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FISH INDUSTRY IN KARELIAN REPUBLIC (RUSSIA)*

Information about the state and main possible ways of fishery development in the Republic of Karelia (Russia) is presented. It includes information about fisheries, aquaculture status, and reproduction of fish stock.

Key words: Fish facilities, aquaculture, fish farming, reproduction, fish harvesting, lake-river system, water environment, marine and fresh-water fishery, fish cultivation

The Republic of Karelia is located in the north-western part of the Russian Federation. It borders with the Murmansk region in the north, with Arkhangelsk region in the east, with Vologda and Leningrad regions in the south-east. The western border with Finland is the longest one; its length is 723 km. The total area of Karelia is 172.4 thousand km^2. It extends for 660 km from the north to the south and for 424 km from the west to the east [4], [6].

Karelia is rich in water bodies. More than 60 000 lakes, among them the largest ones in Europe – Lake Ladoga and Onega, cover about 21 % of the Republic area. Several thousand rivers have the total length of about 80 000 km. Most of the lakes are connected by rivers, forming lake and river systems, covering the entire territory of the republic. Most lake basins of these systems have numerous bays, guts and islands and are usually elongated from the north-west to the south-east. Most of the rivers are torrential ones. Rapids usually alternate with deep river pools (lakes) with tranquil flow. The vertical drop of the river level can serve as an indicator of rapids magnitude. For example, the river Lososinka (total length – 27 km) has the flow inclination level of 40 m, the river Suna (total length – 282 km) has the flow inclination level of 325 m, the river Shuya (total length – 265 km) has the flow inclination level of 162 m, the river Kem (total length – 358 km) has the flow inclination level of 220 m, and so on. The flow inclination levels of Karelian rivers range from 0,6 to 5,6 m per kilometer depending on the terrain configuration

To estimate the density of the lake-river system it is sufficient to note that 12 km of lakes accounts for every 100 km of total river length, that is the lake surface ratio is 12 %. The ratio of lake length to the total length of the lake-river system ranges from 25 % (Shuya) to 68 % (Kovda). Such ratio of the river length to the lake surface is unique for Russia [3], [6].

The importance of lake-river systems for formation of water and fish resources is huge. They regulate the general hydrological regime. In particular, as natural accumulators of water masses, they determine the level regime of rivers and lakes located downstream, preserve spawning grounds of valuable fish species, providing favorable conditions for their reproduction. Such storage systems help to reduce the negative impact of floods and to conserve normal water regime during summer low water. Lake-river systems reduce the magnitude of negative human impact. Suspended solids from industrial, agricultural and domestic wastewater after intensive mixing in the rapids of the rivers, arriving at deep river pools with tranquil flow are partially precipitated and then transformed into less harmful to natural water components.

The White Sea with its unique natural conditions serves as the reserve for fisheries in Karelia, along with fresh water bodies. Unlike other arctic waters, it is less connected with the ocean, but gets a huge land runoff (from 130 to 360 km^3). These conditions favor the formation of specific flora and fauna. The area of the White Sea is about 90 000 km^2, average depth of 67 m, maximum depth – 350 m, water mass volume 6 km^3. The coastline length is over 850 km in the Karelian part of the sea. The coast is mostly high and rocky with numerous bays, which contributes to the development of marine aquaculture [1], [7], [8].

Huge water resources, the uniqueness of the lake-river systems, significant length of the spawning rivers, species diversity and richness of ichthyofauna create ample opportunities for development of the fish industry (fishing, reproduction, aquaculture). Moreover, the variety of scenic and exotic aquatic facilities could attract the interest of tourism managers, especially for development of boating, sport and recreational fishing facilities.

In marine waters and fresh waters of Karelia there are 63 members of ichthyofauna, of which about half are of commercial importance [4]. Currently the main types of fisheries activity in Karelia include fishing and seafood harvesting, aquaculture in the form of cage culture and based fisheries, which focus primarily on the reproduction of valuable fish species.

Fishing. Karelian fishermen are involved both in fresh water and marine fishing Fresh water fishing is mostly developed in the northern part of Ladoga Lake and in a large water area of Onega Lake. Regu-

lar fishing is also performed in 40 major reservoirs (Vygozero, Topozere, Segozere, Pjaozero, Vodlozero, Syamozero and others). Sport and recreational fishing is developed in medium and small reservoirs. Local population is engaged in sustenance fishing in many small lakes. Recorded fish capture rate in fresh water has been very low during the last decade, ranging within three thousand tons (table 1).

Table 1

Fishing in fresh waters of Karelia (thousand tons)

Years	2000	2001	2002	2003	2004	2005
Catches	2,3	2,5	1,9	1,7	2,2	2,6
Years	2006	2007	2008	2009	2010	2011
Catches	2,7	2,7	2,5	2,7	2,5	2,3

Note: The information in Tables 1–5 is provided by the Ministry of Agriculture of the Republic of Karelia. Unrecorded catches account for not less than five thousand tons according to our observations. The total catches of fish in fresh water bodies of Karelia give probably 8–9 thousand tons per year.

A significant amount of algae (Laminaria, Fucus, Ahnfeltia) is harvested in the Karelian part (about 20 thousand km²) of the White Sea. The total amount of fish and seafood harvesting in the White Sea varies within 1,5 thousand tons (table 2). Algae harvesting makes about half of this volume. Its production mainly depends on the market demand. Unfortunately the White Sea mussel stocks are not exploited.

Table 2

Fish and seafood harvesting in the White Sea (thousand tons)

Years	2000	2001	2002	2003	2004	2005
Capture	1,8	1,6	2,5	1,2	1,0	0,7
Years	2006	2007	2008	2009	2010	2011
Capture	0,7	0,6	0,4	0,5	0,5	0,4

Karelian entrepreneurs are engaged in marine fishing in the Barents Sea, in the coastal sea bed areas of foreign countries and in the convention areas of the Atlantic Ocean. Fish catches varied within 42–75 thousand tons in the last decade (table 3). Particularly low catches were in the middle of the decade. At present definite increase in fishing has been obtained; fish catches reached 75 thousand tons.

Table 3

Volumes of marine fishing (thousand tons)

Years	2000	2001	2002	2003	2004	2005
Capture	55.1	62.1	71.1	47.0	49.3	43.0
Years	2006	2007	2008	2009	2010	2011
Capture	45.1	42.3	47.5	58.3	68.3	75.5

Seafood is also harvested in the ocean waters (table 4). Its volume is small, but can be significantly increased in the long term.

Table 4

Seafood harvesting (thousand tons)

Years	2000	2001	2002	2003	2004	2005
Harvesting	2,1	4,0	4,4	2,9	3,2	3,3
Years	2006	2007	2008	2009	2010	2011
Harvesting	3,4	3,3	2,9	3,3	3,0	2,8

Aquaculture in the Republic of Karelia is presented by cage culture fishery and is mostly developed in fresh waters. 47 cage farms are currently operating in Karelia; they produced over 13 thousand tons of fish products in 2011. Dynamics of cage fish production during last 12 years is shown in table 5.

The main object of cage culture is the rainbow trout. The technology of its breeding is generally developed. Small amounts of whitefish and sturgeon are also raised. Favorable natural conditions of Karelia and the proximity of the vast market will contribute to further and more rapid development of new facilities.

Table 5

Fish raising at cage farms of Karelia (thousand tons)

Years	2000	2001	2002	2003	2004	2005
Output	1,7	2,0	2,7	2,9	4,4	5,8
Years	2006	2007	2008	2009	2010	2011
Output	7,0	9,4	12,2	12,9	10,7	13,2

Nowadays about 75 % of cage products manufactured in Russia are produced in Karelia. In the long term ecological capacity of inland water bodies of Karelia allows to increase fish production in cages up to 25–30 thousand tons. This is a real prospect. Cage fish farming is recognized in Russia as one of the most promising directions of fisheries development in inland waters and is included in the federal program of agriculture development.

Reproduction of fish stocks in Karelia is realized in hatcheries, fish farms, and in some cage farms. The main objects of reproduction are the Atlantic salmon (Salmo salar Linnaeus, 1758), freshwater salmon (Salmo salar L. morfa sebago Girard, 1853), pink (Oncorynchus gorbuscha, Walbaum, 1792), lake char (Salvelinus lepechini, Gmelin, 1788), lake trout (Salmo trutta trutta Linnaeus, 1758) and European whitefish (Coregonus albula Linnatus, 1758). Reproduction of valuable fish species is focused on the Atlantic salmon. In 2000 only 72,8 thousand mixed-age young Atlantic salmon was released in the river basin of the White Sea, whereas in 2004 this number increased to 506 thousand individuals. In subsequent years, despite some fluctuations, production of mixed-age salmon remained at a high level of 400–350 thousand individuals. Due to the reproduction activities this species is preserved in salmon rivers running into the White Sea.

The condition of freshwater salmon population in Lake Onega was critical in the 90s of the last century. The recorded catches dropped to 2 tons / year, 6–8 times less compared to the 1980s. To preserve this population in Lake Onega freshwater salmon was included in the Red Data Book of Karelia and Russia. At the same time its reproduction was significantly increased. 270 thousand mixed-age juveniles (age 1–2 years) were raised and released into the river Shuya (the basin of Lake Onega) in 2000. In subsequent years, the volume of its cultivation remained at 200 thousand individuals per year. The results of artificial reproduction manifested themselves very quickly. The total number of salmon in Lake Onega has increased significantly; the catches grew up as high as 3–5 tons / year. Catches of salmon grown from juvenile fish released from fish farms amounted to 70–75 %. The total catch of salmon in all waters of Lake Onega reaches about 100 tons / year according to I. L. Schurova and V. A. Shirokova [2].

Good results were obtained for lake char (Salvelinus lepechini) reproduction in Lake Ladoga. In the late 80s of the last century, catches of lake char in Lake Ladoga were next to nothing (catch of 0,15 tons in 1989). The annual release of 30–80 thousand yearlings of lake char resulted in 8 tons catch in 2004, and even 14 tons in 2011. Reproduction of whitefish and lake trout is carried out in small volumes and has not given positive results in the reservoirs of Karelia. Good results were obtained with the resettlement of whitefish in a lake of the Southern Urals region. The main directions of further development of the fisheries in Karelia will be: fishing, aquaculture and reproduction. The fishery will be evolving not only due to the further development of inland water bodies, but the expansion of oceanic fisheries. The latter will require modernization of the fishing fleet and development of the fish processing industry.

Cage fish farms will constitute the basis for aquaculture. Its development will include cultivation of new aquaculture species (sturgeon, whitefish), development of fish hatcheries, enhancement of fish production technology, development of effective ways to improve welfare of fish. Creation of integrated lake farms, combining cultivation of fish, sport fishing and fishing tourism also has future potential. Reproduction of fish stock will be developed through involving new species (walleye pike (*Sander vitreus*), whitefish), increase in seeding production and its quality improvement. This will require establishment of new hatcheries and raising farms, and technology improvement. These activities will result in increasing fish capture rate in Karelia up to at least 100 thousand tons / year.

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