Coalition Clean Baltic
FOR PROTECTION OF THE BALTIC SEA ENVIRONMENT

Land-locked Salmon in the Ladoga and Onego basins

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SALMON OF LAKE LADOGA

In the beginning of the 20th century, the basin of Lake Ladoga had over 40 salmon spawning rivers (Valetov, 1999). By the end of the 20th century the number had decreased to 10 - 18 rivers most of which are small ones flowing into the northern part of the lake (picture 1).

The first signs of the reduction of the number of local spawning populations of Ladoga salmon were noted as early as in the beginning of the 20th century after the construction of cascades of hydraulic facilities (Hydro Power Plants (HHP), longitudinal dykes, splash and mill dams) that completely or partly blocked the upstream migration of spawners. As a result, the total migration ways of salmon to the tributaries of Northern Ladoga were reduced from 661 km to 320 km (Jaaskelainen. 1917) and in the 1930s down to 292 km (Persov, Jandovskaya, 1940). Fish ladders were constructed only at two dams on the rivers Yanisjoki and Uuksa. After the construction of the Nizhnesvirskaya HPP (1933) the key spawning grounds of the Svir salmon were completely cut off which resulted in the population getting close to extinction. During the Great Patriotic War most dams were destroyed but by the beginning of the 1950s, 44 hydropower plants out of 51 had been restored with no consideration of the interests of fish migration (Veber, 1967). At present, most dams are not used for their intended purposes and some have been partly dismantled; however they still constitute impassable barriers for migrating salmon spawners. As a result of these constructions, the area of spawning grounds in salmon tributaries of Lake Ladoga is less than 20% of its potential.

Among the other human impacts on the local populations of Ladoga salmon the worst ones are illegal fishing, destruction of spawning grounds as a result of construction along the banks of the rivers and deterioration of the environment as a result of pollution. Some populations of Ladoga salmon have gone extinct under the long-term and permanently increasing human burden.

According to V.A. Valetov (1999), at the end of the 20th century the productivity of salmon spawning tributaries of Ladoga and Yanisjarvi was over 50 000 salmon smolts and the number of spawning salmon in those rivers was about 5000 individuals. At the same time the potential productivity of the existing spawning grounds is 180 000 smolts and the potential number of spawners is over 40 000 individuals.

Picture 1. Salmon rivers of Lake Ladoga with marked up-to-date status of salmon populations. Green – extinct population (the environment in the river is suitable for the restoration of the population); red – the population is on the verge of extinction; purple – population with unstable reproduction and numbers much lower than the optimum; orange – the population is sustained by reared smolts.

The Hijtola River

The Hijtola River is one of the main spawning tributaries of Lake Ladoga. The river flows for 62.5 km (50.5 km on Russian territory). There are four key rapids on the river and mixed-aged young salmon have been found on all of them (picture 2). The total area of spawning and nursery grounds (SNG) is 7.5 hectares. The spawning population of salmon in the river consists of spawners with 2 - 6 year long fattening period in the lake and 3 - 4 year long river period (2+ - 3+). Spawners prevail that migrate to fattening in the lake at the age 2+ and they make up 83% of the whole stock. 37% of the spawning population is male salmon.

Picture 2. Spawning and nursery ground of salmon located near destroyed dam of HPP at the Hijtola River.

Anadromous salmon migration to the river starts at the end of May when the water temperature reaches 10^0C and continues till the very spawning in the second half of October. The main migration of salmon to the river occurs right on the eve of spawning. According to the data collected by Y.V. Kostylev et al. (1980) the Hijtola salmon population was most abundant during the period 1890 - 1910 with not less than 1000 individuals. The number of salmon in the river at the end of the 20th century was approximately 250 - 300 spawners (Ryzhkov et. al. 1999); however at present there are only 150 individuals. Therefore, natural salmon reproduction in the Hijtola can be characterized as unstable during the recent years. The numbers of spawning salmon is far from its potential (2400 individuals).

The Suskuanjoki River

The Suskuanjoki River is 40 km long, and the drainage basin is 234 km^2. There is only one spawning and nursery ground for salmonids in the Suskuanjoki River; a 300 m long stretch with the size of 0.3 ha which is located directly under the milldam (picture 3). The depth here is from 0.3 to 1.5 m, the speed of the current is from 0.5 to 1.0 m/s. The spawning grounds occupy about 30% of the site. The bottom is made up of fine and medium grain pebbles and gravel.

Picture 3. The dam of the former HPP at the Suskuanjoki River.

The river period of young salmon of the Suskuanjoki River is most commonly two years (98%), and the lake period is two or three years. Spawning migration of salmon spawners in the Suskuanjoki takes place from the beginning of September up till spawning (usually after the 10th of October). The largest number of individuals returns to the river at the end of September. There are no data on smolt production. The number of the population does not exceed 50 spawners, and the potential number of the spawning population in the river is about 100 individuals.

The Ikhala River

The Ikhala River flows for 40 km and drains an area of 318 km^2. The total area of spawning and nursery grounds is about 1.5 ha. Five sections of the river located 12 - 21 km from the mouth are suitable for young salmon growth. Spawning takes place on up to 30% of the total area of spawning and nursery grounds. Predominant depths at the grounds are 0.3 - 1.5 m, and the speed of the current is 0.4 - 1.0 m/s. The river period of most individuals of young salmon in the Ikhala is two years, and about 40% of smolts leave the river at the age of three. There are no data on smolt production.

The lake age of salmon is 2 – 3 years, and they spawn maximum twice. Spawning migration of salmon spawners starts in late June and end on the eve of spawning (after 10th of October), with a peak in late June, July (the highest one) and September. However there has been no record of salmon entering the Ikhala in the recent years. The calculated potential number of spawners in the river is about 250 fish.

The Mijnala River

The Mijnala River flows for 90 km and its drainage area is 501 km^2. The total area of spawning and nursery grounds of salmon is 3 - 4 ha according to different estimations. Salmon spawning and nursery grounds in the Mijnala are situated at a distance of 10 to 65 km from the mouth. The depth at the spawning and nursery sites is from 0.5 - 1.5 m. The speed of the current at different levels is from 0.3 - 1.1 m/s. Salmon spawning grounds occupy 24–27% of the total SNG.

Most young Atlantic salmon (over 80%) live in the Mijnala for 2 years. There are no records of smolt production. Duration of the lake period is 2 - 3 years. The average weight of spawners is 5 kg, and the length is about 75 cm. Spawning migration of salmon spawners in the Mijnola is stretched in time from May to October; however, most spawners migrated upstream in the August to September period (migration peak). However, no salmon entering the Mijnola have been registered during recent years. The calculated potential number of the spawning population in this river is about 100 fish.

The Tokhma River

The Tokhma River flows for 74 km and its drainage area is 1602 km^2. There are four channel lakes with the total length of 16.6 km and the area of 15 km^2. The only salmon spawning and nursery ground of the area - 0.4 hectares and 100 m in length - is harboured under a dam in Mylykyla. The depth here is from 0.5 - 2.5 m and the speed of the current is 0.3 - 1 m/s. Up to 25% of the area of the SNG is used for salmon spawning.

The river period of salmon parr in the Tokhma is two (47.9%), three (35.4%) or four (16.7%) years. The lake age of salmon is 2 - 4 years, and maximum three spawning "runs" are possible. The peak of spawning migration of salmon spawners in the Tokhma is in August – September, and spawning occurs in the middle of October. There are no data on smolt production. The number of the population at present does not exceed 50 individuals which is approximately ten times less than the potential number for this river.

The Yanisjoki River

The Yanisjoki River flows for 126 km (72 km on Russian territory) and the area of the drainage basin is 3900 km^2. The Yanisjoki flows across Lake Yanisjarvi (37.9 km long and a surface area of 204.3 km^2) dividing the river into Lower and Upper Yanisjoki.

After the construction of a cascade of HPP dams on the 25 km long section of the Lower Yanisjoki (1890 - 1910), Lake Yanisjarvi became a water reservoir, and a totally isolated local group of Atlantic salmon appeared there. The salmon SNG is located in the Upper Yanisjoki and its tributaries Sayanjoki, Ulmasenjoki and Kelokoski. The latter nurtures no Atlantic salmon at present. Construction of a pulp-and-paper mill and a woodworking plant on the banks of the Lower Yanisjoki and timber floating down the river resulted in the situation that by the 1960s the river below the Lake Yanisjarvi had become unsuitable for reproduction of salmonids and some other fish species. Thus, the local population of Ladoga salmon disappeared from the Lower Yanisjoki.

According to estimates made by V.A.Valetov (1999), by the beginning of the 20th century, the population of salmon in the Yanisjoki was made up of 2500 spawners, in the 1920s and 1930s the number had dropped to 500 - 750 individuals, and by the 1950s the population had gone extinct. The approximate area of spawning and nursing grounds used to be 15 hectares but has now decreased to no more than 0.3 hectares. The SNGs are used solely by the salmon from Lake Yanisjarvi.

Yanisjarvi salmon is special for its unique downstream spawning migration to the River Yanisjoki. The reason for the migration is probably the lack of spawning grounds in the tributaries of the lake. According to D.G.Veber (1953), salmon spawning grounds are located at the source of Yanisjoki. Observations of V.A.Valetov (1999) showed that some spawners go downstream even further passing the HPP dam in Hamekoski and reproduce in gravel under the dam. From this location smolts can migrate only downstream. However, passing two active dams and HPP machinery, as well as the impact of pulp-and-paper mill wastes that have accumulated on the bottom of the river there is no hope for their survival.

The river period of young salmon in the rivers of the basin of Yanisjarvi is two years, (about 90%) the rest staying for 3 - 4 years. The fattening period in the lake is one 1 – 5 years, but most often 2 - 3 .Salmon spawns in the rivers Ulmasenjoki, Soanjoki and Yanisjoki in late October to early November. As of today, the numbers of salmon in Lake Yahisjarvi does not exceed a few dozen spawners given the potential number of the local population to be 1000 spawners.

The Sjuskjuanjoki River

The Sjuskjuanjoki River is 33 km long and the area of the drainage basin 477 km^2. The SNGs are situated in the upper reach at a distance of 22 - 25 km from the mouth. Salmon spawning grounds occupy about 30% of the total SNG. The main spawning and nursing ground of about 0.4 hectares is located below the HPP dam. High density of salmon parr – about 100 individuals/100 m^2 – has been recorded here in recent years. According to our estimations, about 40 salmon individuals spawn in this section annually. According to previous research (Valetov, 1999) historical figures tell that the spawning population of the river used to be 100 spawners. As of today, there are all prerequisites to increase it as the density of young salmon above the dam is also rather high (66 individuals/100 m^2). Presence of young salmon above the dam shows that the upper sections of the river have become accessible for spawners after the dismantling of an old Finnish dam.

The river period of salmon in the Sjuskjuanjoki River lasts 2 (the majority) - 3 years and the lake period is 3 years. Spawning migration of spawners starts in the second half of July or early August, and finishes right before spawning (usually in the middle of October); the peak falls in late September. In addition to spring spawners in the end of October to November a small number of winter migrants enter the river (up to 4% of the total number of spawners). At present, the number of individuals annually spawning in the river is about 100 individuals given the potential number of 500.

The Kojrinjoki River

The Kojrinjoki flows for 22 km and the drainage basin is 124 km^2. Spawning and nursing grounds of salmon in the Kojrinjoki River are located in two areas, 2.5 and 7 km from the estuary. Their sizes are 0.5 hectare (500 m long) and 0.3 hectare (300 m long) respectively; the depth vary from 0.2 - 1.2 m and the speed of the current from 0.3 - 0.9 m/s. Spawning grounds occupy about 30% of the SNG. Young salmon mainly dwelled 2 years (88%) in the Kojrinjoki River. There are no data on smolt production.

The lake period usually last 2 years. The average weight of spawners is 5 kg, and the length 70 cm. Spawning migration of salmon spawners in the Kojrinjoki River occur in August to September with a peak in late September. Spawning usually occur in mid-October. However, no salmon entering the Kojrinjoki River has been recorded recently. The estimated potential number of spawning individuals for this river is about 50 fish.

The Uuksa River

The Uuksa River flows for 121 km, with a drainage area of 1080 km^2. Salmon SNG are scattered along the river at a distance of 3.5 - 38.5 km from the mouth. Predominant depths at SNG are 0.3 - 1.2 m, and the speed of the current is 0.3 - 1.6 m/s. The area of potential spawning and nursing grounds is about 24 hectares; however, for certain reasons the area of active grounds is only one hectare. Atlantic young salmon live in the Uuksa River for two (about 80%) or three years. There are no recorded data on smolt production. The lake period usually lasts for three years. The average weight of spawners is 5 kg and the length is 75 cm. Spawning migration of salmon to the Uuksa lasts from mid-July till early October with a peak in September. Spawning usually occurs in mid-October. The population size does not exceed 100 individuals given the estimated potential of 1000 spawners.

The Tulema River

The Tulema flows for 55 km with a drainage basin of 1720 km^2. Spawning and nursing grounds in the Tulema River are located at the following distances from the mouth: 1.5 km (area of 0.2 ha, length 30 m); 2.5 km (2.7 ha, 700 m); 4 km (0.8 ha, 200 m); 8 km (0.8 ha, 200 m). Spawning grounds (gravel and pebbles) constitute on average 30% of the total area of SNG. The area of potential SNG totals to a minimum 10 ha. Predominant depth at SNG is 0.8 - 2.0 m with flow rate of 0.4 - 1.2 m/s.

The river period of young Atlantic salmon in the Tulema River lasts for 2 (87%) or 3 years. There are no recorded data on smolt production. The duration of the lake period is usually 3 years. The average weight of spawners is 4 kg, and they are about 70 cm long. Spawning migration of salmon in the Tulema is usually stretched in time from May to October with a peak in September. The spring peak of spawners' migration has not been clearly observed in the recent decades. Spawning usually takes place in mid-October. The number of the spawning population is estimated at 150 - 200 individuals. The SNGs in the river are sufficient to sustain a potential number of 800 spawners.

The Vidlitsa River

The Vidlitsa River flows for 67 km with a drainage area of 1320 km^2. The basin harbours 152 rivers and streams and 26 lakes with the total length of over 600 km. The river holds 11 rapids. The key spawning grounds are located in the middle reach of the river. There are 4 groups of spawning grounds located in the lower reach between 9 and 24 km, in the middle reach between 36 and 51 km and in the upper reach (the upper 11 km). The total area of SNG of Vidlitsa is 12.5

ha. The depths at the SNG vary within rather a big range (from 0.5 - 4 m) and current velocity is 0.4–1.5 m/s.

Most young salmon – 63% – spend 3 years before migrating downstream, and the reminder stay for 3 years. Salmon of the Vidlitsa population are special for their relatively large size (for Ladoga salmon). The average weigh of spawners is about 6 kg, and the length is about 80 cm. Both in the spawning population and in all age groups female salmon make up 70% of the stock. The main migration period is in May - June, and spawning takes place in late October.

The current bad state of the population of the Vidlitsa salmon is primarily due to the fact that the river has suffered a lot from timber floating, - logs litter the stretches of the river and rapids have been turned into timber floating channels. The bottom at most rapids is very dense and slow-moving being unsuitable for salmon spawning. During the last several years the density of young salmon has dropped significantly. If in the end of the 20th century the Vidlitsa population was estimated at 600 – 700 individuals (Valetov, 1999), at present the number of spawning salmon spawners has declined to 50 - 100 individuals, many times lower than the potential which is estimated at 3000 spawners.

The Tuloksa River

The Tuloksa is 77 km and has a drainage basin of 900 km^2. The basin holds 110 rivers and streams and 26 lakes with a total length of 456 km. The total area of potentially suitable SNG makes 14 hectares; however, active spawning and nursing grounds constitute 10 hectares. The key salmon spawning and nursing grounds in the Tuloksa are located at a distance of 5.9 - 43 km from the mouth. On average, 10 - 15% of the total area of SNGs is actually used as salmon spawning grounds. The depth of some SNG varies from 0.6 - 2.5 m with a flow rate of 0.5 - 1.2 m/s. Duration of the river period of salmon in the river is 2 or 3 years, and the lake period usually lasts for 3 years (from 2 - 6). There are no recorded data on smolt production. The average weight of spawners caught in the river is 5.4 kg and the length is 70 - 80 cm.

Together with the Vidlitsa, the Tuloksa has always played an important role in salmon species reproduction in the rivers of the northern part of Lake Ladoga. One third of the total number of salmon caught in the northern part of Ladoga was caught at the estuary part of those rivers. As early as in the 1950s, 2 - 5 tonnes of salmon were caught annually in this area; however, at present just occasional salmon individuals enter the Tuloksa. Remaining SNG areas can sustain a potential population of 800 individuals.

The Olonka River

The Olonka is 87 km long, and the drainage basin is 2620 km^2. The key salmon SNG in the Olonka are located at a distance of 44 - 81 km from the mouth. As a result of large anthropogenic impact, such as pollution of the river waters with industrial and municipal effluent and consequences of loose timber floating, the main part of SNG is not active at the moment. Spawning grounds themselves constitute not more than 10% of the total area of actually active SNG (1 hectare). The depth of SNG varies from 0.4 - 1.6 m, and current velocity is from 0.4 - 1.3 m/s. The river period lasts for 2 (85%) or 3 years. There are no recorded data on smolt production.

Salmon usually fatten in the lake for 3 years. The average age of spawners is about 5 kg, and they are about 75 cm long. Spawning migration of salmon spawners to the Olonka mainly takes place in May - June and in September, and spawning occurs in early and mid-October. No salmon entering the Olonka has been recorded during the recent years. The estimated potential number of the spawning population for this river is 500 fish.

The Svir River

The Svir is 224 km long and has a drainage basin of 21780 km^2. The area of the basin of the Svir expands unevenly, and this process mainly goes on in the lower reach, where during the last 15 years two major tributaries have been flowing into it, the Ojat and the Pasha constituting over 50% of the total area of the basin of the Svir.

At present, there are two active hydropower plants, Nizhne-Svirskaya located 81 km from the mouth and Verkhne-Svirskaya situated 128 km from the mouth. As a result, the section between the HPPs has lost its rapids, and rapids remain only in the section from the source and 96 km downstream. However, all those rapids can be considered solely as potential spawning grounds because both dams are barriers impassable for salmon spawners.

Out of the total numbers of vast areas of SNG that used to exist some time in the past, and that were estimated by some researchers to make up 150 hectares, not more than one hectare is really active at the moment. There is a chance that spawning and nursing grounds remain in such tributaries as the Vazhinka and the Ivina that flow into the Svir in the upper reach, and they are probably being used by the population of the non-anadromous brown trout. No research of those SNG has been carried out so far, and there is no data available on the density of young salmon and smolt production. Young salmon usually spend two or, more seldom, three years in the lake.

Most spawners enter the river at the age of 2 or 3. The average weight does not exceed 4 kg. Spawning in the Svir River starts in September and ends in late October.

In the 19th century in the Svirskaya Bay and in the Svir itself, not less than half of all Ladoga salmon was caught. The catch was at a minimum 100 - 150 tonnes annually. As early as in 1920-1930, before the construction of the dam (1933) the registered catch was 20 - 50 tonnes per year. Thus, a minimum of 8 - 16 000 salmon spawners were caught; at the same time, a minimum of 1500 - 6000 spawners passed for spawning. Starting from 1960, target salmon fishing was prohibited. Some spawners were caught by the Svir fish farm, from 5 tonnes in 1974 to 150 kg in 1985. At present, not more than 100 individuals are caught for fish farming annually.

In 1932, for compensating the losses inflicted to the populations of salmonids by the presence of two hydropower plants, the Svir fish farm was built on the river. However, it was ineffective for a long period of time till the mid 1950s. In 1965 - 70 the farm switched from releasing fry and one year olds to production of two year olds, but those were released at inappropriate times and in locations not suitable for young salmon. The numbers released were 70 - 80 000 individuals. Production recovery was estimated to be 0.05%. Since 1986, the farm has been releasing two year old migrants. According to the data available, production recovery has risen and is now from 0.2 - 1.02 %. In the 1980s, almost all fish (40 - 50 individuals) caught for farming (in the area of the dam of Nizhne-Svirskaya HPP) were of farm origin. At present, not more than 10 - 15 Svir salmon spawners are used for reproduction at the Svir fish farm.

The Pasha River (tributary of the Svir)

The Pasha flows for 242 km and its drainage basin is 6650 km². It flows into the Svir from the left bank, 7.9 km from the mouth. The Pasha and its numerous tributaries - being rather impetuous and with many rapids - resemble mountain rivers which is one of the characteristic features of "salmon" biotopes. There are 70 rapids on the Pasha that are from 20 m to 3.3 km long, 31 km of the total length of rapids are in the upper reach. The abundance of rapids and chutes contribute to frequent change of current velocity which reaches 2.5 m/s in many rapids. At 19 rapids the velocity of the current exceeds 1.5 m/s.

At the moment, the total area of active SNG varies from 37 - 70 hectares according to different estimations. There are scarce data on young salmon living in the Pasha. Most young salmon (90%) is known to spend two years in the river. Data on the density of young salmonids and smolt production in the river are not available. Most spawners (about 70%) spend three years in the lake.

According to data from the 1960s, spawning migration of salmon spawners to the Pasha starts as early as in the beginning of May and finishes in September. Spring migration is special for being short as it starts at the very beginning of May and finishes after the 20th of the same month. At that time, the temperature of the water varies from 5.0°C - 6.9°C. Spawners have a very intensive migration, i.e. having arrived at the mouth of the Svir in early May, by the end of May – beginning of June they reach deep holes with slow-moving water in the upper reaches of the Pasha River where they spend summer and autumn till time for spawning. The spawners of the spring migration feature very large sizes being almost twice as big as autumn fish. Salmon spawning in the Pasha mainly takes place in late September - mid-December. The redds are usually located at a depth from 10 - 20 cm (crests of rifts) to 1.0 - 1.5 m. The approximate number of the population amounts to 600 - 700 spawners which is many times fewer than the potential.

The Ojat River (tributary of the Svir)

The Ojat is 266 km long which is 24 km longer than the Svir and flows into the Svir at a distance of 15 km from the mouth. The drainage basin is 5220 km². The Ojat River used to harbour the main part of SNG (over 250 hectares) of salmon in the basin of the Svir River. At present, the areas of actually active SNG have shrunk significantly; nevertheless, they currently constitute a minimum of 50 hectares. The river has a record 36 rapids with extremely high flow rate (up to 2.5 m/s). The rapids are located in the middle reach of the river and their total extension is a minimum of 65 km. The largest rapids are called Shandolovskije, and are 12 km long. The total area of spawning grounds is minimum 5 hectares (data from GosNIORH research of 1960 - 1961).

Most young salmon (about 93%) spend two years in the river. A minor part of young salmon can fatten in the river for 3 years and longer. There are no data on the density of young salmonid and smolt production. Most spawners spend three years (> 70%) in the lake, the remainder two. According to publications, spawning migration of salmon spawners to the Pasha River starts as early as the beginning of May and finishes in September. The spawners entering the river in May are remarkably large. Salmon spawning in the Pasha commences in September and lasts till the end of October. As a rule, redds are located at the depth from 10 - 20 cm to 100 cm. Approximate number of the population is 500 spawners which is many times fewer than the potential population size.

The Syas River

The Syas is 250 km long. The main riverbed carries 21 rapid with the total extension of 20 km. The tributaries also have rapids. Conceivably, the total area of SNG makes about 39 hectares. There is little information available about Ladoga salmon entering the Syas in particular. Pravdin highlighted that spawners entered the Tikhvinka tributary. In 1960 - 1961, GosNIORH organized test fishing for tracing the spawning migration of salmon on the river Volozhba, a tributary of the Syas. It was established that spawners migrate there from May to October (with some break in August). The main part of the catch was brown trout spawners predominantly 4 - 5 years of age. Some single individuals of salmon were caught.

Before the construction of a pulp-and-paper mill in the lower reach of the river in 1928, up to 10 tonnes of brown trout were caught annually. In 1948 - 57 the yearly catch was 1.8 - 2.4 tonnes but in later years only 20 - 70 kg per year. As of today, there is no salmon in the Syas, but non-anadromous brown trout dwells in the upper reach.

The Vuoksa River

The river Vuoksa springs from the territory of Finland and appears in Russia in the area of Svetogorsk. Below Svetogorsk, in its middle and lower reach (except for the Taipale River), the Vouksa is not a river in the exact sense of the term. There is a system of lakes that vary in length and width being connected by short, narrow and sometimes rapid canals. Lake-like sections are very elongated as for instance 30-kilometer-long and 2-kilometer-wide Sukhodolskoye Lake. The river flows into Lake Ladoga by two distributaries. The northern arm (Kyakisalmskii) flows into the lake at the town of Priozersk and the southern one (the Tajpalejoki River or the Burnaja) - near Kyrelya village. The southern arm is 150 km long. and the length of the northern one is 61.5 km. The area of the drainage basin of the Vuoksa is large 7344 km^2.

The total length of the rapids of the whole Vuoksa system is 4.5 km, which is 3% of the river. Five rapid sections are located in the main riverbed. Before WWII and right after the War, the key salmon spawning grounds in the Vuoksa system were concentrated at four spots: Kamenogorsk, Gremutchiy lock, Losevo station and Taipale. However, at present active spawning grounds remain only on the rapids of the Kiviniemi (Losevo station) and Bolshoi Porog at Taipala (picture 4). The total area of SNG used to be an estimated 45 hectares, but today the area of actually active SNG has shrunk almost tenfold and does not exceed five hectares.

Young salmon spend from 2 (great majority) - 3 years in the river and on average two years in the lake. Thus, the average age (river + lake) of salmon in the Burnaja makes 4 - 5 years (variation is from 2 - 11 years). The average weight of spawners was from 2.9 - 3.9 kg with annual variation. Some cases were recorded of small male salmon being caught that were "post-smolt" or "pre-grilse" that weighed 400 - 500 grams and that were returning to the river the same year they had migrated down the stream to the lake, i.e. after one year of fattening in the lake. However, some facts are known about salmon being caught that weighed up to 10.4 kg. All large individuals were of old age – up to 11 years old – and had several spawning rings. Up to 30% of the individuals spawn a second time including those 3.8% that have two spawning rings and 2.3% with three rings.

Picture 4. Rapid "Bolshoi Porog" at the Taipala River (southern Vuoksa River).

Salmon of the Burnaja typically migrate for spawning in summer and autumn. Salmon spawning occurs in October at water temperatures from 8.6°C down to 2.2°C. The number of the salmon spawning population in the late 19th – beginning of 20th century came to over 10 000 individuals in the Taipala (Southern arm) and from 1000 to 5000 individuals in the Vuoksa (Northern arm). Up to 45 tonnes of salmon were caught annually at that time. In the 1920s and 1930s the number

of the spawning population in the Vuoksa did not change though in the Taipala it was reduced from 5000 to 1000 individuals and the yearly catch was 8 - 9 tonnes. In the 1940 - 50s the salmon population in the Taipala varied from 1000 to 5000 individuals and in the Vuoksa from 100 - 500 individuals. In the 1960s salmon fishing completely ceased.

During the last 10 - 15 years the number of the salmon spawning population in the Burnaja River has been estimated at 500 - 1000 spawners. The data obtained during the recent 15 years on the density of young salmon at the best SNG in the area of Bolshoj Porog (from 20 - 26 individuals/100m^2) give evidence of the fact that the numbers of young salmon in the Vuoksa are much lower than the potential. Therefore, in the recent years natural regeneration of salmon in the Burnaja River can be characterized as extremely unstable, and numbers of salmon are far from the potential of 2500 individuals.

SALMON OF LAKE ONEGO

In the late 19th century, salmon entered a minimum of 22 tributaries of the Lake Onego for spawning (Smirnov, 1971). It is known for certain, that Onego salmon used to spawn in the following tributaries: the Lososinka, the Shuja with tributaries the Syapsya and the Malaya Suna, the Lizhma, the Unitsa, the Kumsa, the Povenchanka, the Nemina with the Pazha tributary, the Pyalma with its tributaries, the Tuba, the Vodla with its tributaries the Vama and Koloda, and Andoma, the Vytegra, the Megra, the Vodlitsa, the Shoksha, the Tambitsa, the Arzhema, the Vozritsa, the Neluksa, the Isselga and the Filippa.

The picture of the degradation of natural reproduction in the main rivers (besides secondary tributaries) in the basin of Lake Onego is the following:

- By the end of the 19th century, salmon became extinct in the rivers Shoksha, Tambitsa, Arzhema, Vozritsa, Nekuksa and Filippa;
- By the end of the 20th century the same happened in the rivers Suna, Lososinka, Unitsa, Nemina, Tuba and Megra (picture 5);
- Given the existing pressure from poaching, salmon will disappear from the Lizhma, the Vama (the key spawning tributary of the Vodla) and the Pyalma within the next 5 - 10 years.

At present, the spawning and nursing potential of the tributaries of Lake Onego come to about 223 hectares but only 15 - 20% of it is used for salmon spawning. The largest areas of SNG have been preserved on the Shuja River and its tributary the Syapsya (60% of the total area of SNG of Lake Onego), in the Vodla with its tributaries (17%), in the Pyalma (13%), in the Kumsa (4%) and in the Lizhma (2%). The other rivers share about 4 % of the total area of SNG of the Onego basin. At the same time, more or less stable reproduction has been preserved only in the Shuja, the Kumsa and the Pyalma. It is obvious that the numbers of the spawning population in all rivers are much smaller than the potential. This can be perfectly demonstrated by the example of the Lizhma River where in the period from 1987 to 2006, the number of young salmon at SNG was reduced by more than ten times. During the same period, the number of young salmon was reduced threefold in the Pyalma.

Picture 5. Salmon rivers of Lake Onego with identification of the up-to-date status of salmon populations. Black – extinct population (today conditions are unsuitable for restoration of the population); green - extinct population (the environment in the river is suitable for the restoration of the population); red – the population is on the verge of extinction; orange – the population is being kept up by natural spawning and by fish farming.

Productivity of those tributaries differs in terms of the number of migrating young salmon (individuals/hectare SNG), and it is determined by river specific hydrological features and different food availability. The Nizhnyaya Lizhma turned out to be the most productive river where the yield of migrating salmon/hectare of SNG was 10 times higher than in the other tributaries. Up till now, despite a drastic reduction in the numbers of salmon, SNG of the Lizhma

can be taken as a model for restoration of the SNG of other rivers. According to our estimates, the total productivity of all spawning tributaries of Lake Onego produced 65 - 70 000 smolts annually during the period 1950 - 1960. In the period from 1998 to 2006, this number did not exceed 15 - 20 000.

The Lososinka River

The Lososinka River is 23.3 km long and the drainage basin is 322.5 km^2. The river flows from Lake Lososinnoje and has three water reservoirs in its lower reach. The most suitable sections of SNG are located in the section 16 km upstream from the mouth, and the rapids constitute an insignificant area, only 20%. Possibly, salmon have migrated upstream to Lake Lososinnoje, but no data on the distribution of salmon in this river has been kept. The optimal number of the spawning population of salmon in this river is an estimated 1000 individuals.

The Shuja River

The Shuja River is 272 km long and flows from Lake Suojarvi, and it has a drainage basin of 10267 km^2. Two large tributaries of the Shuja, i.e. the Syapsya (34 km) and the Malaja Suna (23.2 km) were considered salmon rivers before they were regulated. At present, three sections still harbour active SNG areas: in the Syapsya (between 124 - 102 km from the mouth of the Shuja) and in the Shuja itself a bit lower than Lake Vagat (between 84 and 6 - 20 km from the mouth). Before the construction of the HPP in the vicinity of Ignoily village (130 km from the mouth) salmon reached as far as Lake Salonjarvi (208 km from the mouth). Its spawning grounds were in a rapid canal Karatsalma (4 km) which connects this lake with Lake Suojarvi (between 193 - 130 km from the mouth). In the Malaya Suna the spawning grounds were in the middle reach of the river (between 154 and 143 km from the mouth of the Shuja), but after the construction of a dam seven kilometres upstream from the point where the Malaya Suna enters the Shuja these grounds became inaccessible for salmon.

The current situation is that effective spawning takes place only at three main rapids in the whole drainage basin. According to our estimations, about 80% of all spawners entering the river spawn at Vidany rapids. The rest are spawning at Besovetskii (about 10%) and Nizhnebesovetskii (about 5%) rapid and just a small number spawn at Kindasovaskii, Kutizhemskii, Yumanishji and Tolli rapids although they constitute rather a large area of the spawning and nursing grounds of the river (picture 6).

Picture 6. Typical spawning and nursery ground of salmon at the Shuja River.

Since 1977, the Shuja salmon has been bred at the Kem fish farm located in the basin of the White Sea, 400 km from the spot where young salmon are released into the Shuja. Restocking has secured a rather stable number of the salmon population in the river, which allowed excluding the Shuja population from the Red Data Book of the Russian Federation in 2004 with the aim to use the river for amateur and sport fishing. Applications from only Russian sports fishing organisations exceed many times the catch limits established for the river which for the period of 2005 - 2007 was set to 17 tonnes. At the same time, poachers catch up to 120 tonnes of Onego salmon annually.

The key factor, which keeps up the numbers of salmon in Lake Onego is the release of farmed young fish. As our research has shown, natural reproduction at present plays a secondary role in forming the numbers of fattening salmon in Lake Onego. Today, individuals of farm origin dominate in the waters of Lake Onego. The ratio between "wild" and "reared" salmon is given in table 1.

Table 1. The ratio between "wild" and "farmed" salmon in the test catch in Lake Onego (%).

Year	«Reared»	«Wild»	
		Shuja salmon	Salmon from other rivers
2002	57.3	39.0	3.7
2003	67.6	25.0	7.4
2004	69.5	17.0	13.5
2005	60.5	25.0	14.0
2006	51.8	35.9	12.3
2007	60.5	35.0	4.5

On the whole, the spawning population of the Shuja salmon has recently increased from 1500 to 3000 individuals, however far from the potential number of 12000 spawners.

The Suna River

The Suna River is 281.6 km long and has a drainage basin of 7665 km^2. There used to be three clusters of spawning grounds; in the Tivdiika (tributary of the Suna, 16 km), in the Sandalka (tributary of the Suna, 14.9 km) and the Suna itself down from Kivach waterfall (30.0 - 0.1 km from the mouth); the lowest spawning ground (Nizhka rapid) was located almost in the river mouth. However, due to serious changes in the hydrological regimes of the whole river system in the 1920 - 1950s (switch of the Suna flow to Tivdiika. blocking the Sandalka with a dam etc.) most of the spawning grounds ceased to exist. The area of the remaining spawning grounds is sufficient for keeping up a salmon population of 500 spawners (picture 7).

Picture 7. Re-cultivated rapids of the Suna River.

The Lizhma River

The Lizhma starts in a nameless lake and flows into the Chorga Gulf of Lake Onego. The Lizhma cuts across three lakes; Lizhmozero, Kedrozero and Tarasmozero. The total length of the river is 68.3 km, and the area of the drainage basin is 717.6 km^2. The upper section of the Lizhma (The Verhnaya Lizhma) is 12 km long from the source to Lake Lizhmozero. The total length of salmon SNG in this section is 3.4 km, and the area is 1.4 ha. The Srednaja Lizhma is 12.2 km long; with just a few rapids, and the SNG is not more than 0.4 ha. The Nizhnaja Lizhma is about 4 km long. The section of the river between Kedrozero and Tarasmozero lakes is 800 m long, and has rapids all the way. The area of salmon SNG in this section totals about 2 ha. There are three rapids below Tarasmozero with the area of SNG of 1.8 ha. Small spawning grounds still remain in the Elgamka, a tributary of the Lizhma.

Thus, the total area of the SNG of the river makes 5.6 ha with active SNG of 3.8 ha. Previously, the Lizhma was considered to be one of the most productive salmon rivers. In 1916, the salmon catch in the Lizhma was 2000 salmon (Petrov, 1926). In the 1970s the number of the spawning population had an estimated 200 individuals (Smirnov, 1971). At present, poaching on the river is so severe that the number of annually spawning fish does not exceed 100 individuals. At the

same time, the area of SNG of the river is enough for reproduction of a salmon population of 2500 spawners.

The Unitsa River

The Unitsa is 56.7 km long and has a drainage basin of 394.3 km^2. In the old times, the riverbed was straightened in many places to make timber floating easy, which resulted in destruction of salmon SNG. Later on, the Unitsa was merged with the Pigmozerka, and several dams were built. Before the dam, salmon had been caught at the section of the river of about 40 km from the mouth of the Unitsa. Salmon no longer enters this river for spawning. The remaining areas of SNG in the river are sufficient for the reproduction of up to 500 salmon spawners.

The Kumsa River

The Kumsa River is 60.2 km long and has a drainage basin of 745.4 km^2. Despite the fact that the riverbed was blocked with dams in the upper, middle and lower reaches, salmon has remained there till now. Salmon SNG are located between the mouth of the Oster River and the lower rapid (Zakharjevkii or Zavodskoi) (15.3 - 2.7 km from the mouth of Kumsa) but possibly up to 37 km from the mouth (six rapids with the total length of 1350 m with the average width of 12 m and an area of 1.6 hectares). People in the area used to catch salmon and young salmon and observe spawning in the river below where the Oster River joins the Kumsa River. At present, the numbers of spawners entering the river for spawning every year does not exceed 100 fish, given the potential number of 1000 spawners.

The Povenchanka River

The Povenchanka River used to be 16 km long and the area of the drainage basin 822 km^2. The SNGs of the river were located between 10 and 0.3 km from the mouth and were about 8 km long. However, after the Povenchanka became part of the White Sea – Baltic Sea Channel, salmon ceased to exist in the waters of the river.

The Nemina River

The Nemina is 79.4 km long. and has a drainage basin of 635.2 km^2. Salmon spawning grounds are located both in the Nemina itself (22 - 8 km from the mouth) and in a tributary, the Pazha (46 - 40 km from the mouth of the Nemina). Salmon never moved to the upper reach of the Nemina, above the joining with the Pazha (30 km from the mouth); therefore, the splash dam situated 0.3 km above the mouth of the Pazha does not hinder spawning. At present, the number of the spawning population in the river does not exceed 10 - 20 salmon given the potential number of 500 spawners.

The Pyalma River

The Pyalya is 68 km long, and its drainage basin is 922.2 km^2. It was previously thought (Smirnov, 1971) that the key spawning grounds of salmon were located in the Pyalma itself (6.0 - 0.4 km from the mouth) and in its tributary, the Zhilaya Tambitsa (30 - 22 km from the mouth of the Pyalma). There are some suitable rapids in a tributary of the Zhilaya Tambitsa, the Tuna (joins the Tambitsa 17 km from the mouth), but they are only 4.5 km long (40 - 35 km from the mouth of Pyalma), and their area is extremely small. Salmon never entered the upper reach of Pyalma (above where the Zhilaya Tambitsa joins the Pyalma); only brown trout can be found in this river stretch.

The Pyalma used to be the third largest river of Lake Onego in terms of salmon numbers; however, as of today it has lost its significance in this respect due to extensive poaching. Test fishing in SNG (picture 8) showed rather low density of one year olds (24.4 individuals/100 m^2) and parrs (13 individuals/100 m^2) at the rapids close to the mouth, and no young salmon at the other rapids, giving evidence of the poor situation of natural reproduction. Judging by the density of young salmon at present, only a few dozen salmon spawn annually, given the potential number of 2500 individuals.

The Tuba River

The Tuba is 15.5 km long and has a drainage basin of 324.2 km^2. There are three spawning rapids on this short river at a 4.5 km section upstream from the mouth. The key rapid is Velikii Kamen (4.5 - 2.5 km from the mouth). The rapids upstream from this rapid are not suitable for spawning (blocks, boulders and large rocks). At present, only single salmon fish can be found in the river. Estimates have shown that the optimal number of spawners in the river is not higher than 100 individuals.

Picture 8. Electro-fishing at nursery grounds of the Pyalma River.

The Vodla River

The Vodla, being 169.5 km long, has the largest drainage basin among all salmon rivers of Lake Onego, 13655 km^2. The key spawning and nursing grounds are located in the tributaries of the river. Primarily in the Vama (170 - 147 km from the mouth of the Vodla) which springs from Lake Vodlozero (the total length of the Vama is 23.4 km). The main problem of the Vama salmon is a former timber floating dam at its source. Rising of the lake level results in considerable drying of spawning grounds and freezing of redds in the river, as well as high death rate of eggs and young salmon during the winter. Besides, a significant number of spawning salmon aggregate right before the dam where salmon is caught by poachers. We did not find young salmon in the section of the river 4 km down from the dam despite availability of spots suitable for spawning. The first salmon parrs we found at a rapid in the middle reach and in scarce numbers (density 10 individuals/100 m^2).

There are no salmon spawning grounds in the Vodla itself apart from a small section after the tributary Vama has joined Vodla. A much more favourable situation for young salmon is in the Koloda River, a rather lengthy tributary of the Vodla (110 km). Salmon parrs evenly inhabit all

rapids and their density is 40 individuals/100 m^2. In total, salmon spawning and nursing grounds of the Vodla River make up 37 ha including; the Vama – 16 ha, the Koloda – 10 ha and the Vodla – 11 ha. At present, the numbers of spawners annually coming for spawning to the Vodla is estimated at a maximum of 100 salmon. The areas of SNG in the river are enough for reproduction of a population of 3500 salmon spawners.

The Andoma River

The Andoma River is 156 km long and has a drainage basin of 2570 km^2. SNGs in the Andoma itself (Malyanovskije rapids 60 - 50 km from the mouth) are cut of by a HPP dam. The rest of the spawning grounds are located in the Samina River, a tributary of the Andoma. At present, the spawning population of salmon in the Andoma does not exceed a few dozen spawners. The potential number of the spawning population is estimated at 500 individuals.

The Vytegra River

The Vytegra – a 66-kilometer long river with a drainage basin of 1280 km^2 – became part of the Volga – Baltic Channel, and it was blocked with locks. By 1961, a tiny spawning ground was located below the first dam near Vytegra but as a result of the reconstruction of the channel it disappeared and this watercourse lost the status of a salmon river.

The Megra River

The Megra River is 69 km long and has a drainage basin of 660 km^2. Spawning grounds are located 12 km upstream from the mouth; however a dam blocks the way for salmon. Modern salmon population in the river is extremely small and constitutes only of a few dozen spawners. The areas of SNG are sufficient to keep up a spawning population of 100 salmon.

The Vodlitsa River

The Vodlitsa flows for 43 km and has a drainage basin of 411 km^2. Salmon and whitefish used to enter the river for spawning via lakes Megorskoye and Vodlitskoye above a point 10 km from the mouth. The river has lost the status of a salmon river.

ACTIVITIES AIMED AT CONSERVATION OF LAKE SALMON POPULATIONS

Analysis of research on salmon rivers show that as of today 13 rivers (besides tributaries) of the basin of Lake Ladoga and nine rivers of the basin of Lake Onego still hold freshwater salmon populations. However, the situation of Atlantic salmon reproduction in Ladoga and Onego is evaluated as extremely poor. No more than 1000 spawners enter the basins of the rivers Vodla, Svir, and Vuoksa (with numerous tributaries) that very recently used to be of the utmost significance in terms of fishing and fish breeding. The Svir salmon population has almost completely disappeared after the river was blocked by a dam of the Nizhnesvirskaya HPP. Natural reproduction remains just in two lower tributaries of the Svir i.e. the Pasha and the Ojat. However, poaching is on the verge of extinguishing the population in the river. Natural reproduction has long played no crucial role in keeping up the numbers of feeding salmon in Lake Onego: the largest spawning salmon population of the Shuja River is composed of 60% reared individuals. In other rivers, that are of less significance, predominantly in the northern parts of Lake Ladoga and Lake Onego, the conditions of salmon reproduction have deteriorated to such an extent that many salmon populations are on the verge of extinction. No more than a few dozen spawners enter those rivers. Due to the overall reduction of the areas of SNG, almost everywhere in the rivers of Ladoga and Onego, salmon is being gradually replaced by the closely-related, brown trout (table 2).

According to calculations, at present about 25 000 and 17 000 smolts of freshwater salmon migrate down the stream from salmon tributaries into Ladoga and Onego lakes respectively. Not more than 2500 spawners enter the same rivers of Lake Ladoga for spawning, and about 3000 salmon spawners enter the rivers of Lake Onego including 2500 spawners from the Shuja population. At the same time one should take into account that the existing spawning and nursing grounds in the rivers of Ladoga and Onego together allow to secure spawning of a minimum of 50 000 spawners and production (given the existing food resources) of a minimum of 250 000 smolts. If we consider potential spawning and nursing areas as well, those figures might increase by 4 - 5 times. The existing food supply in lakes Ladoga and Onego is no limit, and it can ensure fattening of the populations even in their maximum numbers.

For restoring the numbers of the populations and preserving the gene pool of freshwater salmon in the basin of lakes Onego and Ladoga, it is essential to implement a comprehensive program of developing salmon farming in Onego and Ladoga areas. The program should incorporate three key areas:

- Restoration of salmon rivers;
- More intensive salmon farming;
- Enhancement of the system for protecting salmon water bodies.

Activities in the first area should encompass mainly the works on melioration of the riverbeds of salmon rivers (extraction of sunken timber, complete elimination of outdated and unused dams etc.) and reclamation of potential spawning and nursing grounds (removing timber and other litter, restoration of rapids, adding pebbles at SNGs etc.). We should note that some negative factors that resulted in the reduction of the numbers or extinction of salmon populations have been partly mitigated by now.

In the 1970s, timber floating was stopped completely on the salmon rivers and the rivers were partly cleaned from logs, some old dams were destroyed which shortened the migration ways and increased the area of spawning and nursing grounds. Some industrial facilities were closed, converted or equipped with treatment plants. Due to the crisis of agriculture in the 1990s the discharge of biogens, fertilizers and herbicides was reduced. Nevertheless, the quality of restoration activities does not meet the requirements of today, and in most cases the environment is not suitable for the normal existence of local salmon populations (table2). Providing proper melioration on the rivers in the Ladoga basin would create a minimum of 100 hectares of additional SNG. In salmon tributaries of Lake Onego, the spawning and nursing areas can be extended by a minimum of 40 hectares.

Development of salmon breeding in Onego and Ladoga regions is to be based on both restoration of habitats and the expansion of existing fish farms (Kem and Svir) and the construction of new up-to-date facilities (in particular in the basin of the Vuoksa River). The essential condition for the effectiveness of salmon breeding in the region is the release of viable downstream migrating juvenile salmon.

If the recommended activities are implemented in all areas of developing salmon breeding, the total stock of freshwater salmon in the basins of lakes Ladoga and Onego can be increased by 10 - 15 times and reach the previous (1930s) maximum fishing levels (not less than 200 - 300 tonnes of product). A considerable increase of the Ladoga and Onego salmon stock will facilitate licensed sport fishing on both lakes. Development of the infrastructure for sports fishing will provide an opportunity for new jobs, first of all, for the local people of the Ladoga and Onego areas. Fishing business will help attract additional financial resources to regional budgets and at the same time some money from selling licenses could be used for the activities aimed at

providing environmental education to the local people. Taking into account that the increasing burden of poaching has recently become the key factor limiting the numbers of salmon in all rivers of lakes Onego and Ladoga, it is necessary to realise that the planned activities can bring results only providing that effective protection of water bodies is in place.

Systematic analysis of available data allow us also to pinpoint the key areas of ichthyologic studies in the rivers of the basin of lakes Ladoga and Onego that needs to be performed:

1. Assessment of actually existing and potential spawning and nursing grounds of lake salmon and spawning grounds in the rivers of Ladoga and Onego;
2. Assessment of the up-to-date situation of natural reproduction of freshwater salmon (data on the numbers of migrating and fattening young salmon and numbers of spawners entering the rivers for spawning) in spawning tributaries of Ladoga and Onego;
3. Development of a register (list) of rivers that lost their natural populations of freshwater salmon;
4. Search for potential donor populations (of farm and natural origin) for compensation releases of young salmon into the rivers that have lost their salmon populations with the aim to restore natural spawning.

Table 2. The number of the spawning populations of lake salmon in the tributaries of lakes Ladoga and Onego. Factors that have an impact on the local salmon populations. Poaching is a factor in all rivers and not included in the table. Presence of brown trout in the river is indicated.

The basin	The river	Present number of salmon spawning populations (individuals)	Potential number of salmon spawning populations (individuals)	Factors that influence the condition of the SNG and the population size			Presence of brown trout in the river
				HPP and dams	Timber floating	Pollution	
LAKE LADOGA	*Hijtola*	<150	2400	+	+	+	+
	Suskuanjoki	<40	100	+	-	+	+
	Ikhala	-	250	+	+	+	+
	Mijnala	-	100	-	+	+	+
	Tokhma	<50	500	+	+	+	+
	Yanisjoki	Isolated occurrences	1000	+	+	+	+
	Suskuanjoki	<100	500	-	+	+	+
	Kojrinjoki	-	50	+	+	+	+
	Uuksa	<100	1000	+	+	+	+
	Tulema	<200	800	+	+	+	+
	Vidlitsa	<100	3000	-	+	+	+
	Tuloksa	Isolated occurrences	800	-	+	+	+
	Olonka	-	500	-	+	+	?
	Svir	Isolated occurrences	?	+	+	+	+
	Pasha	600-700	~5000	+	+	+	+
	Ojat	500	~5000	+	+	+	+
	Syas	-	?	+	+	+	+
	Vuoksa	500	2500	+	-	+	+
LAKE ONEGO	*Lososinka*	-	1000	+	+	+	+
	Shuja	< 2500	12000	+	+	+	+
	Suna	-	500	+	+	+	?
	Lizhma	< 100	2500	+	+	+	+
	Unitsa	-	500	+	+	+	+
	Kumsa	< 100	1000	+	+	+	+
	Povenchanka	-	0	-	+	+	-
	Nemina	< 100	500	+	+	+	+
	Pyalma	< 100	2500	-	+	+	+
	Tuba	Isolated occurrences	100	+	+	+	+
	Vodla	< 100	3500	+	+	+	+
	Andoma	< 100	500	+	+	+	+
	Vytegra	-	0	+	+	+	?
	Megra	Isolated occurrences	100	+	+	+	+
	Vodlitsa	-	0	-	+	+	+

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