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TO THE QUESTION ABOUT THE CURRENT STATE AND PROBLEMS OF FORMATION OF INVASIVE ICHTHYOFAUNA OF THE MIDDLE IRTYSH BASIN

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The article presents new data on biology and ecology of invasive ichthyofauna of the Middle Irtysh basin on the territory of Pavlodar region. Using the literature data, the species composition of alien species inhabiting the upper, middle and lower reaches of the Irtysh River is summarized. In the Middle Irtysh basin, 15 invasive fish species belonging to 5 families and 13 genera are currently registered. The largest number of species belong to the carp family (9 species or 60%), salmonids include 3 species or 20%, other families are represented by one species. Only three species have acclimatized and entered the fishery in the Middle Irtysh basin: bream, carp (carp) and pikeperch. The share in commercial catches is from 15.7 to 27.7% for bream, from 0.2 to 1.5% for carp and from 0.8 to 1.3% for pikeperch. The largest number of caught bream individuals was registered in backwaters, carp in channels and lakes, pikeperch in Irtysh channels. The data on growth rate of these three fish species with the results of regression analysis are given. Data on the results of introduction of 11 more fish species are briefly summarized. It is concluded that spontaneous introductions sometimes lead to complete reorganization of biocenosis as a result of introduction of predator or food competitor, transfer of dangerous parasites or diseases. Most often, after a small "acclimatization effect" a water body not ready for the press of an introduced species becomes impoverished and becomes unattractive for fishermen and unpromising for commercial fish farming. Given that the problem of alien fish species is a serious environmental problem, its solution requires a comprehensive approach including scientific research, monitoring, management and educational programs.

Keywords: *Irtysh River, ichthyofauna, invasion, fish introduction, bioproductivity.*

INTRODUCTION

Large-scale activities on introduction of new fish species in the Irtysh river basin in order to increase the bioproductive potential of the region began in the last century and continue up to the present time. Unfortunately, together with valuable fish species, non-target fish species have entered the Irtysh basin, and their expansion into new water bodies has taken significant proportions.

The issue of increasing the bioproductive potential of water bodies through the introduction of new fish species is complex and multifaceted. It affects ecological, economic and social aspects of water resources management. It is important to realize that the introduction of introduced fish species can have both positive and negative consequences for the ecosystem of a water body. Undoubtedly, there are positive aspects such as increasing fish biomass**,** developing the local market (creating new jobs and improving the economic situation in the region), and attracting tourists. However, there are also negative aspects: alteration of the food chain (introduction of alien species may disrupt the natural food chain, leading to a decrease in the number of native fish species and other animals), pollution of water bodies (some fish species may negatively affect water quality, e.g. through the release of organic matter or through the accumulation of parasites), economic risks (may lead to unexpected economic losses if they start competing with native species for resources or if the consumption of these fish species does not increase), and economic risks (may lead to unexpected economic losses if they start competing with native species for resources or if the consumption of these fish species does not increase).

Therefore, it is very important to develop and implement management measures for these activities: ecological impact assessment (before introducing a new species, a thorough assessment of its potential impact on the environment should be carried out), monitoring (after the introduction of a new species, the condition of the water body and fish population should be regularly monitored), population management (population control measures may be applied to control the numbers of the introduced species to avoid negative impacts on the ecosystem), education and information (it is necessary to inform).

It is important to approach the issue of increasing the bioproductive potential of water bodies using invasive fish species taking into account all these aspects and in order to minimize the negative impact on the environment.

In the present report new data on biology and ecology of invasive ichthyofauna of the Middle Irtysh basin (on the territory of Pavlodar region) are given, which will serve as a basis for understanding the nature of invasive processes of fishes, analyzing the nature of relationships between aboriginal fishes and omnivores, estimation of productive possibilities of omnivores when used in fishery, aquaculture and nature protection activity.

MATERIAL AND METHODS OF RESEARCH

The collection of field material was carried out at different times from spring to autumn in the fisheries reservoirs of the Middle Irtysh basin in the Pavlodar region,

assigned to nature users and fish producers. Fish were caught with their own set nets, and fish caught by fishermen with set nets, seines and traps, and fish caught by amateur fishermen were also examined. Mass measurements of the entire fish catch were carried out and individual specimens were selected, which were subjected to biological analysis in fresh form on the spot. First of all, the species belonging of the caught specimens was determined. The length of the fish's body was measured from the snout to the end of the scale cover using a measuring board. The fish was weighed on a cup scale or digital electronic scales. The total weight of the fish and the weight without entrails were measured. During dissection and external examination, the sex of the individuals and the maturity stage of the reproductive products were determined. The results were recorded in special ichthyological journals. To determine the age of the fish, scales were collected, as a rule, under the dorsal fin above the lateral line [1]. The scales were placed in special scale books. Gill covers were additionally selected from walleye and perch. The calculation of annual rings was carried out in the laboratory under a binocular microscope. Material processing was carried out according to generally accepted ichthyologic guidelines [1]. Statistical processing of the data was performed using Excel software package Microsoft®Office 2010, STATISTICA 13.3.0. Certain biological and statistical material was obtained during the period of the first author's participation in commissions on stocking the floodplain reservoirs of the Irtysh with young valuable fish species. Data on species composition and fish production values were collected from informative and statistical sources (reports, publications) of various government agencies. General scientific (analysis, synthesis, comparison, generalization) research methods were used in writing the work.

RESULTS AND DISCUSSION

Ichthyofauna of the Irtysh River includes 43 fish species, among which 28 species are indigenous and 15 are introduced. Due to the fact that in the Irtysh basin there are different ecotopes with specific conditions of fish habitat, the species diversity is somewhat different. Analyzing the results of our own research and available publications on ichthyofauna of the Irtysh we grouped its species composition by three sections of the Irtysh: upper, middle and lower (Table 1).

The list of invasive species contains 15 species belonging to 5 families and 13 genera. The largest number of species belong to the carp family (9 species or 60 %), salmonids include 3 species or 20 %, other families are represented by one species.

Table 1. Distribution of alien fish species in different reaches of the Irtysh river flow

Family, species	Upstream[1]	Middle course [2*]	Lower reaches[3]
Family Surpinidae Bonaparte, Carpidae			
Ctenopharyngodon idella Valenciennes, 1844 / White Cupid	+	+	–
Hypophthalmichthys molitrix Valenciennes, 1844 / White-finned fathead minnows	+	+	+
Hypophthalmichthys nobilis Richardson, 1845 / Speckled fathead minnow	+	–	–
Carassius auratus Linnaeus, 1758 / Chinese Carp	+	?	–
Cyprinus carpio Linnaeus, 1758 / Carp (carp)	+	+	+
Abramis brama Linnaeus, 1758 / Bream	+	+	+
Leucaspius delineatus, Heckel, 1843) Common Verkhovka		+	+
Pseudorasbora parva Temminck & Schlegel, 1846 / Amur tadpole	+	?	+
Alburnus alburnus alburnus alburnus Linnaeus, 1758 / Walleye	+	+	–
Family Salmonidae G. Cuvier, Salmonids			
Coregonus ladogae Pravdin, Golubev & Belyaeva, 1938 / Core*gonus* ladogae Pravdin, Golubev & Belyaeva, 1938 / Ladoga Ripus	+	–	–
Coregonus peled Gmelin, 1789 / Peljat	+	?	+
Oncorhynchus mykiss Walbaum, 1792 / Rainbow trout	+	–	–
Family Percidae Cuvier, Percidaceae			
Sander lucioperca Linnaeus, 1758 / Sudak	+	+	+
Family Gobiidae Bullfishes			
Proterorhinus marmoratus Smitt, 1900/ Bullhead tzatziki	–	–	+
Family (Eleotrididae) Cephalopods			
Perccottus glenii Dybowski / Cephalopod mole 1877)	–	+	+

Note: [1] – [2];[2] – our data;[3] – [3]; * – territory of Pavlodar region; ? – the species has not been found in recent years.

Only three species have acclimatized and entered the fishery in the Middle Irtysh basin: bream, carp and pikeperch. The bream has the highest abundance and wide distribution in this section of the Irtysh (Table 2). Its share in catches ranges from 15.7 to 27.7%. The share of carp varies by years from 0.2 to 1.5%, pikeperch – from 0.8 to 1.3 %. There is a tendency for the share of bream in catches to decrease over the years and a slight increase for carp.

Acclimatizants are found in all sections of the Irtysh, but their specific confinement to a certain ecotope in the Irtysh ecosystem was revealed during the research. Thus, the highest number of bream caught was registered in the river backwaters and less in the channels, carp in the channels and lakes, and pikeperch in the channels (Table 3).

Bream. This species has been known in the Middle Irtysh basin since the 30s of the last century. In Lake Zaisan, in Bukhtarma and Ust-Kamenogorsk reservoirs bream was introduced in 1959–1964. In Bukhtarma reservoir bream is spread throughout its water area and in all biotopes. In the reservoirs of the Irtysh basin it is one of the highly abundant fish species. At present, the Bukhtarma Reservoir is a "bream" reservoir, as bream make up 80–85% of the fish population. In the Shulba reservoir and Ust-Kamenogorsk reservoirs bream has also become a dominant species (at the level of 30–40% of the total fish production) [2]. In the Irtysh River within the Omsk region, acclimatizants appeared in the fishery statistics since the 60s, and at present their share in catches is also quite high and amounts to about 27%. [4, 5].

In the Middle Irtysh in Pavlodar region, bream of both sexes aged 2+ to 8+ years were encountered in catches. It had an average body length of 21 cm (11.0–33.0) and an average body weight of 223 g (25–750) (Table 4). Comparative analysis of linear growth (Table 5) showed that bream from the Middle Irtysh River was inferior to bream from many water bodies in terms of growth rate, which is most likely due to both the high abundance of the species and the influence of anthropogenic factor.

Table 2. Share of invasive fish species in total catch from the Irtysh River, %

Type of fish	Years								
	2014	2016	2017	2018	2019	2020	2021	2022	2023
bream	27.7	23.4	17.4	20.2	21.3	21.2	18.8	16.3	15.7
Carp	0.5	0.3	0.2	0.7	0.8	1.5	0.8	0.8	0.9
Sudak	1.3	0.9	0.8	1.0	1.1	1.3	1.3	0.9	1.1

Table 3. Share of fish species in commercial catches in the Irtysh channels, backwaters and lakes

Type of fish	Share of fish, %		
	ducts	backwaters	lakes
bream	18.5	47.9	24.7
Carp	6.6	2.2	5.7
Sudak	5.8	3.1	1.3

Table 4. Linear and weight growth of bream in the Irtysh River (Pavlodar region) (n=45)

Parameters		Age, years								
		2+	3+	4+	5+	6+	7+	8+	9+	10+
length, cm	average	11.5	14.2	17.6	20.3	23.3	26.8	30.5	–	32.3
	limits	11.0–12.0	13.0–15.3	16.0–18.5	18.5–21.0	22.0–24.0	25.0–29.0	30.0–31.1	–	31.5–33.0
weight, g	average	32	64	122	180	264	423	628	–	733
	limits	25–40	45–79	95–140	147–205	226–305	320–535	610–645	–	715–750
n		4	8	9	8	6	5	3	–	2

Table 5. Linear growth of bream in different water bodies (based on observations)

Water body	Age, years										Author
	1+	2+	3+	4+	5+	6+	7+	8+	9+	10+	
Irtysh River RK	–	11.5	14.2	17.6	20.3	23.3	26.8	30.5	–	32.3	our data
Balkhash Lake	7.9	13.5	19.1	21.6	23.0	25.1	27.0	–	–	–	[6]
Kapchagai reservoir	–	–	18.0	24.5	26.8	28.9	29.9	-	–	–	[6]
Ili River	7.7	11.1	15.6	20.1	21.6	–	–	–	–	–	[6]
Ural River	8.9	13.8	20.5	23.9	27.3	30.2	33.4	–	–	–	[6]
Bukhtarma reservoir	9.6	16.2	19.0	23.6	27.1	29.1	32.4	37.3	39.9	–	[6]
Irtysh-Karaganda Canal	12.0	20.5	24.9	30.5	36.0	–	–	–	–	–	[6]
Yesil River	12.3	14.8	17.1	19.5	22.9	26.8	29.1	29.5	–	–	[7]

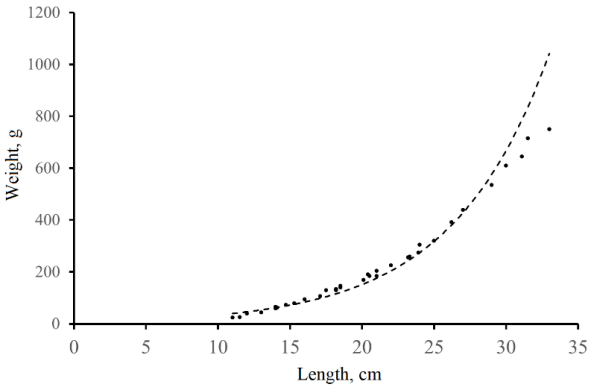

Figure 1. Relationship between bream mass and body length $(y = 7.7736e)^{0,1484x}$

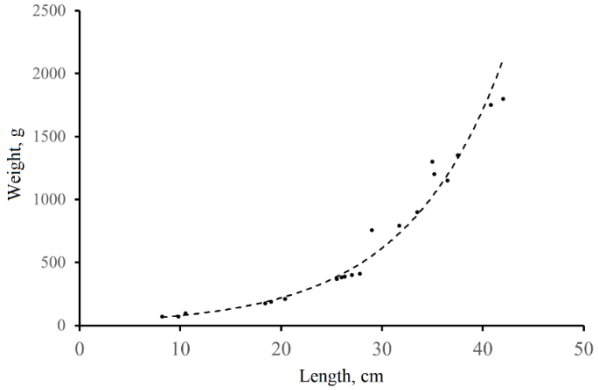

Figure 2. Relationship of carp body mass and length $(y = 27.999e)^{0,1029x}$

The curve reflecting the relationship between bream mass and body length is shown in Fig. 1. The scatter of points in each range of body length is small, which allowed us to testify to the determinism of these indicators. A statistical regression line with the equation: $y = 7.7736e^{0,1484x}$ was obtained. This equation can be used for modeling the process of bream mass accumulation, searching for missing calculated indicators.

Carp (carp). Carp settlement in the basin occurred after the introduction of carp into Lake Zaisan and reservoirs in the 1930s, self-dispersal of carp from pond farms and cage farms (including purebred lines of German, Cherepetsk, Kazakh and Sarboyan carp). Fishery statistics began to register carp in the Middle Irtysh basin in the mid-70s (in 1976 – 0.5 tons). It has not yet been recorded in the 1978 control catches. At present, despite numerous measures on stocking of the Irtysh, it occupies only from 0.2 to 1.5% in commercial catches (Table 2). In catches of the Irtysh, downstream (Omsk region), this species is not taken into account, which does not allow to analyze the course of the naturalization process of this species in the region [4].

Due to the fact that only different breeds of carp were released into the reservoirs of the Middle Irtysh and only carp individuals were encountered in the control and commercial ones, we further describe the characteristics of carp rather than carp.

In catches from the Irtysh River (Pavlodar region**),** carps of both sexes aged 1+ to 6+ years were encountered. They had an average body length of 27.0 (8.2–42.0) cm and an average body mass of 688 (69–1800) g (Table 6). Comparative analysis of linear growth (Table 7) showed that carp from the Middle Irtysh were inferior to carp from water bodies of the south of Western Siberia (territory of the Russian Federation), but not inferior in growth to carp from water bodies of central and southern regions of Kazakhstan (Table 7).

The curve showing the relationship between carp mass and body length is shown in Fig. 2. The spread of points in each range of body length is small, which allowed us to obtain the regression line in the form: $y = 27.999e^{0,1029x}$). This equation can be used for modeling the process of carp mass accumulation, searching for missing calculation indicators.

Table 6. Linear and weight growth of carp in the Irtysh River (Pavlodar Oblast)

Parameters		Age, years					
		1+	2+	3+	4+	5+	6+
length, cm	average	9.0	17.1	26.5	31.4	36.1	41.4
	limits	8.2–9.8	10.5–20.4	25.5–27.0	29.0–33.5	35.0–37.5	40.8–42.0
weight, g	average	70	167	390	815	1250	1775
	limits	69–71	96–211	370–410	755–900	1150–1350	1750–1800
n		2	4	5	3	4	2

Table 7. Linear growth of carp in different water bodies (based on observations)

Water body	Age, years						Author
	1+	2+	3+	4+	5+	6+	
Irtysh River RK	9.0	17.1	26.5	31.4	36.1	41.4	our data
Ob River	–	–	34.4	39.3	44.5	49.5	[8]
Burlin Lakes	–	–	35.4	38.2	42.3	44.0	[8]
Chardara reservoir	13.4	19.8	26.6	32.3	36.0	40.1	[9]
Alakol Lake	12.2	23.5	25.4	27.3	29.7	33.7	[9]

Table 8. Linear and weight growth of pikeperch in the Irtysh River (Pavlodar region)

Parameters		Age, years					
		1+	2+	3+	4+	5+	6+
length, cm	average	19.0	20.4	28.8	40.4	44.6	46.3
	limits	17.0–21.1	18.2–23.0	26.1–31.0	38.2–42.1	39.9–51.0	–
weight, g	average	84	93	260	866	1399	1422
	limits	85–88	90–95	215–390	830–910	1002–1600	–
n		3	4	6	4	3	1

Table 9. Linear growth of pikeperch in different water bodies (based on observation data)

Water body	Age, years									Author
	1+	2+	3+	4+	5+	6+	7+	8+	9+	
Irtysh River RK	19.0	20.4	28.8	40.4	44.6	46.3	–	–	–	our data
Bukhtarma reservoir	13.2	22.8	32.2	41.6	51.8	58.9	64.9	68.5	–	[9]
Ural River	19.8	27.9	35.4	41.5	47.9	–	57.3	–	–	[9]
Kapchagai reservoir	16.0	23.5	36.8	40.5	48.0	58.3	59.7	63.7	70.3	[9]
Middle Irtysh RF	–	31.5	35.6	40.5	42.6	44.0	–	–	–	[10]

Pikeperch. Acclimatization in the Irtysh basin began in 1958, when about 1300 specimens of pikeperch from the lower reaches of the Syr Darya were released into the Ust-Kamenogorsk reservoir. In Bukhtarma reservoir from 1959 to 1966 more than 16 thousand specimens were released, mainly from the lower reaches of the Ural, but also from Lake Biylikol (about 4 thousand specimens) and from the Aral Sea. Already in the first years after the introduction of pikeperch from reservoirs and its spreading down the Irtysh was noted. [2]. This species in the region is noted in the statistics of fishing since 1978, the average catch in the Irtysh River is 2.4 tons (11.1% of the total catch) [4]. In the Omsk region, the first specimens were caught in the Irtysh River in 1962, where it is still found in its tributaries and floodplain reservoirs [5].

In catches from the Irtysh River (Pavlodar region**),** pikeperch of both sexes aged 1+ to 6+ years were encountered. They had an average body length of 31.4 cm and an average body mass of 544 g (Table 8). Comparative analysis of linear growth (Table 9) showed that pikeperch from the Middle Irtysh are not inferior to those from other water bodies of Kazakhstan and the Russian Federation.

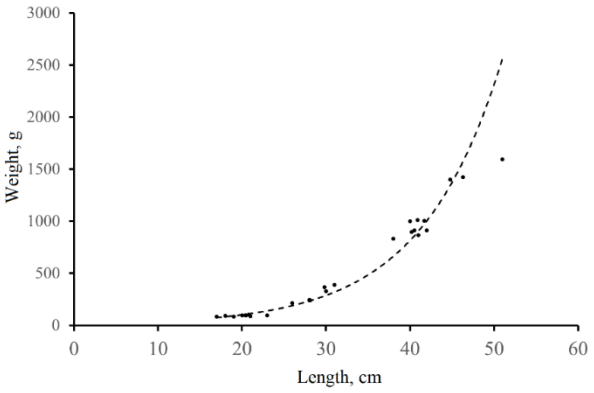

Figure 3. Relationship between pikeperch mass and body length (y = 12.589e)^{0,1043x}

The curve showing the relationship between the mass and body length of pikeperch is shown in Fig. 3. The scatter of points in each body length range is small, which allowed us to testify to a close correlation between these indices. Pikeperch growth is close to isometric and is described by the equation $y = 12.589e^{0,1043x}$. This equation can be used for modeling the process of bream mass accumulation, searching for missing calculation indices.

As we have already noted earlier [11], of particular concern is the introduction of Russian sturgeon into the Irtysh River from the cage warm-water farm of the Aksuk SDPP located in the Stary Irtysh channel. As a result of non-compliance with the technological process and poor organization of work during 2011–2013, a large number of young sturgeon of different ages (larvae, seven-year olds, two-year olds) were released from the hatchery and cage farm into the Irtysh River. Considering the age of maturation of the Russian sturgeon is 8–10 years, spawning of this alien species on spawning grounds, the original breeding grounds of the Siberian sturgeon, is possible already at the end of the second decade. There is a high probability of the appearance of hybrids of these two species and the emergence of an ecological catastrophe.

Fish of the Amur complex: white amur, white and mottled fathead minnows. Since 2000, the stocking of juvenile white amur in Lake Zaisan and the Bukhtarma reservoir has been repeatedly carried out. Stocking with juvenile white carp was carried out as early as in the 80s of the last century. After their introduction into these reservoirs, apparently, some individuals have penetrated into the reservoirs of the middle part of the river, where they are occasionally caught by amateur fishermen. Periodically, the spring passage of white thickhead along the main channel of the Irtysh is registered. Despite stocking for several years, natural reproduction of these species has not been noted [2]. In the Irtysh River within the Omsk region there are also single cases of white amur capture [4].

Chinese crucian carp. In the basin of the upper Irtysh is a commercial species, an object of recreational fishing [2]. Finding of Chinese crucian carp as an independent species in water bodies of Pavlodar Priirtyshye has not been registered yet. Probably, it lives in water bodies of the basin together with other indigenous species of crucian carp. It is necessary to conduct scientific research using special methods of morphometric features and molecular-genetic analysis.

Common Verkhovka. In the reservoirs of the Middle Irtysh both on the Kazakhstan territory and downstream, it has mastered the niche of phyto- and zooplanktophage of shallow littoral of the river channel part of the river and its tributaries, as well as of the floodplain. It is a trophic competitor of juveniles of native species and at the same time a food object of predatory fish [5].

Amur tetter. It is a non-numerous alien species in the Irtysh basin, which arrived together with planting material of carp and white amur [2]. Since Chebachek is registered both in the upper and lower reaches of the Irtysh, it is highly probable that it inhabits the waters of the Middle Irtysh as well. It is considered to be a weedy species, competes in feeding with commercial fish, eats fish eggs and larvae.

Ukleya. Widely distributed in the Irtysh River of the Kazakh territory since the beginning of the present century. Its numbers are increasing and with simultaneous expansion of habitats. This is facilitated by the presence in the Irtysh basin of numerous areas of well-warmed littorals with zooplanktonic organisms. The eel itself is an available food for both native predators (pike, perch) and alien predators (pikeperch). Object of recreational fishing. In the Irtysh River within the Omsk Oblast there is also an increase in the number of this species [4].

Ripus ladoga and pelad. Population of whitefish (eggs and larvae) in water bodies of the upper Irtysh resulted in formation of commercial herd of ripus and small herd of pelada. In recent years, there is no information on the occurrence of these species in the Kazakh territory of the Middle Irtysh. However, in the Irtysh of the Omsk region pelada are found in small numbers [5].

Rainbow trout. In the Upper Irtysh basin, stocking with yearlings (10 thousand rainbow trout) was carried out, but this species was not acclimatized [2]. This species was not found in the Middle Irtysh basin.

Headed mole-rotan. In the basin of the Middle Irtysh of the Kazakhstani territory began to be observed in recent years and immediately attracted the attention of both amateur fishermen and ecologists. This species is very ecologically plastic. As an overgrown benthic form, has a higher number and biomass on characteristic biotopes. By type of feeding rotan and predator and benthophagous among thickets of macrophytes. The presence of roten reduces the abundance of roach and spruce grouse, as it competes strongly with them for food resources. The greatest danger is the eating of eggs of other species breeding in coastal shallows by roten. A negative correlation was found between the presence of rotans in water bodies and the diversity of invertebrate species – potential predators for amphibians ($r = -0.552$). In water bodies inhabited by rotan, adult beetles of the family Dytiscidae and their larvae were absent or rare. Dytiscidae and their larvae, beetles Hydrous sp., larvae of dragonflies *Aeschna cyanea, Somatochlora aenea and* Erythromma *viridulum*, spiders Dolomedes sp., leeches *Haemopis sanguisugaii*[12]. To some extent, the "pressure" of rotan on the level of reproduction of dragonflies can negatively affect the results of measures to suppress the number of bites.

In November 2013, fishermen caught one fish specimen in the Irtysh River in Pavlodar region, which was identified as Colossoma macropomum (Cuvier, 1818) – brown pacu. The caught fish had a body length of 29 cm and a weight of 2.2 kg.

Amateur fishermen gave us a skull of a fish caught in the Irtysh, which belonged to the Amur catfish (*Parasilurus asotus* (Linnaeus, 1758).

CONCLUSION

The species composition of alien species inhabiting the upper, middle and lower reaches of the Irtysh River is summarized using literature data. In the basin of the Middle Irtysh, in the territory of the conducted research, 15 invasive fish species belonging to 5 families and 13 genera are currently registered. The largest number of species belong to the carp family (9 species or 60%), salmonids include 3 species or 20%, other families are represented by one species. Only three species have acclimatized and entered the fishery in the Middle Irtysh basin: bream, carp (carp) and pikeperch. The share in commercial catches is from 15.7 to 27.7% for bream, from 0.2 to 1.5% for carp, and from 0.8 to 1.3% for pikeperch.

In general, the results of the studies suggest that some invasive species, acclimatized in the Irtysh River, will develop new water bodies, including those outside the Zaisan-Irtysh basin, in particular along the channel named after K.K. Gubkin. K. Satpayev channel.

According to the Fishery Rules, measures on introduction (introduction) and acclimatization of new species can be carried out only in accordance with approved biological justifications. Illegal introduction, even with good intentions, is criminal. Hundreds of water bodies in the Irtysh basin have been and are subjected to various kinds of fish transplants. The composition of the transplants is diverse and depends on imagination and possibilities of the transporter. But, as a rule, they are perch, crucian carp, carp and pike. Spontaneous introductions sometimes lead to a complete restructuring of the biocenosis as a result of introduction of a predator or food competitor, transfer of dangerous parasites or diseases. Most often, after a small "acclimatization effect" (increase in catches and growth rate of the alien) the water body not ready for the "alien onslaught" becomes impoverished and unattractive for fishermen and unpromising for commercial fish farming.

Given that the problem of alien fish species is a serious ecological problem, solving it requires a comprehensive approach that includes research, monitoring, management and education programs.

The first step should be to conduct thorough monitoring and research to determine the prevalence of invasive fish species in a particular region. This will help to understand the extent of the problem and to select the most effective control methods.

Regular monitoring of invasive species populations using a variety of methods including trawl surveys, photofixation, and molecular identification.

Conduct aquatic-bio-ecological studies to examine the behavior, feeding, and reproductive strategies of invasive species, which can help develop more targeted control measures.

Once enough information has been gathered on the distribution and impact of invasive species, population management plans can be developed and implemented.

The use of natural enemies or diseases to control populations of invasive species. For example, introducing specialized parasites or viruses that will not harm the environment or other species.

Catch fish using special licenses and restrictions on their sale or disposal. This may be a temporary solution but requires continuous monitoring.

Develop and adopt laws and regulations to prevent further introduction of invasive species and regulate their populations.

An important aspect of addressing invasive species is educating the public about the risks associated with these species and how to control them.

Develop and conduct educational programs for schools, universities, and the general public to raise awareness of the invasive species problem and the importance of addressing it.

Include local communities in the problem-solving process by providing them with the tools and knowledge to participate in monitoring and managing invasive species populations.

Develop predictive models to assess the potential spread of invasive species and the effectiveness of applicable management measures.

Continually adapting management strategies in response to changes in invasive species populations and new challenges.

Addressing the problem of invasive fish species is a long-term process that requires coordinated efforts between the scientific community, governments and the public. The key is to realize that successful solutions to this problem can only be achieved through an integrated approach that combines scientific research, legislative measures and active public participation.

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ОРТА ЕРТІС БАССЕЙНІНІҢ ИНВАЗИЯЛЫҚ ИХТИОФАУНАСЫНЫҢ ҚАЛЫПТАСУЫНЫҢ ҚАЗІРГІ ЖАҒДАЙЫ МЕН ПРОБЛЕМАЛАРЫ ТУРАЛЫ МӘСЕЛЕГЕ

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Мақалада Павлодар облысы аумағындағы Орта Ертіс бассейнінің инвазиялық ихтиофаунасының биологиясы мен экологиясы бойынша жаңа деректер келтірілген. Әдеби деректерді пайдалана отырып, Ертіс өзенінің жоғарғы, орта және төменгі ағысында мекендейтін бөтен түрлердің түрлік құрамы жинақталған. Орта Ертіс бассейнінде қазіргі уақытта 5 тұқымдасқа және 13 ұрпаққа жататын 15 инвазиялық балық түрі тіркелген. Түрлердің ең көп саны тұқы тұқымдасына жатады (9 түр немесе 60%), албырттар тұқымдасы 3 түрден немесе 20% - дан тұрады, қалған тұқымдастар бір түрден тұрады. Орта Ертіс бассейнінде тек үш түр ғана бейімделді және балық кәсіпшілігіне кірді: табан балық, сазан (тұқы) және көксерке. Балық аулау кәсіпшілігіндегі табан балықтың үлесі 15,7-ден 27,7 % - ға дейін., тұқының үлесі 0,2-ден 1,5 % - ға дейін, көксеркенікі 0,8-ден 1,3 % - ға дейін. Ұсталған табан балықтардың ең көп саны бөгеулерде тіркелген, тұқылар тармақтар мен көлдерде, көксерке Ертістің тармақтарында тіркелген. Регрессиялық талдау нәтижелері бар осы үш балық түрінің өсу қарқыны бойынша мәліметтер келтірілген. Балықтың тағы 11 түрін енгізу нәтижелері бойынша қысқаша мәліметтер келтірілген. Стихиялық қоныстандырулар кейде жыртқыштың немесе азықтық бәсекелесінің интродукциясы нәтижесінде биоценоздың толық қайта құрылуына, қауіпті паразиттерге немесе ауруларға ұшырауға әкеледі деген қорытынды жасалды. Көбінесе, аздаған «акклиматизация әсерінен» кейін, жерсіндірілген түр қысымына дайын емес су қоймасы кедейленіп, балықшылар үшін тартымсыз және тауарлық балық өсіру үшін келешексіз болады. Ертіс өзеніне бейімделген жекелеген инвазиялық түрлердің жаңа су қоймаларын, соның ішінде Зайсан-Ертіс бассейнінен тыс жерлерді игеру ықтималдығы жоғары. Бөтен балық түрлерінің проблемасы маңызды экологиялық проблема екенін ескере отырып, оны шешу ғылыми зерттеулерді, мониторингті, басқаруды және білім беру бағдарламаларын қамтитын кешенді тәсілді қажет етеді

Түйінді сөздер: *Ертіс өзені, ихтиофауна, инвазия, балықты енгізу, биопродуктивтілік.*

К ВОПРОСУ О СОВРЕМЕННОМ СОСТОЯНИИ И ПРОБЛЕМАХ ФОРМИРОВАНИЯ ИНВАЗИОННОЙ ИХТИОФАУНЫ БАССЕЙНА СРЕДНЕГО ИРТЫША

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В статье приведены новые данные по биологии и экологии инвазионной ихтиофауны бассейна Среднего Иртыша на территории Павлодарской области. С использованием литературных данных обобщен видовой состав чужеродных видов, обитающих в верхнем, среднем и нижнем течении реки Иртыш. В бассейне Среднего Иртыша, в настоящее время зарегистрировано 15 инвазионных видов рыб, относящихся к 5 семействам и 13 родам. Наибольшее число видов относятся к семейству карповых (9 видов или 60%), лососевые включают 3 вида или 20%, остальные семейства представлены одним видом. В бассейне Среднего Иртыша акклиматизировались и вошли в промысел только три вида: лещ, сазан (карп) и судак. Доля в промысловых уловах составляет у леща 15,7 до 27,7%., у карпа от 0,2 до 1,5%, судака от 0,8 до 1,3%. Наибольшее число пойманных особей леща зарегистрировано в затонах, карпа в протоках и озерах, судака в протоках Иртыша. Приведены данные по темпу роста этих трех видов рыб с результатами регрессионного анализа. Кратко приведены сведения по результатам интродукции ещё 11 видов рыб. Сделан вывод, что стихийные вселения приводят иногда к полной перестройке биоценоза в результате интродукции хищника или пищевого конкурента, перенесению опасных паразитов или болезней. Чаще всего, после небольшого «эффекта акклиматизации» водоем, не готовый к прессу интродуцента, обедняется и становится малопривлекательным для рыболовов и неперспективным для товарного рыбоводства. Учитывая, что проблема чужеродных видов рыб является серьезной экологической проблемой, решение её требует комплексного подхода, включающего научные исследования, мониторинг, управление и образовательные программы

Ключевые слова: *река Иртыш, ихтиофауна, инвазия, интродукция рыб, биопродуктивность.*