Қызыл кітабына енгізілген сирек кездесетін Балқаш алабұғасы. Шеннон (2,76–2,87) және Симпсон (0,81–0,83) индекстері биологиялық әртүрліліктің жоғары деңгейін көрсетеді. Кәсіптік түрлер жақсы морфобиологиялық көрсеткіштерді көрсетеді (қоңдылық коэффициенті 2,00–3,21), ал шабақтар концентрациясы 0,063 дана/м³ жетеді. Қорытындылай келе, тұрақты су ресурстарын басқарудың, сирек кездесетін түрлерді сақтаудың және тұрақты биоалуантүрлілік пен балық шаруашылығының өнімділігін қамтамасыз ету үшін бейімделген экожүйені басқарудың маңыздылығын көрсетеді.

Түйін сөздер: Балқаш бассейні,ихтиофауна, түрлік құрамы, су қоймалар, биоалуантүрлілік, абориген түрлер, шабақ, жергілікті суқоймалар.

ВИДОВОЙ СОСТАВ ИХТИОФАУНЫ ОЗЕР ДЕЛЬТЫ РЕКИ ИЛИ (БАЛХАШСКИЙ БАССЕЙН)

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Аннотация

Исследование ихтиофауны водоёмов Алижан, Ардак и Аркар Балхашского района Алматинской области проведено с

целью оценки видового состава, экологических характеристик и промыслового потенциала. Для анализа использовались данные стандартных уловов рыбы с применением сетей разной ячеистости, а также экологические параметры воды (глубина, минерализация, содержание кислорода). В статье дана общая характеристика ихтиофауны водоемов Алижан, Ардак и Аркар, а также представлены результаты исследований ихтиофауны всех трех водоемов. Выявлено 13 видов рыб, представляющих 10 семейств, включая промысловые виды (сазан, змееголов, сом, вобла, жерех, карась) и редкий балхашский окунь, включённый в Красную книгу Казахстана. Индексы Шеннона (2,76–2,87) и Симпсона (0,81–0,83) подтвердили высокий уровень биоразнообразия. Промысловые виды демонстрируют хорошие биологические показатели (коэффициент упитанности 2,00–3,21), а концентрация молоди достигает 0,063 экз./м³. Полученные данные подчёркивают важность рационального использования водных ресурсов, сохранения редких видов и адаптивного управления экосистемами для обеспечения устойчивого биоразнообразия и рыбохозяйственной продуктивности.

Ключевые слова: Балхашский бассейн, ихтиофауна, видовой состав, водоемы, биоразнообразие, аборигенный вид, молодь, местные водоемы.