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The Impact of Fishery on the State of Populations of the European Whitefish *Coregonus lavaretus* in Lake Imandra

A. A. Lukin[a], Yu. N. Sharova[a], and B. F. Prishchepa[b]

[a]*Institute of Water Problems of the North, Karelian Research Center, Russian Academy of Sciences, prosp. A. Nevskogo 50, Petrozavodsk, 185000 Russia*

[b]*Federal State Unitary Enterprise Murmanrybvod, ul. Kominterna 7, Murmansk, 186320 Russia*

E-mail: lukin@nwpi.krc.karelia.ru

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Abstract—The impact of fishery on the state of populations of the European whitefish *Coregonus lavaretus* in Lake Imandra, the largest water body of the Kola Peninsula, is considered. The retrospective analysis of catches in the period of 1930 to 1998 indicated that the consequences of an uncontrolled fishery are comparable with the effects of intensive technogenic pollution. As a result of the intensive commercial load on the water body over many decades, the number of age groups decreases, the size–weight indices in fish change, an early maturation at sizes small for the species is observed, and the population structure becomes more simple. Against the background of the improving environmental quality, the numbers of fish under the effects of the uncontrolled amateur and poaching fisheries continue to decrease, which leads to the change of the nucleus of the fish proportion of the community and the change of dominant species.

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The long-term anthropogenic impact on the inland water bodies of Kola Peninsula, including technogenic pollution and intensive fishery, has resulted in a considerable decrease of the numbers of many valuable species, primarily salmonids and coregonids. During the assessment of the commercial human activity, as a rule, greater attention was focused on the study of the effects of industrial pollution on natural systems. At the same time, in some regions, fishery, including poaching, exceeds the effects of industrial pollution in the extent of impact on the stock of valuable commercial species. Although a great many investigations are concerned with this problem (Kuderskii, 1991; Reshetnikov, 1995; Shatunovskii et al., 1996; Pavlov et al., 1999; Rudenko, 2000), the impact of amateur and sport fishery on the fish stock is little-studied and not considered by the statistics. Meanwhile, it is known that even when fish are caught within framework of the rules established by the law, it is possible to considerably affect the stock and numbers of populations of some valuable species.

The purpose of our investigation was to study the effects of the fishery, including the amateur fishery, on the state of populations of *Coregonus lavaretus* and possible changes in their structure in Lake Imandra, the largest oligotrophic water body of the Kola Peninsula.

MATERIAL AND METHODS

The paper is based on materials of long-term studies of Lake Imandra (1978–1998) collected during expeditions and the check of commercial teams and amateur fishermen together with workers of the Murmanrybvod Administration. *C. lavaretus* is among the main commercial items of the studied water body, which made it possible to obtain mass material in specific regions.

In scientific expeditions, fish were seined with a set of fixed gill nets made of nylon monofilament (length of 25 m, height of 1.5 m) with a mesh size of 10, 12.5, 16, 22, 25, 30, 35, 38, and 45 mm, which provides for catching fish 5 cm and longer. During the control seinings, during the inspection of commercial teams and amateur fishermen, and during the removal of poaching nets, mass measurements of the length and weight of individuals were made and scales for age determination were collected.

RESULTS AND DISCUSSION

Lake Imandra is located in the central part of the Kola Peninsula and is its largest water body: length of 109 km, average width of 3.19 km, area with islands, 880.4 km^2; and water volume, 10.86 km^3. The total area of the drainage basin of the lake is 12300 km^2. The drainage system is represented by 1379 water courses with a total length of 4761 km, and 2495 lakes with a total area of the water plane of 1575.35 km^2. Most of the water courses (approximately 1300) are small streams with a length under 10 km (*Resources*…, 1970; Moiseenko et al., 2002). Only the Niva River, discharging to Kandalaksha Bay of the White Sea, flows out of the lake. The lake's extremely complicated form conforms to the diversity of the coast topography. The lake consists of three considerably isolated stretches,

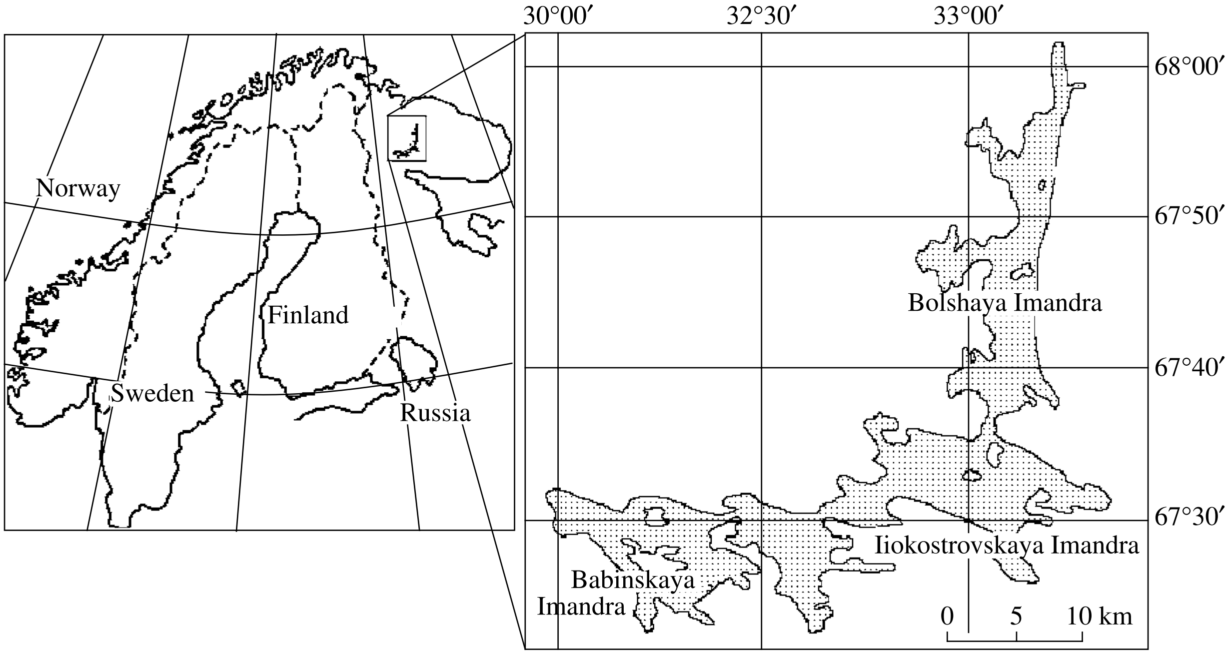

Fig. 1. Map-scheme of Lake Imandra.

Bol'shoi, Iokostrovskii, and Babinskaya Imandra, which are interconnected by narrow channels–salmas (Fig. 1).

The climatic conditions of the arctic basin determine the specific conditions of the formation of water quality. In terms of chemical composition, the water of Lake Imandra is of the hydrocarbonate-sodium type, and in terms of the mineralization value, the lake can be classified as an ultrafresh water body (Baranov, 1962). At the present time, the hydrochemical conditions of the water body are considerably determined by the technogenic factor; nevertheless, the concentration of biogenic substances in the natural waters of Lake Imandra is low; in terms of biological water productivity, it has the status of an oligotrophic water body (Moiseenko et al., 2002).

As regards the fishery, Lake Imandra was considered a promising water body, since its hydrological and hydrochemical conditions are favorable for the dwelling of salmonids and coregonids sensitive to environmental conditions. The proportion of these species in the annual catches in the 1950s was 82% (Moiseenko, 1982). In the 1960s, the nucleus of the fish proportion of the community in Lake Imandra was composed of the European cisco *C. albula* and European whitefish *C. lavaretus*; among predatory fish, char *Salvelinus alpinus* was dominant. The fish productivity of the lake in this period was assessed as slightly higher than 2 kg/ha (Reshetnikov and Vladimirskaya, 1964; Galkin et al., 1966), as at this time the lake was already subject to moderately high commercial and technogenic impacts.

In Lake Imandra, there are several forms of *C. lavaretus*; few-rakered and medium-rakered whitefish prevail (Krogius, 1933; Reshetnikov, 1980, 1994). *C. lavaretus* forms local schools whose ranges are distinctly attributed to large bays of the lake, such as Tik Bay, Pitkul Bay, the area of Kumuzhii and Nesterov islands, Voche-Lambina, Medvezhya Bay, Kislaya Bay, Vitte Bay, Upoloksham, etc. In the summer period during feeding migration, *C. lavaretus* migrates over the water area of the lake in search of food. In autumn, individuals ready for spawning assemble on the spawning grounds. Juveniles at this time continue to feed in the littoral zone. In winter, whitefish of all age groups leave for deeper sites.

Over the course of many decades, *C. lavaretus* formed the bulk of catches. Only *C. albula* and *Osmerus eperlanus* (in the mid-1950s) were caught in greater amounts. The analysis of the long-term dynamics of catches of whitefish in Lake Imandra indicates that there were several periods in the formation of the modern state of populations of this fish species (Fig. 2).

The 1930s–1940s are the beginning of the fishery in the water body. The numbers of *C. lavaretus* were considerable, which was evidenced by large catches. In 1926 in the water area of Imandra and Umbozero, the two largest lakes of the Murmansk oblast, the catch of this species was 28 000 kg (55% of the total volume of catch); in the 1930s, 63 500 kg (53%); and in 1933, over 100 000 kg (Krogius, 1933). Regrettably, only the data of the total catch in the two water bodies are cited. Note that the fishery was irregular, and in some years no fishery was performed at all.

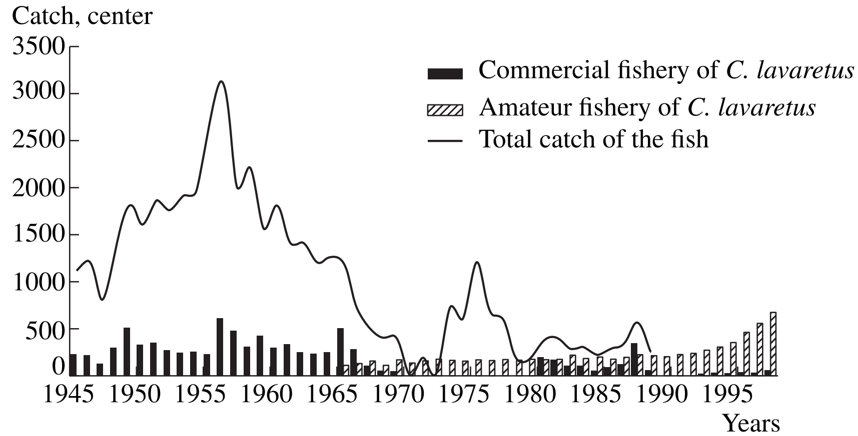

Fig. 2. Dynamics of catches of whitefish *Coregonus lavaretus* in Lake Imandra.

The 1950s–1960s were characterized by an intensive whitefish fishery. In this period, the annual catches of *C. lavaretus* in Lake Imandra reached 35 000 kg. Parallel to the industrial fishery of *C. lavaretus*, there was also an amateur fishery. At this time in some regions of the lake, the fishery was based largely on immature individuals, whose proportion in the catch reached 80% (Belyaeva, 1976).

In the 1970s, the total catch of *C. lavaretus* decreased to 12 400 kg. Parallel to a drastic decrease in the catches of *C. lavaretus*, its population indices also changed: a decrease of the length and weight, a decrease of the proportion of individuals of elder age groups, and a decrease of the average age of individuals in the spawning and feeding schools (Moiseenko, 1980), which indicated considerable overfishing. In the same period, the lake was subjected to maximum technogenic load on the part of industrial enterprises.

Toward the mid-1980s the catch of fish increased insignificantly (up to 13 000 kg) due to the intensification of fishery activity and the appearance of more advanced nets made of monofilament. In this period, the number of age classes in catches decreases (there are no more than four; five- and six-year-old individuals dominate), fish sizes decrease, and the numbers of spawners on the spawning grounds drastically decline. All this most likely resulted from overfishing and the increased mortality of individuals under conditions of pollution typical of the 1970s. At the end of the 1980s, the official commercial fishery of the fish in Imandra was stopped due to low profitability.

The late 1980s and early 1990s were characterized by a decrease of the anthropogenic load on the lake and the improvement of hydrochemical indices due to a significant decline of output at enterprises of the mining and metallurgical industries. In the absence of an official fishery, *C. lavaretus* was seined by amateur fishermen and private entrepreneurs. According to available data, the total catch of private traders over the period of 1989–1994 comprised about 20 000 kg. In addition, there was also uncontrolled poaching of *C. lavaretus*. The extremely high level of fish removal was the cause of the incessant rejuvenation of the spawning school: individuals spawning for the first time entered the spawning school at the age of 3+ and the main mass of fish spawned at the age of 4+–5+.

The size composition of whitefish in Lake Imandra was first characterized in the paper of Krogius (1926). In 1926, whitefish at the age of 3+ to 8+ had a weight of 520–975 (on average, 720) g and a length of 33.4–43 (on average, 37.9) cm. The long-term studies of populations of *C. lavaretus* in Lake Imandra made it possible to reveal the basic tendencies of changes in the weight and linear growth of individuals (Table 1). Toward the 1960s, a drastic decrease was observed in the indices of the linear and weight growth, by 16 and 38%, respectively; these indices remained low in all the subsequent years of studies. In the mid-1990s, the weight of fish of the same age groups (3+–8+) varied from 159 to 730 (on average, 411) g and the length, from 23.3 to 37.4 (on average, 31.4) cm.

The lowest estimates of the length and weight in each age group were observed in whitefish from the Bol'shaya Imandra Stretch where the average weight of individuals was 248 (18–559) g and the average length, 25.0 (12.4–34.0) cm. In whitefish dwelling in the Babinskaya Imandra Stretch, the average values of weight and length were slightly higher, 251 (36–539) g and 26.9 (15.9–35.3) cm. The highest indices were in whitefish from Iokostrovskaya Imandra—350 (75–750) g and 28.9 (19.8–38.4) cm, which are 10% higher than the average values of the length and weight of whitefish from Bol'shaya and Babinskaya Imandra.

Thus, over a long period, there occurred a considerable decrease of indices of the linear and weight growth of whitefish in comparison with the 1930s. The observed changes in the sizes of whitefish in Lake Imandra are accounted for not only by an intensive technogenic load on the water body, but also by fishery activity. At the present time, due to the active amateur

Table 1. Linear and weight growth of whitefish *Coregonus lavaretus* in Lake Imandra

Period, years	Age									Number of fish, ind.
	1+	2+	3+	4+	5+	6+	7+	8+	9+	
	The entire water body									
the 1930s[1]			33.4/520	34.2/543	37.1/663	38.8/751	41.0/872	43.0/975		86
the 1960s[2]		20.3/60	26.2/180	29.1/282	32.0/390	35.7/553	38.9/726	42.3/954	44.2/1190	300
the 1970		22/97	25.1/166	27.7/240	29.6/302	30.5/368	31.8/549	35.8/1108	39.8/923	1201
the 1980		22.7/160	23.6/178	36.9/243	30.4/334	33.9/417	35.2/560	36.2/820		958
the 1990	16.0/43	19.9/87	23.3/159	27.5/245	29.2/325	32.7/440	35.1/568	37.4/730		1900
	Bol'shaya Imandra									
1965–1970[3]		21.0/81	25.2/157	27.2/210	28.8/256	30.9/335	33.6/448	36.1/618	41.3/940	2477
1978–1981		22.0/91	23.6/131	26.0/202	28.1/268	29.0/307	30.3/375	35.0/616	39.8/923	592
1986		22.0/140	25.7/200	27.2/249	29.6/326	36.0/410	33.5/490			800
1996–1998	12.4/18	18.7/89	23.5/164	26.6/252	29.1/322	31.2/416	34.0/559	36.4/710		756
	Iokostrovskaya Imandra									
1972–1973				28.3/243	29.4/283	32.7/396	36.3/608			44
1978–1981				27.9/236	29.3/273	30.1/312				10
1986			20.8/100	26.7/237	30.5/329	32.7/424	35.2/621	36.2/820		76
1996–1998	19.8/75	20.4/90	24.6/165	27.8/251	30.6/345	33.7/494	36.1/606	38.4/750		918
	Babinskaya Imandra									
1972–1973		20.1/105	27.2/191	28.6/236	29.6/286	32.0/393	35.0/581	42.2/1062		203
1978–1981		22.7/123	26.5/201	29.2/283	31.5/365	33.9/482	37.8/723	45.5/1600		518
1986		23.4/180	24.2/156	27.0/243	31.2/349	33.1/419	35.9/570			82
1996–1998	15.9/36	20.6/82	24.5/148	28.1/232	30.5/310	33.2/411	35.3/539			226

Note: Above the line is length (AC), cm; below the line, weight, g; according to the data of: [1]Krogius, 1926; [2]Galkin et al., 1966; [3]Belyaeva, 1976.

and poaching fishery performed with fine-mesh nets, the average weight of *C. lavaretus* in the lake is 159 g.

The rearrangements in the size structure of populations affected the indices of the weight and linear growth of spawners (Table 2). In the 1970s–1980s, the average values of the length of individuals participating in spawning varied from 27.6 to 35.1 cm; at the present time, whitefish enter the spawning school at a length of 24.0 cm. The analysis of indices of the growth of *C. lavaretus* revealed considerable differences between the average values of the length and the limits of its variation in mature individuals in regions differing in the extent of the industrial load. The lowest indices are recorded in spawners inhabiting Bol'shaya Imandra. Apart from the intensive industrial load, this stretch is distinguished by the highest extent of industrial pollution. It can be assumed that under conditions of chronic toxicosis leading to additional energy expenditures for life activity and survival (Moiseenko et al., 2002), in this region, fish suffer a deficiency of energy resources for a full-value support of somatic and generative metabolism.

The results of long-term studies of the age structure of catches of whitefish in Imandra are presented in Table 3. The maximum age of *C. lavaretus* in control catches of the 1990s reached 12 years (11+). Over 70 years ago, when the lake was not subjected to an industrial load, age groups of 7+, 8+, and 9+ prevailed, which corresponded to the natural structure of this species. In the early 1960s, the age series of *C. lavaretus* in Lake Imandra considerably decreased; two age groups, 4+ and 5+, formed the bulk of catches. Fish older than nine years were lacking. If in 1926, the proportion of whitefish at the age of 9+ to 11+ comprised 30%, by the beginning of the 1960s, it was only 0.6%. An analogous pattern was observed in the subsequent periods of studies also. Fish at the ages of 4+, 5+, and 6+ remained dominant over the entire water body. Thus, the unfavorable changes in the age structure of whitefish—a decrease in the number of age groups and in the proportion of fish of an elder age became evident beginning in the late 1950s.

The specific features of population dynamics in fish are conventionally related to characteristics of their age structure such as the number of age groups, the age composition of the mature proportion of the population and the recruitment (Kriksunov, 1995). The long-term studies of the mature proportion of the *C. lavaretus* population in Lake Imandra revealed several changes in its age structure (Table 2). In the 1970s, spawners were represented by age groups of 4+ to 8+. Most of the mature individuals (56%) were of the summer 7–8 (6+–7+) age; the proportion of individuals spawning for the first time at the age of 4+ did not exceed 16%; nine-year olds (8+) represented 12% of this group. In the 1980s, the number of age classes of spawners drastically decreased. In this period, whitefish ready for spawning were of an age 3+ to 6+: individuals at an age of 4+–5+ made up 90% of all spawning fish; 3+, 9%; and 6+, no more than 2%. In the early and mid-1980s, the age structure of the spawning school of *C. lavaretus* slightly changed: unlike in the 1980s, it included age groups from 3+ to 8+. The bulk of spawning schools (about 70% of all spawners) in most areas of Imandra was formed by fish at the age of 4+ and 5+.

One of the causes of the observed change of the size–age structure of catches of *C. lavaretus*, besides the technogenic pollution of the lake, is the overfishing of elder age groups. In the late 1950s, Lake Imandra experienced the most intensive commercial load: in 1950, fishermen caught 60 000 kg of fish; in this case, individuals of elder age groups with high linear–weight indices were taken, as a rule. As a result, as early as at the beginning of the 1960s, a drastic decrease of the size series and the rejuvenation of populations are recorded. Subsequently, there was a decline in fishery activity, with particular peaks in 1965 and 1987 when over 40 000 kg of fish were caught; on average, the annual catch did not exceed 5000 kg. However, despite a decrease of the commercial load on the water body, no increase of the sizes and life span of *C. lavaretus* was observed; on the contrary, a stable tendency for their decrease was revealed because the technogenic load on the water body constantly increased in this period. This led to the domination in populations of fish at the age of 3+, 4+, and 5+. In the late 1990s and the early part of the new century, the hydrochemical indices in the water body considerably improved in comparison with the 1970s–1980s (Moiseenko et al., 2002). However, this did not result in increasing numbers and number of age groups in the populations of *C. lavaretus*. Moreover, at this time, owing to the severe economic situation in the country, the load on the water body from amateur fishermen and poachers drastically increased. As a result, the size–age parameters of *C. lavaretus* decreased more rapidly than under the technogenic impact.

The investigations performed revealed that the sites currently used for net fishery comprise approximately 25% of the area of Lake Imandra. If one considers that the density of net setting is, on average, 10 nets/km^2, the estimated load (with consideration of poaching capture) over the entire lake is about 2000 nets. This index is typical of the period of intensive fishery (August–mid-October); in the remaining seasons, the total number of nets is slightly lower.

Based on the data obtained, we calculated the approximate number of caught fish. These estimates are rather rough, but sufficiently reflect the commercial load on the water body. We used the following equation for calculations:

$$P = K \times C \times M \times 365,$$

where P is the annual volume of catch, kg; K is average daily catch per one net, ind./net/day; C is the number of nets; M is the average weight of one individual, kg; and 365 is the number of days in the year.

Table 2. Linear (AC, cm) and weight (g) indices of mature individuals (maturity stage IV of gonads) of the whitefish *Coregonus lavaretus* in Lake Imandra (August–September)

Period, years	Age, years											
	3+		4+		5+		6+		7+		8+	
	length, cm	weight, g	length, cm	weight, g	length, cm	weight, g	length, cm	weight, g	length, cm	weight, g	length, cm	weight, g
Bol'shaya Imandra												
the 1970s			26.5 ± 0.3 / 26.0–27.2	202 ± 10 / 184–224	26.6 ± 0.4 / 25.8–27.4	223 ± 11 / 202–254	30.6 ± 0.9 / 27.8–33.3	330 ± 32 / 239–450	32.6 ± 0.6 / 30.2–35.4	460 ± 41 / 326–650	35.5 ± 0.3 / 35.0–36.0	596 ± 33 / 530–640
			(4)		(4)		(6)		(8)		(3)	
the 1980s	24.2 ± 0.6 / 21.2–26.3	195 ± 15 / 110–260	26.5 ± 0.2 / 24.0–30.0	273 ± 8 / 160–410	27.4 ± 0.3 / 24.0–31.0	307 ± 8 / 210–44	32.0 ± 0.2 / 31.0–33.0	413 ± 43 / 300–540				
	(9)		(51)		(40)		(2)					
the 1990s	23.1 ± 0.2 / 22.5–23.5	169 ± 19 / 131–194	26.9 ± 0.1 / 25–28.5	232 ± 4 / 189–303	29.1 ± 0.2 / 25.2–30.7	306 ± 5 / 167–390	31.2 ± 0.4 / 27.0–33.5	374 ± 17 / 205–502	31.6 ± 0.6 / 29.0–34.8	449 ± 37 / 227–636	35.5 ± 0.3 / 35.0–36.0	759 ± 52 / 656–825
	(4)		(38)		(71)		(25)		(12)		(3)	
Iokostrovskaya Imandra												
the 1990s	25.5 ± 0.2 / 24.0–28.4		28.4 ± 0.1 / 25.0–31.8		31.1 ± 0.2 / 27.0–35.6		35.5 ± 0.3 / 29.0–37.0		35.8 ± 0.7 / 31.5–38.2		37.8 ± 0.9 / 35.5–40.5	
	(59)		(149)		(131)		(50)		(14)		(8)	
Babinskaya Imandra												
the 1970s			30.3 ± 1.2 / 27.5–33.0	250 ± 11 / 231–283	30.8 ± 0.9 / 27.0–34.5	302 ± 14 / 240–362	32.5 ± 1.1 / 28.3–36.8	390 ± 18 / 319–455	39.9 ± 3.7 / 36.2–43.7	998 ± 400 / 600–1398		
			(4)		(8)		(7)		(2)			
the 1990s	26.3 ± 0.7 / 25.6–27.0	170 ± 9 / 161–170	28.7 ± 0.4 / 27–32.0	253 ± 13 / 204–375	30.3 ± 0.3 / 29.0–32.5	313 ± 13 / 253–397	32.9 ± 0.3 / 32.0–34.2	394 ± 11 / 360–445				
	(2)		(12)		(10)		(7)					

Note: Above the line is the average value of the index and its error; below the line are limits of variation.

Table 3. Characteristics of the age composition (%) of the whitefish *Coregonus lavaretus* in Lake Imandra

Years	Age, years											Number of fish, ind.
	1+	2+	3+	4+	5+	6+	7+	8+	9+	10+	11+	
	The entire water body											
1926[1]		4.7	2.4	3.5	9.3	10.5	19.8	19.8	19.7	8.1	2.2	86
1960[2]		5.1	4	30.8	40.6	11.4	4.6	2.9	0.6			175
1978–1981		0.9	9.6	24.3	31.7	17.6	6	1.8	0.2			1201
1986		0.3	6.5	34.7	46.2	10.4	1.6	0.1				958
1996–1998	1.4	7.4	18.3	31.4	26.5	9.1	4.1	1.4	0.05			1900
	Bol'shaya Imandra											
1965–1970[3]		0.6	10	33	36	15.7	3.5	1	0.2		0.16	2477
1978–1981		1.6	8.1	15	31.7	27.8	11.5	3.5	0.5			592
1986		0.1	6.7	37.5	48	7.1	0.2					800
1996–1998	1.98	7.1	11.2	23.4	33.8	12.4	7.4	2.4	0.1			756
	Iokostrovskaya Imandra											
1972–1973				10.5	42.5	36.5	10.5					44
1978–1981				30	40	20						10
1986			1.3	9.2	44.7	35.5	7.9	1.3				76
1996–1998	0.7	7.3	22.4	38.3	22.2	6.3	1.5	0.9				918
	Babinskaya Imandra											
1972–1973		0.7	3.8	29.8	35.3	23.2	5.8	1.4				203
1978–1981		0.7	12.5	37.7	37.2	10.5	1.1	0.1				599
1986		2.4	9.7	31.7	30.4	19.5	6.1					82
1996–1998	2.6	9.3	25.6	30.1	19.9	8.8	3.5					226

Note: According to data: [1]Krogius, 1926; [2]Galkin et al., 1966; [3]Belyaeva, 1976.

Proceeding from the fact that the average number of fish caught by one net daily is 2.8 ind. and the average weight of fish is 0.22 kg, we conclude that in Lake Imandra, amateur fishermen catch about 110 t of fish a year (at the average annual number of nets in the lake of about 500). Although in the period of the intensive fishery in autumn the number of nets reaches 2000. Thus, 1.4 kg of fish is annually removed from each hectare of the lake area.

CONCLUSIONS

The irrational fishery has inflicted severe damage on the state of the fish stock in Lake Imandra. In the first years of commercial exploitation, the fishery was uncontrolled; in particular, spawners were caught on the spawning grounds or along the route of migration. This situation persists up to now.

As Nikolsky (1974) noted, the changes taking place in the structure of the population of a commercial species under the impact of fishery are rather diverse. In some cases the school is rejuvenated; in other cases, despite a considerable intensity of the fishery, the age structure remains stable. However, in the latter case, no consideration is taken of an additional factor such as technogenic pollution, in the presence of which against the background of the deterioration of the state of the fish population, mortality increases and the rate of reproduction decreases. According to the data of Reshetnikov (1980), northern water bodies have low tolerance for the effects of environmental conditions, and extreme overfishing can lead to drastic successional changes in the ecosystem. The tendencies related to the change in the fish proportion of the community in lakes of Lapland, including Imandra, were observed as early as the 1960s (Reshetnikov and Vladimirskaya, 1964; Reshetnikov, 1991, 1994). The impact of the commercial load on the water body under the technogenic pollution increases. In the period of a decrease of discharges of industrial eneterprises and the improvement of the environmental quality, overfishing becomes a dominant negative factor.

The main characters of populations undergoing structural changes as a result of an intensive long-term commercial load are the following: a decrease of the number of age groups, an increase of the proportion of slow-growing individuals, a decrease of the lifespan, and an early maturation at sizes extremely small for a species. Similar changes related to overfishing in populations of coregonids and other fish species were recorded for different types of lakes in the northern part of Bol'shezemel'skaya tundra, the Pechora basin, and water bodies of Eastern Fennoscandia (Ponomarev, 1996; Lukin et al, 2000; Novoselov, 2000; Sterligova, 2000). These facts testify to a tense state of populations of the main valuable commercial fish species in the study water body. A commercial school devoid of an annual replenishment can be completely extinguished. The remaining adult individuals at their low reproductive capacity and slow growth can increase the numbers of the population minimum upon two generations (over ten years) provided fishery is completely banned.

Thus, the consequences of an uncontrolled fishery exert a negative impact on the state of fish populations and are comparable to the technogenic factor in their effects. Moreover, against the background of the improvement of the environmental quality, the numbers of fish under the effects of amateur and poaching fishery continue to decline, which leads to the change of the nucleus of the fish community and the replacement of some dominant species by other species. In particular, in Lake Imandra against the background of a decrease of salmonids trout (*Salmo trutta*, char) and coregonids (smelt, whitefish), a jump in the numbers of smelt is observed.

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