Characteristics of the ecological danger of illegal poaching fish catches in the lower reaches of the Irtysh river

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Abstract. Poaching of aquatic biological resources is one of the most common environmental crimes, causing direct and indirect harm to the entire amount of fish stocks. It is necessary to have a clear understanding of the composition and quality of poacher's catches in order to properly manage fish stocks. This paper examines the poaching catches of the lower reaches of the Irtysh River, based on the data of forensic ichthyologic examinations over the past 9 years. The study showed that the basis of poaching catches is Siberian sturgeon, sterlet, ide, carpbream, nelma, burbot, less in demand, gibel carp, crucian carp, common roach, zander, perch, pike. Poachers harvest Siberian sturgeon, burbot, sterlet, gibel carp, nelma and pike of all sizes, not giving preference only to large or small ones. From 2013 to 2019, sturgeons dominated the catches, but since 2020, the share of cyprinids has increased significantly. An analysis of the fatness of fish in poacher catches shows that poachers try to seize healthy and well-fed representatives of all fish species, except for the Siberian sturgeon, which is harvested regardless of condition.

1 Introduction

A poacher's catch is a collection of fish obtained in violation of accepted fishing rules and using prohibited fishing gear. Illegal fishing can be carried out by workers in the fishing industry, amateur fishermen, as well as poachers, whose main income is poaching. Poaching causes direct harm to the ecosystem of aquatic biological resources, increasing the intensity of exploitation of fish stocks [1]. Illegal fishing leads to overfishing, which in turn leads to a violation of natural self-reproduction and, as a result, to a reduction in fish stocks [2]. Also, as a result of poaching activities, the composition of the ichthyofauna changes, valuable fish species are replaced by low-value ones [1]. Particular attention is paid to illegal fishing during the spawning season. This activity causes additional harm, reduces the number of spawning herds. Firstly, this leads to a shift in the sex ratio in favor of males (often only females are caught during the spawning period in order to obtain caviar), and secondly, it reduces activity on spawning grounds, which, as a result, become silted up and overgrown [3].

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Representatives of the sturgeon (Acipenseridae), burbot (Lotidae), carp (Cyprinidae), perch (Percidae), whitefish (Coregonidae), and pike (Esocidae) families form the basis of the ichthyofauna of the Lower Irtysh River [4]. The same representatives are objects of illegal fishing [5-9]. The sturgeon family is represented by Siberian sturgeon (*Acipenser baerii* Brand, 1869) and sterlet (*Acipenser ruthenus* Linnaeus, 1758). Illegal fishing of Siberian sturgeon, together with hydro construction, has had a negative impact on the population since the 1980s and continues to the present. Sterlet stocks vary widely, but numbers are low everywhere due to poaching pressure [10]. The number of cases of poaching Siberian sturgeon and sterlet in the water area of the Irtysh river has been gradually increasing over the past 7 years [11].

In order to understand the extent of damage caused by poaching, it is important to know the composition, nature and extent of catches taken from illegal fishing. For competent management of fish stocks, it is necessary to understand what part of the fish population is taken by poachers and is not taken into account when monitoring the state of fish stocks [12]. The purpose of this work is to characterize the composition of poaching fish catches in the lower reaches of the Irtysh River.

2 Materials and methods

The work was performed on the basis of data obtained during the forensic ichthyologic examinations by the staff of TCSS UB RAS in the period from 2013 to 2021. Examinations were carried out on fish caught in the waters of the Lower Irtysh River, on the territory of the Russian Federation, the South of the Tyumen Region and Khanty-Mansi Autonomous Okrug-Yugra. Biological analysis was carried out according to the generally accepted method of Pravdin I.F. [13]. According to the same method, the fatness coefficient according to Fulton was calculated. Statistical data processing was carried out using the STATISTICA 12 software using basic descriptive statistics [14]. Graphic drawings prepared in Microsoft Excel 2016.

3 Results and discussion

For 9 years, as a result of the actions of poachers in the water area of the lower reaches of the Irtysh River, 2147 specimens of fish of various species and sizes have been irretrievably seized. The biomass of fish caught was 1055 tons for the entire study period. Consequently, the daily poaching of fish is more than 300 kg/day. This is a large value for an area of this size, given that the recommended daily catch of all users of aquatic biological resources in the West Siberian fishery basin in 2018 was 24 tons [15]. It turns out that in the lower reaches of the Irtysh River, more than 1% of the daily catch of all Western Siberia is withdrawn per day. It is important to understand that we only count recorded cases of illegal fishing. The actual catches may be larger.

Linear and weight body parameters and species affiliation of the fish seized by poachers are presented in Table 1.

Table 1. Linear and weight body parameters of the fish caught by poachers.

Fish species	Valid N	Parametr[a]	Mean±Std.Dev	min-max	Cv,%
Siberian sturgeon	214	l, cm	49.6±22	13.5-149	44
		m, g	1170±2560	16-19250	219
Sterlet	1406	l, cm	34.4±6.2	9.2-61.5	18
		m, g	199.3±147.2	5-1814	74
Ide	227	l, cm	41.8±3.2	26-48.6	8
		m, g	950.2±192.3	214-1504	20

Carpbream	145	l, cm	39±5	29-50.4	13
		m, g	807.9±370.3	274-1754	46
Gibel carp	34	l, cm	33.9±3.6	25.5-41.5	11
		m, g	760.4±249	214-1297	33
Crucian carp	5	l, cm	24.5±3	20-27.2	12
		m, g	310±110.7	138-420	36
Common roach	2	l, cm	20.7±5.2	17-24	25
		m, g	120±99	50-190	82
Nelma	56	l, cm	52.5±9	31.5-80	17
		m, g	1642±920	290-5064	56
Burbot	30	l, cm	45.8±16.6	22-81.5	36
		m, g	1112±1229	64-5846	110
Zander	6	l, cm	50.8±3.8	44-54.5	7
		m, g	1389.7±305.5	888-1704	22
Perch	9	l, cm	32.9±1.2	31.2-34.5	4
		m, g	564.2±116.4	406-688	21
Pike	13	l, cm	63.2±10.5	41-81	17
		m, g	1990.9±1072.7	470-4560	54
[a)] l – body length, m – body mass, values are significant at $p \leq 0.05$					

When analyzing these data, it is noted that poaching, for a number of fish species, exerts pressure not on a separate size group, but on the entire population at once. According to Lakin G.F. groups of organisms with a coefficient of variation (Cv) of more than 25% have a strong variability of the trait, and with a strong asymmetry in the distribution of the trait, the Cv can reach and exceed 100% [16]. The biggest shift in poaching preferences is observed for the Siberian sturgeon and burbot (*Lota lota,* Linnaeus, 1758), the bulk of the catches are only very small or extremely large fish. The catch of only small and large Siberian sturgeons can be explained. Small individuals are used for falsification in the sale, they are issued as sterlet [17], and large individuals are used mainly for obtaining black caviar, which is of great value [18]. The distribution of linear and weight body parameters of sterlet, carpbream (*Abramis brama,* Linnaeus, 1758), gibel carp (*Carassius auratus,* Linnaeus, 1758), nelma (*Stenodus leucichthys nelma*, Guldenstadt, 1772) and pike (*Esox lucius,* Linnaeus, 1758) testifies to the removal of all size groups by poachers. Common roach (*Rutilus rutilus*, Linnaeus, 1758), zander (*Stizostedion lucioperca*, Linnaeus, 1758), ide (*Leuciscus idus*, Linnaeus, 1758), crucian carp (*Carassius carasius*, Linnaeus, 1758), and perch (*Perca fluviatilis*, Linnaeus, 1758) do not have high variation values, which indicates that poachers are not interested in representatives that are not included in the size groups from table 1.

Over the entire period of the study, the main part of the catches were representatives of the sturgeon family with a share of 75% (Figure 1). Cyprinids account for 19% of the total, 3% for whitefish, and 1% each for burbot, perch, and pike. In all years, except for 2020 and 2021, the share of sturgeons in poacher's catches is dominant and ranges from 88-99%. At the same time, the share of sterlet relative to the share of Siberian sturgeon in all cases, except for 2014 (sterlet is 64%), 2017 (sterlet is 35%) and 2018 (sterlet is 46%) is extremely high and varies within 77-98%. In 2020, there is a sharp change in the proportion of fish in catches. The leading place in terms of share in poacher's catches is occupied by cyprinids (75%), mainly ide with a share of 66% of all cyprinids. For the first time, cyprinids were observed in catches in 2017, but their share was low - 5-7%. In 2021, their share of the total catch is not so large, but a significant 25%. The reasons for the appearance of significant volumes of cyprinids in poacher's catches can be different. In the rivers of Western Siberia, in general, there is an increase in the number of low-value fish species, including cyprinids, while an observed decrease in the number of more valuable fish species [8]. It was noted that in the last decade in the Astrakhan region, against the background of a noticeable decrease in

sturgeon catches, poachers interest has increased in such fish species as zander, carp, catfish, pike, vobla, etc. [19]. Probably, now this trend is also true for the lower reaches of the Irtysh River.

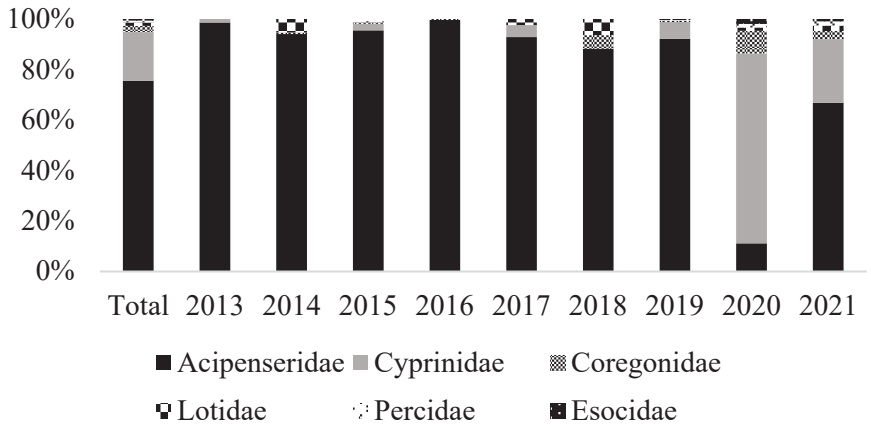

Fig. 1. shares of fish in poacherr's catches by years and in total.

As it was noted earlier, the poaching catch of mature fish during the spawning period is subject to separate consideration. When analyzing the most common fish species in poacher's catches, the following situation developed (Figure 2) A significant proportion of all representatives of the Siberian sturgeon over the entire period of the study were immature individuals (86%). The share of sexually mature Siberian sturgeons accounted for 14%, of which only 4% of the total mass was caught during the spawning period. Siberian sturgeon spawns in the spring-summer period with a body length of 70 to 120 cm [20-22]. In the Astrakhan region, it is noted that most of the poaching takes place in the spring season, during the mass spawning run [19]. At the same time, in the Amur region, sturgeons are caught in significant quantities in winter [18]. In our case, no such trend is observed with respect to the Siberian sturgeon. In turn, sterlet spawns in spring at a body length of 30 cm [23]. The share of such individuals in our study was 79%, 9% were caught during the spawning, and 21% fell on immature individuals. This situation is partly inconsistent with the view that the rivers of Siberia are dominated by juvenile sterlet [10], but according to our data in table 1, the mature sterlet would spawn for the first time if it had not been caught. With regard to the ide, which spawns at the same time as the sterlet, upon reaching the same length [20, 23, 24] the situation is opposite. The proportion of mature ides in poaching catches was 98%, 88% were caught during the spawning period. Representatives of a related species of ide, carpbream, are represented in poacher's catches in a similar way. Sexually mature individuals of carpbream accounted for 100% of poacher's catches. Of these, 72% were caught during the spawning period. Other species presented in our work, but absent in Figure 2, did not differ in diversity. All individuals of crucian carp and gibel carp in poacher's catches were sexually mature and were caught in the spring-summer period of their spawning [23, 24]. Also, almost all individuals of nelma were sexually mature, and in the autumn period, the spawning period [23], only 8 specimens were caught. Burbot during the spawning period is not caught by poachers, as well as perch and zander. Pike, represented exclusively by sexually mature individuals, was also not caught by poachers during the spawning period.

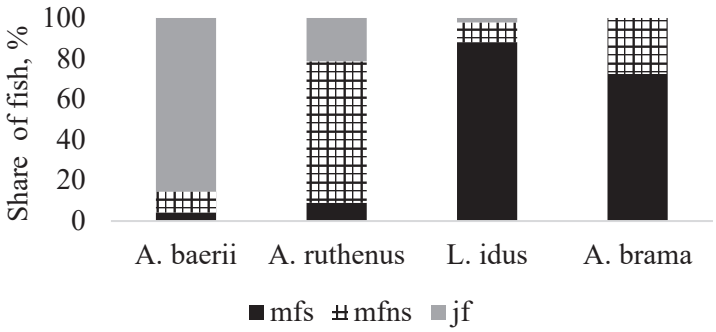

Fig. 2. share of fish caught by poachers during spawning and non-spawning periods mfs - share of mature fish caught during spawning season, mfns - share of mature fish caught during non-spawning season, jf – juvenile fish.

To assess the physical condition of the fish, we determined the fatness coefficient according to Fulton for mass fish species. The result is presented in table 2. The fatness of fish in poacher's catches does not tend to decrease or increase. The average fatness values of the Siberian sturgeon fluctuate in the range of 0.45-0.61. Such values correspond to normal values for Siberian sturgeon underyearlings 0.40-0.60 [25, 26]. This is consistent with the predominance of immature individuals in poaching catches shown in Figure 2. It should be noted that the fatness of large specimens of the Siberian sturgeon (0.96-2.14) corresponds to and even prevails over sturgeons from other water areas [27, 28]. At the same time, the minimum fatness values of representatives of the Siberian sturgeon rarely exceed 0.40, which is typical for individuals affected by diseases or malnutrition [29]. Average fatness values of sterlet in poacher's catches fluctuated within 0.38-0.62. These values are in good agreement with the values obtained for fish from nurseries or reared in recirculating aquaculture system [28- 32]. The average fatness values of the ide are observed in the range of 1.26-2.74, which is quite consistent with normal, pre-spawning ones [33, 34]. The fatness of the carpbream on average (1.22-1.56) is within the normal limits of variability (1.05-3.57) [33, 35], but at the lower limit. This may be due to the preferences of poachers, as on the Tobol River (included in the Irtysh basin), the average fatness values are 2.13 [35]. The fatness of nelma (0.95-1.17) is not out of the normal range for 1–2-year-old ones.

Table 2. fatness coefficient values according to Fulton of mass fish species in poacher's catches.

Fish species	Siberian sturgeon	Sterlet	Ide	Carpbream	Nelma
2013	0.52±0.22[a]	0.44±0.09	1.53±0.08	-	-
	0.38-1.14	0.29-1.13	1.48-1.63	-	-
2014	0.45±0.12	0.41±0.12	-	-	-
	0.30-1.00	0.26-1.45	-	-	-
2015	0.48±0.14	0.44±0.12	-	1.56±0.16	-
	0.05-0.68	0.12-1.40	-	1.39-1.71	-
2016	0.58±0.33	0.44±0.12	-	-	-
	0.32-2.12	0.21-1.25	-	-	-
2017	0.51±0.19	0.62±0.60	2.74±0.17	-	-
	0.33-1.13	0.34-2.62	2.62-2.86	-	-
2018	0.42±0.12	0.46±0.16	-	-	1.17±0.13
	0.30-0.96	0.28-1.22	-	-	1.04-1.33
2019	0.50±0.09	0.44±0.33	1.51±0.04	1.39±0.18	0.95±0.11
	0.37-0.75	0.27-6.55	1.48-1.54	1.04-1.80	0.87-1.02
2020	0.48±0.09	0.38±0.05	1.26±0.13	1.26±0.19	1.05±0.40

	0.39-0.64	0.31-0.49	0.96-1.80	0.88-1.84	0.49-3.14
2021	0.61±0.06	0.45±0.08	1.34±0.14	1.22±0.15	1.06±0.12
	0.54-0.64	0.3-1.16	1.11-1.67	0.98-1.61	0.85-1.30
a) $\frac{\text{Mean}\pm\text{Std.Dev}}{\text{min}-\text{max}}$					

4 Conclusions

Thus, over 9 years of illegal fishing, poachers on the lower reaches of the Irtysh River seized fish biomass in the amount of 1055 tons, at a rate of 300 kg / day, which is more than 1% of the official recommended daily volume for the entire Western Siberia.

Poaching puts pressure on representatives of all size groups of Siberian sturgeon, burbot, sterlet, carpbream, gibel carp, nelma and pike.

The main interest for poachers is sturgeon, in particular sterlet, whose share in catches during 2013-2019 tends to 100%, but in the last 2 years' low-value fish species, mainly cyprinids, in particular ide and less bream, began to dominate in catches. This indicates an increase in the interest of poachers in low-value fish species, which probably indicates a decrease in the number of valuable species.

The degree of sexual maturity of fish in catches is different. Siberian sturgeon is represented mainly by immature individuals (86%), which is strange, given the value of black caviar. This is probably evidence of the low abundance of mature sturgeon specimens in the environment. In turn, sterlet in poaching catches is represented by sexually mature individuals (79%), but most of them were caught during the non-spawning period. Catches of ide and bream practically did not have immature representatives. And most of them (>60%) were caught during the spawning period.

The fatness of fish in poaching catches is quite high. Poachers seize mainly well-fed and healthy representatives of the ichthyofauna. Except for the sturgeon, whose individuals are caught in any condition (sick or malnourished), probably for the purpose of selling under the guise of sterlet.

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