Ministry of Agriculture of the Russian Federation
Federal Agency for Fisheries
Federal State Budgetary Scientific Institute
RUSSIAN FEDERAL RESEARCH INSTITUTE OF FISHERIES

AND OCEANOGRAPHY
Sakhalin Branch of FSBSI «VNIRO» (SakhNIRO)

UDC
574

[Official seal of the Sakhalin Branch of FSBSI «VNIRO» SakhNIRO]

APPROVED
Acting Head of the Sakhalin Branch of FSBSI «VNIRO» SakhNIRO

PhD, Biology
V.V. Lapko,
2021

REPORT
ON SCIENTIFIC RESEARCH WORK

Fishery Survey of Water Bodies of Kunashir Is. (Lake Ilinskoye, the Pervukhina R., and Lake Lagoonnoye) during the 2021 Spawning Migration of Pacific Salmon

(Agreement № 03-78/2021 dated August 9, 2021 with
LLC PKA “Yuzhno-Kurilsky Rybokombinat”)

Project Director:
Head of the
Hydrobiology Lab

E. S. Korneev

Yuzhno-Sakhalinsk 2021

PROJECT IMPLIMENTATION:

Project Facilitator, Head of the Salmon Research Laboratory	signature	E. S. Korneev (general leadership)
Responsible Party: Senior scientist of the Department of population dynamics of Pink Salmon and other salmon with prolonged freshwater life cycle stage, PhD, Biology	signature	A. A. Zhivoglyadov (Introduction, chapters 1, 2, 3, 4, Conclusion)

ABSTRACT

Report 45 pp., 9 tables, 24 figures, 28 references.

AGREEMENT № 03-78/2021-RESEARCH IN THE PERVUKHINA RIVER, LAKE LAGOONNOYE, LAKE ILINSKOYE (KUNASHIR ISLAND): PACIFIC SALMON, ASSESSMENT OF REPRODUCTIVE SUCCESS.

Iturup Island is the main Pacific salmon reproduction zone (both natural and hatchery produced) on the South Kuril Islands, where, in spite of a relatively small spawning area, up to 40 thousand tons of Pink Salmon were harvested in some years.

Salmon reproduction in the waters of Kunashir Island occurs on a significantly smaller scale, although in the last few years, the island has attracted much attention for its salmon aquaculture potential. Of principle interest here is the potential for a large scale artificial reproduction of Pacific salmon (there are already two hatcheries operating on the island), as well as the existing stocks and reproductive success of wild fish. In this context, monitoring activities appear to be necessary in some Kunashir Is. water bodies.

TABLE OF CONTENTS

INTRODUCTION

The Kuril Islands can be considered one of the more valuable Pacific Salmon *Oncorhynchus* reproduction areas, where a significant number of Pink and Chum Salmon are produced on a relatively small spawning area (0.8 mil. m^2) allowing for the harvest of up to 40 thousand tons in some years [1].

Beginning in 1994, monitoring of Pacific Salmon stocks has been conducted on Kunashir Is., although on the ground observations were discontinued in 2013, making only expert estimates of Pink and Chum Salmon escapement since then. Until recently, Kunashir Island was one of the few areas in the Sakhalin region, where Pink and Chum Salmon stocks were regenerated via strictly wild reproductive capacity. Both species migrate into almost all of the Kunashir Island rivers.

Kunashir Chum Salmon is represented by two ecotypes: lake Chum and river Chum which is smaller in size. Lake Chum accounts for approximately half of the wild production on the island [2]. Chum Salmon population abundance in the river and lake systems of the island is not large.

The role of salmon hatcheries in this region is looming and continues to grow. Iturup Island is the main Pacific salmon reproduction (both natural and “industrial”) site on the Kuril Islands, however in the recent years, salmon hatcheries are also being build and operated on other islands in the chain.

Specifically, there are already two hatcheries on Kunashir and several more are in various stages of design.

The goal of this research is to assess the 2021 reproduction level of Pacific Salmon (Pink and Chum) in the Pervukhina R., and lakes Lagoonnoye and Ilinskoye (Kunashir Island).

This scientific research objectives are as follows:

- to conduct field surveys in the identified above water bodies;

- analyze and summarize the data obtained during the planned field work; provide an overview of the Sakhalin Branch of FSBSI «VNIRO» (SakhNIRO) archival resources and other available literature;

- and provide a report characterizing 2021 reproduction levels of Chum and Pink Salmon in the Pervukhina R., as well as lakes Lagoonnoye, and Ilinskoye (Kunashir Is.).

This research is based on the Agreement between LLC PKA "Yuzhno-Kurilsky Rybokombinat" and Sakhalin Branch of FSBSI «VNIRO» (SakhNIRO) № 03-78/2021 dated August 09, 2021 and titled "Fishery Survey of Water Bodies of Kunashir Is. (Lake Ilinskoye, the Pervukhina R., and Lake Lagoonnoye) during the 2021 Spawning Migration of Pacific Salmon".

1 PHYSICAL AND GEOGRAHIC DESCRIPTION OF THE STUDY REGION

Kunashir is a part of the Greater Kuril Islands stretching for 1,200 km between Point Lopatka (Kamchatka Peninsula) and Shiretoko Peninsula (Hokkaido Is.). The straits of Bussol and Krusenstern, deeper than the other straits in the region, divide this island chain into three sections: north, middle, and south.

Kunashir is the most southern of the islands. Its length is 123 km, the shoreline circumference — 349 km, and the area — 1,555 km^2 [3]. Kunashir is separated from the nearby Iturup Is. by the Ekaterina Strait, which is 23.2 km in width, with the deepest point of 485 m. The average depth of the strait is 235 m.

In the west across the Kunashir Strait, the Shiretoko Peninsula range of mountains lies and just south of the island across the Izmeny Strait is the low plains of Hokkaido Is. In the southwestern direction beyond the South Kuril Strait lies the Lesser Kuril Chain of islands that includes a relatively large island of Shikotan and several small land masses not distinguished by any significant landscape features.

The Kuril Islands' origin is related to the geological processes of the Quaternary sub-era. The land above the water level is mostly composed of the Quaternary period volcanic layers: andesite, basaltic andesite and basalt, and in places — tuff and tuff breccia.

As a result, the soil here is easily permeable to water and acidic in qualities, additionally characterized by an increased level of silicon oxide, coarse-silty structure, little amount of melkozem, significant fragmentation and porosity [3]. The islands are located in the zone of high mobility of the earth crust, increased seismic activity, intense modern day volcanic activity above and below the water level, heightened topographic ruggedness, significantly thick sediment layers and fast sediment accumulation [4].

With these factors at play, almost all of the islands are characterized by high meso- and micro- irregularities of the ground surface with distinctively mountainous features. In general, the orography of the Kuril Islands is dominated by marine terraces, volcanic plateaus, mountains and hills. Low rising cones of various volcanoes protrude here and there against the background of monticulate features. Kunashir is not an exception from this rule. As to its topographic characteristics and the degree of relief ruggedness, the island is predominantly mountainous in its orthography.

The island carries a chain of merged volcanoes, one of which (Volcano Tyatya, 1,819 m) lies in the northern part of the island and is the second tallest among the Kuril volcanoes. Kunashir Island coast is distinguished by abrasion and therefore erosion in various stages of progression. Most commonly, coastal cliffs in a completed erosion process are found, with sediment and larger fragments' accumulation at their bases.

On the one hand, this provides shallow rearing areas near the island shores much needed for salmon juveniles, while on the other hand, the island has fewer harbors than the nearby Iturup Island, where juvenile salmon spend their early marine life stage and which serve as safe refuges during sea storms [5-7].

Climate. The climate of the Kuril Islands is affected by a complex interaction of factors, constantly at play on seasonal and multi-year basis. These are solar radiation, air circulation, and the geological terrain. The radiation levels are substantially lower here than on Sakhalin and especially the mainland of the Russian Far East or the central or northern Kuril Islands. Diffused radiation value (56.2 and 55.5 kcal/cm^2) on Kunashir is almost identical to that of Yuzhno-Sakhalinsk, although both the total radiation and the radiation balance are 10.7 and 5.7 kcal/cm^2 lower. These particularities are caused by the latitudinal and oceanic position of the island surrounded by cold currents and the Sea of Okhotsk. All year round, Kunashir island is subject to cold and moderate marine air circulation, which arrives from the Sea of Okhotsk with easterly blowing winds, and from the Pacific Ocean with westerly and southerly winds. This gives the Kuril Islands their standard marine climate marked by specific climate regime and metrics. The marine climate is typically denoted by frequent weather changes, increased cloud cover, fogs, and a high level of annual precipitation [4]. Kunashir matches these characteristics fully: its climate is of the standard marine kind. It enjoys moderate yearly fluctuations of air temperature without abrupt swings and a relatively small (15-24°C) annual range [8]. Winters are mild and last from the middle of December to March. Snow cover forms around December 20 – January 10 and begins to disappear at the end of March – early April. Winter seasons are usually exemplified by thaws, especially in December when thawing occurs almost every day; in January and February thawing takes place five to ten days per month.

Occasionally, it can be foggy and rainy in the winter. February is typically the coldest month with air temperatures falling to -24°C on some of the days. Spring begins in April and lasts for three months. It is cold and humid with frequent rains. Summer arrives in the third decade of June —early July and continues for up to three months. The warmest month of the year on Kunashir is August (maximum temperatures reach 28°C). Higher humidity is typical of the summer months when it is usually at the level of 90-97%. Such high level of humidity generate frequent and continuous fogs. It is possible that over the course of a month, 26-28 days would show no sunshine at all. The freeze free period is up to 180 days. In the winter, the island is often observed to have strong, primarily northwestern winds. In the summer, wind speeds are insignificant, about 3-6 m/sec.

Precipitation is most often formed as a result of cyclone activities. Their frequency is highest in September and October when the maximum monthly precipitation reaches 410 mm. Over the warmer part of the year (March to November), about 65% of annual precipitation falls accumulating the annual average of 1,356 mm [8]. Over the course of the year, the minimal level of precipitation occurs in February. The highest amount of precipitation falls during tropical typhoons; wind speeds during such events can reach 60 m/sec with precipitation level of 100-150 mm, which is often higher than the monthly average. During summer, frequent southerly and southeasterly winds are typically observed.

The relatively small range of air temperature variations over the course of a year also hardly fluctuates from year to year, as can be determined from standard deviation values. Combined with the precipitation quantities and high humidity, this creates hospitable conditions for spawning and subsequent egg and embryo development (water column freezing during winter is not a risk, and sufficient water levels in the rivers for spawner migrations are always the case). That said, precipitation amounts can be very different from year to year, since they are related to typhoon activities, especially in the fall. This factor can play a negative impact on reproductive success of salmon in some years due to riverbed scouring after spawning is complete, as has been observed on Iturup Island [7].

Coastal Marine Waters. The hydrological regime of the coastal marine waters proximate to the South Kuril Islands is controlled by the interplay of a variety of water masses. There are cold waters of the powerful Oyashio Current flowing from the northeast along the Kuril Chain [9]. Warm waters enter from the south via the branching Kuroshio Current and the Soya Current coming from the west. Water exchange between the ocean and the Sea of Okhotsk takes place via the Kuril Islands' straits [10.11]. It is notable that the Sea of Okhotsk water drainage into the Pacific Ocean occurs through all of the shallow straits (except for the Diana and Nadezhda straits), whereas the entry of mixed oceanic and Sea of Okhotsk waters into the Sea of Okhotsk, which is commonplace in the southern deep portion of the sea, occurs through the mentioned earlier deeper straits [12].

Kunashir is the only island of the Greater Kuril Chain with the coastal water temperature regime determined for the most part by the influence of the warm waters of the Soya Current. Thus, speaking from the zoological perspective, the island is located in a different, "warm" area as compared to the nearby Iturup [12.14]. The biological community of the coastal Kunashir Island waters is the result of a substantial blend of northern and southern aquatic organisms.

Internal Waters of Kunashir Is. Specific features of the internal waters of the Kuril Islands are formed by the combination of various forces, such as volcanic rocks, volcanic topography and marine climate. Rivers are predominantly (98.4%) below 10 km in length. The island rivers can be classified into two main categories: those with a graded (these are primarily larger streams) and poised type of long profile. The latter are characterized by a higher gradient in the upper and lower parts of the channel, where they form waterfalls and rapids. This makes for a variety of river valley types on the islands — from the V-shaped river valleys to the typical terraced valley profile. The river network drainage density is less than 1.0 km per km^2 on most islands of the chain (it is 0.84 km/km^2 on Kunashir), which is lower than on Sakhalin (1.3 km/km^2) and is related to permeability, coarseness, and the uneven surface of the volcanic soil which absorbs a significant amount of water and therefore, reduces the surface flow and the development of river systems [4]. At the same time, the lithological composition of the Kuril Islands provides for a deep circulation of

groundwaters and their active seepage through stream and lake beds. For this reason, the high volume of groundwater inflow into the Kuril Islands' streams during an average precipitation year is about 50% of the total discharge, whereas for Sakhalin, this proportion fluctuates between 20 and 30% [8]. The enhanced role of groundwater in the feed ratio of the Kuril streams is also explained by the crumbly volcanic rocks of the Quaternary period that form the riverbeds of the water basins in the region.

There are 518 streams on Kunashir with the total length of 1,037 km. Most of them are mountainous in nature. The rivers are typically characterized by steep channel gradient, high flow velocity and rapids. These are relatively short, although copious drainages 4 to 18 km in length and the depth of 0.5-1 m. The rivers collect inflow from small tributaries along their course. Valleys of the largest rivers at the mouths are typically 200-500 meters in width, whereas at the headwaters, they narrow down to 50-100 m. Current velocity in such streams is usually from 0.5 to 1.5 m/sec. Several water bodies in the relatively low southern part of the island can be called exceptions from this rule. In addition, the Sernovodka and the Serebryanka rivers are another notable exception, although these water bodies are channels connecting Lakes Peschanoye and Serebryanoye with the sea. They flow through the vast lowlands of the island.

In some rivers' lower sections, there are waterfall features obstructing the migration of salmon upstream. Most commonly (seven such water bodies), they are encountered in the northeastern and eastern coasts of the South Kuril Strait, whereas there are only three such streams in the western side of the island.

Four seasonal flow regimes are typical for these rivers: spring flooding, summer low flow, fall time flooding and low runoff during wintertime. Abrupt water level rise does not occur in these in the spring, since low air temperatures and cloud cover prevent fast snow melt and, in addition, some of the melting water is absorbed into the soil, which doesn't freeze much and thaws quickly. Spikes in water levels are typical for August – October, when typhoons and severe rainfalls are most expected [15].

The largest lakes on the island are Peschanoye (7,14 km^2), Goryachee (4.5 km^2), Valentiny (0.83 km^2), Serebryanoye (o.82 km^2), and Ilinskoye (km^2).

In spite of the Kunashir's volcanic origin, there are only two lakes on the island that fall under the category of crater lakes: Kipyaschee and Goryachee. The majority of lakes have either the lagoon (Valentiny and Peschanoye) or depression formation (Serebryanoye and Ilinskoye). The lagoon lakes are commonly located in the post-glacial (Holocene) marine and delta lowlands. The history of "sag pond" type of lakes also includes a lagoon stage, which has since led to isolation of the water body from the sea by barriers, such as bay bars. As a result, these lagoons turned into water drainages, then lost their connection with the sea and were subsequently disconnected from it [3].

In winter, the island lakes are covered with ice (usually by January), although some portions of the surface (20 m and more in diameter) may remain open.

2 MATERIALS AND METHODS

The study is based on the available published sources and archival data from Sakhalin Branch of FSBSI «VNIRO» (SakhNIRO) received during the field expeditions of 1977-2021 to the coastal and internal waters of Kunashir Is.

Commercial Fishery Data Analysis. Salmon biomass in the overall harvest, as well as their distribution by fishery parcels in the coastal Kunashir area were determined from the statistical fishery data from the Sakhalin-Kuril Territorial Administration "Rosrybolovstvo".

Spawner abundance at spawning grounds was established in the process of visual fish count during stream walking field work. Consistent observations were conducted in the Ilyushina R. located in the middle section of the Pacific-facing coast. As for the other rivers (Filatova R, Prozrachny Creek, Valentiny R. Severyanka R., as well as the channels of lakes Serebryanoye and Valentiny), field observations were only occasional due to the difficulty of access to these remote locations.

Biological measurements and analysis (AC and AD length, weight, gender, maturation stage and gonad weight - except for the fifth stage of maturation, female fecundity) were all conducted according to the traditional methodology [16]. Chum Salmon aging for the Pervukhina R. was performed by the Sakhalin Branch of FSBSI «VNIRO» (SakhNIRO) staff member I.Y. Onischenko.

Smolt Abundance. Juvenile salmon outmigration was surveyed by deploying the fyke net using the method of selective sampling adapted to small streams typical for this region [17]. In the Ilyushina R., surveying was performed about 300 m upstream from the river mouth (above the tidal zone) in a relatively straight section of the river with a gently curved cross-profile.

The Pervukhina R. survey took place on 9/23/2021 and 11/5/2021, Lake Lagoonnoye — 11/5/2021, Lake Ilinskoye — 11/6/2021. The Pervukhina R. spawner count was conducted on foot; lakes Lagoonnoye and Ilinskoye — from a boat.

The number of spawners at each spawning area on the time of surveying was determined by total count at a chosen study site. Classification of the spawning area was also recorded (creek, spring-fed, lake). The condition and characteristics of each spawning site were also visually determined and recorded (soil type, aquatic flora

and depth). We measured water temperature and dissolved oxygen concentration using an oxygen meter-thermometer HANNA HI 9142. A GPS-navigator was used for directions on rivers and coordinates documentation.

The surface water velocity was measured using the float method. We also measured the width of river channels to calculate cross-profile area. Lastly, we took pictures and video footage of the surveyed sites.

3 PACIFIC SALMON OF KUNASHIR IS.

The gear used in commercial fishing on Kunashir is set net traps; their number for the period from 2001-2010 was 50 on average ranging from 43 to 61 (Table 3.1).

Table 3.1 — Net trap quantity and Pink Salmon catches in various fishing sites on Kunashir Is., 2001-2020 [18].

Site	**Set nets, N**	**Catch, tons**
Sea of Okhotsk Coast	25.9	1,366
Ekaterina Strait Coast	10.3	996
Pacific Coast	10.7	339
Izmeny Bay Coast	0.2	6

The highest number of traps were found on the Sea of Okhotsk coast of the island, with the southern part (Izmeny Bay) showing low abundance of salmon and therefore fished to a small degree.

There are eight commercial fishing sites on Kunashir (Figure 3.1).

Site	Number of net traps	Harvest Rate (%) & its fluctuations(*CV*,%)	
		M	*CV*
1	2.8	6.2	99.8
2	13.8	38.3	25.6
3	8.6	12.9	53.0
4	8.9	26.2	70.4
5	1.8	1.9	161.0
6	6.7	13.5	31.6
7	1.3	0.8	166.9
8	0.2	0.3	344.9

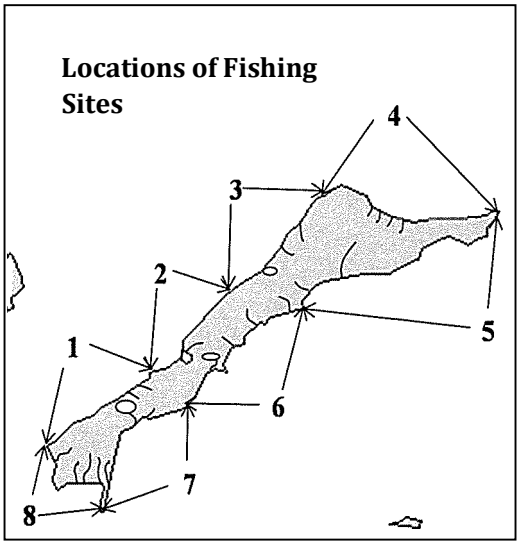

Figure 3.1 — Number of set traps and the percentage of Chum Salmon of the total catch volume by fishery parcel, average for the 2001-2017 period.

3.1 Pink Salmon

Pink Salmon is characterized by two temporal forms. The period of most significant harvest for both generational lines occurred during the end of the 20th and the beginning of the 21st centuries. The odd-year Pink Salmon stocks, having reached the maximum level of 7.4 mln. fish in 2007, fell sharply and were at the minimum

recorded escapement value in 2017 (Table 3.1.1). As to the even-year generations, the lowest escapement was observed in 2014. In 2016 and 2018, spawning abundance (escaped portion of the population) somewhat increased, although did not provide the optimum number of spawners at spawning grounds (about 2 million fish). When the stock's condition was still satisfactory, the average number of Pink Salmon smolts was approximately 150 million fish [19].

Table 3.1.1 — Pink Salmon spawner escapement to Kunashir Island spawning grounds in 2016-2021 (data from the Sakhalin Branch of FSBSI «VNIRO»)

Stream	Spawning area, m^2	2016	2017	2018	2019	2020	2021
Severyanka R.	13,000	-	-	5,300	4100	-	1,640
Luchevoy Creek	4,294	-	-	-	0	-	370
Sevebryanka R.	13,000	-	-	-	-	5	630
Prozrachny Creek	816	600	single	3,200	250	7,800	120
Valentiny Creek	740	1,100	-	3,520	260		
2nd Dachny Creek	170	250	-		-	1,500	38
Asin Creek	5,000	5,300	single	9,700	520	8,200	220
Polynova	3,760		-	15,200		19,200	270
Filatova	9,820	2,000	-	14,500	2,800	23,000	1,470
Ilyushina R.	21,000	9,870	single	13,800	2,150	20,400	840
Tretyakovka Creek	1,021	1,600	-	126	-	0	-
Saratovka R.	30,000				20	-	-
Okunyevka R.	160	26	-	-	-	-	-

Spawning Migration and Spawning. Pink Salmon is the most abundant species of the *Oncorhynchus* genus in the rivers of Kunashir Is. The first reports on the biology of the Kunashir Pink Salmon were compiled by V.N. Ivankov [20], followed by studies conducted by Kaev and Romasenko [19].

The list of the main salmon spawning streams includes nearly 40 rivers and seven lake-river systems, which in total account for 266 thousand m^2 of Pink Salmon spawning area and 51 thousand m^2 of Chum spawning area (Table 3.1.2) [19].

Pink and Chum Salmon enter streams in almost all parts of the island, excluding just several water bodies (rivers Lesnaya, Zolotaya and others). In almost all of them, including lake tributaries, high density of spawners at spawning grounds has been detected, especially during mixed-age spawning events. Only in the southern part of the island, Pink Salmon escapements into the watersheds draining into the Izmeny Strait are relatively low.

Table 3.1.2 — List of the main Pink Salmon spawning water bodies on Kunashir Is. and estimates of spawner escapement numbers [22].

Stream	Escapement	Stream	Escapement
Rivers		Tyatina	High
Rikorda	Medium	Saratovskaya	Medium
Golovnina	Low	Rogachevka	Medium
Sennaya	Low	Mostovaya	HIgh
Temnaya	Medium	Filatova	High
Bystryi	High	Ilyushina	High
Krivonozhka	Medium	Prozrachnyi	High
Alyekhina	High	Tyurina	High
Asin	Medium	Andreevka	High
Valentiny	Medium	Belozerskaya	High
Severyanka	High	**Lakes**	
Zalivnaya	High	Lagoonnoye	High
Nelyudimyi	Medium	Ilinskoye	High
Ptichya	High	Valentiny	High
Zmennyi	Medium	Mikhailovskoe	High
Kedrovyi	Medium	Dlinnoye	Low
Kolodnyi	Medium	Serebryanoye	Medium
Nochka	High	Peschanoye	Low

The Pink Salmon arriving first are seen in the rivers almost immediately after the commercial fishing opening: in late July – early August. The main run falls onto September with the actual end of the migration occurring in the first half of October, even though some individual fish can be observed until the end of the month. Most fish enter freshwater in the fourth stage of maturation which is explained by the short length of the island rivers with the lower spawning sites lying just a few hundred meters upstream from the mouths and the upper spawning sites in average length rivers – at the distance of several kilometers.

Spawning occurs quite late in the season, continuing until early November. The early arriving fish are generally headed to the spawning areas in the upper sections of the island rivers, while the late runners take up the lower sites [19].

The even year generations of both smolts and adult returns used to be dominant in absolute abundance. After 2007, abundance dominance switched to the odd-year generations.

Biological Data. Kunashir Island Pink Salmon are known for their large body size – the largest in the Sakhalin-Kuril fishing region. Thus, over the years of observations, the average length of fish was determined to be 50.4 cm with a wide range of year to year fluctuations (from 46.8 to 52.4 cm). The average body mass was equal to 1,577 g, ranging from 1,287 to 1,714 g.

Female fecundity was found to be 1,534 eggs on average with the lowest average count recorded in 1994 (1,331 eggs), and the highest — in 1992 (1,744 eggs): individual fecundity measurements fluctuated in the range from 804 to 2,921 eggs. In the 1990s, Pink Salmon were larger and more productive during the odd years, although in the later period, fish of the even year cycle became significantly larger in size and (Figure 3.1.1).

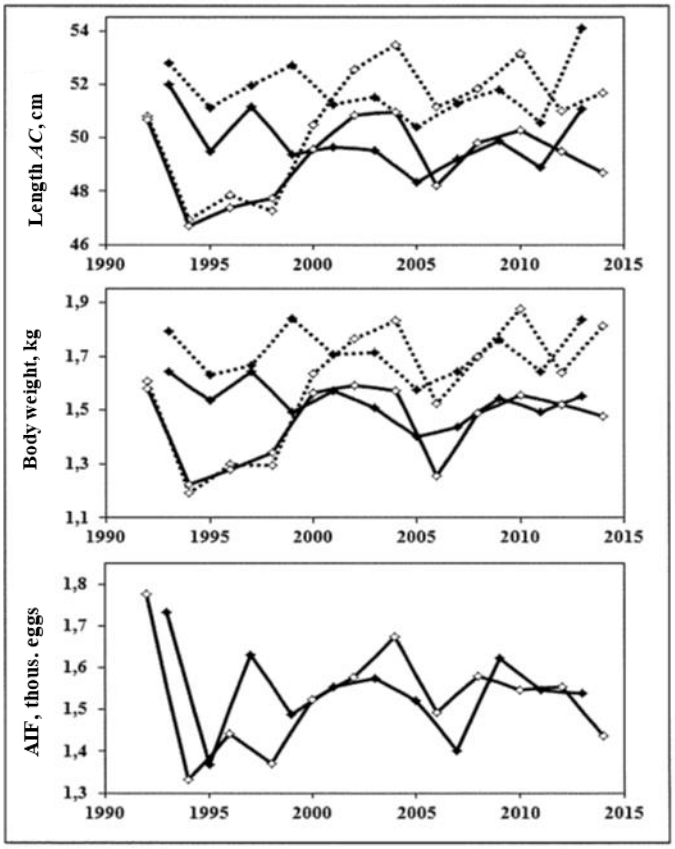

Figure 3.1.1 — Body length and fecundity dynamics in males (dotted line) and females (solid line) for odd-year Pink Salmon generations (dark symbols) and even years — (light symbols) [19].

Significant changes in biological indicators of fish are found during the course of spawning migration. It has been noted that in some years, the fish arriving during the first half of the run were significantly smaller [20, 19].

Biological measurements of Pink Salmon are shown in Table 3.1.3.

Table 3.1.3 — Main biological indicators for Kunashir Island, 2020-2021.

Date	Stream	AC, cm	Weight g	AF	N, fish
2020					
8/6/2020	Asin Creek	51.6	1,649.4	1,524	42
8/26/2020	Asin Creek	50.4	1,337.9	1,471	62
8/12/2020	Ilyushina R.	51.6	1,578.9	1,456	53
2021					
8/6/2021	Asin Creek	49.5	1,489.5	1,405	33
8/21/2021	Asin Creek	49.1	1,323.5	1,465	82
8/30/2021	Asin Creek	48.1	1,276	1,413	31

Downstream Migration. Amongst all of the fishery districts on Sakhalin and the South Kuril Islands, the timing of smolt outmigration on Kunashir appears to be the earliest (April 25th – May 1). The peak of Pink Salmon juvenile outmigration falls on the second and third ten-day periods of May, which is earlier than the neighboring island of Iturup, where outmigration occurs most intensively during the third ten-day period of May – first ten-day period of June [21].

Previous years of observations in the Ilyushina R. showed that the egg to smolt survival of naturally spawned fish ranged from 5.7 to 17.4 % and was on average 11.3%.

Taking this into account, there were 7.8 to 271.7 million juveniles migrating from the Kunashir Island rivers over the period of observations, with an average migration number of 104.1 million. After rearing in the marine environment, the returning adults' abundance was in the 627 to 7,352 thousand fish with the average of 3,377 thousand fish [19].

In the period from 2009 to 2019, these indicators dropped — the total smolt abundance was in the range from 0.02 to 24.1 million fish with the average of 7.6 million, and the adult return — from 0.002 to 1.384 million with the average of 0.44 million fish.

After 2011, smolt count was conducted in the Ilyushina River only twice, both times as part of reconnaissance surveys (Figure 3.1.2).

The number of the outmigrating juvenile Pink Salmon varied from 0.04 (odd year, 2013) to 0.29 (even year, 2014) million fish.

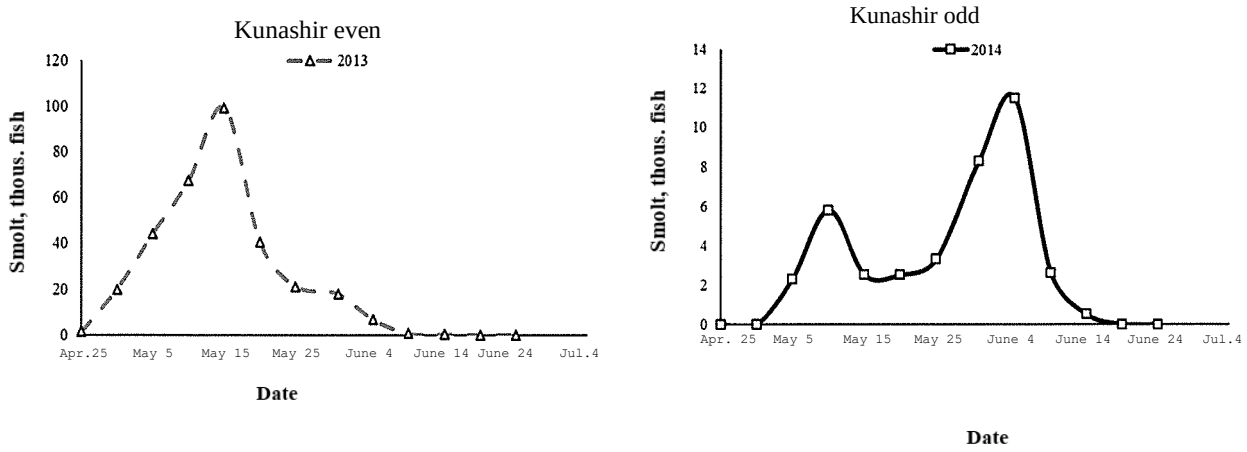

Figure 3.1.2 — Dynamics of juvenile Pink Salmon outmigration on Kunashir Is. (index river, the Ilyushina)

State of the Stocks and the Fishery

The Kunashir Island salmon stocks are formed through natural reproduction alone. Considering the period from 1996 to 2019, the total Pink Salmon abundance on the island (in thousands of fish) varied from 0.002 at the turn of the century to 7.352 (average weight 2.51kg) for odd years and 0.03 - 6.95 (average weight 2.45kg) for even years.

The optimal escapement of spawners into the Kunashir Island rivers has not been set to this day partly due to the wide range of correlation between the early and late temporal forms in the spawner portion of the stock using different parts of the island river systems. Judging by the ratio within the “return - outmigration” pairs, the optimal escapement value should be at least two million spawners since higher escapements have historically resulted in decline of smolt numbers (Figure 3.1.3).

Over the course of observations, anywhere from 171 to 2,888 thousand Pink Salmon spawners entered the island rivers with the average of 1,344 thousand fish.

On average, over the same period of observations, the density of spawners on spawning grounds on Kunashir Island was typically lower than that of the Iturup Island rivers (1.89 compared to 2.44 fish/m^2).

Zooplankton in the waters adjacent to Kunashir consists of a warm temperature grouping (the Tsushima current influence) of high productivity level, where even subtropical and tropical species are encountered [13].

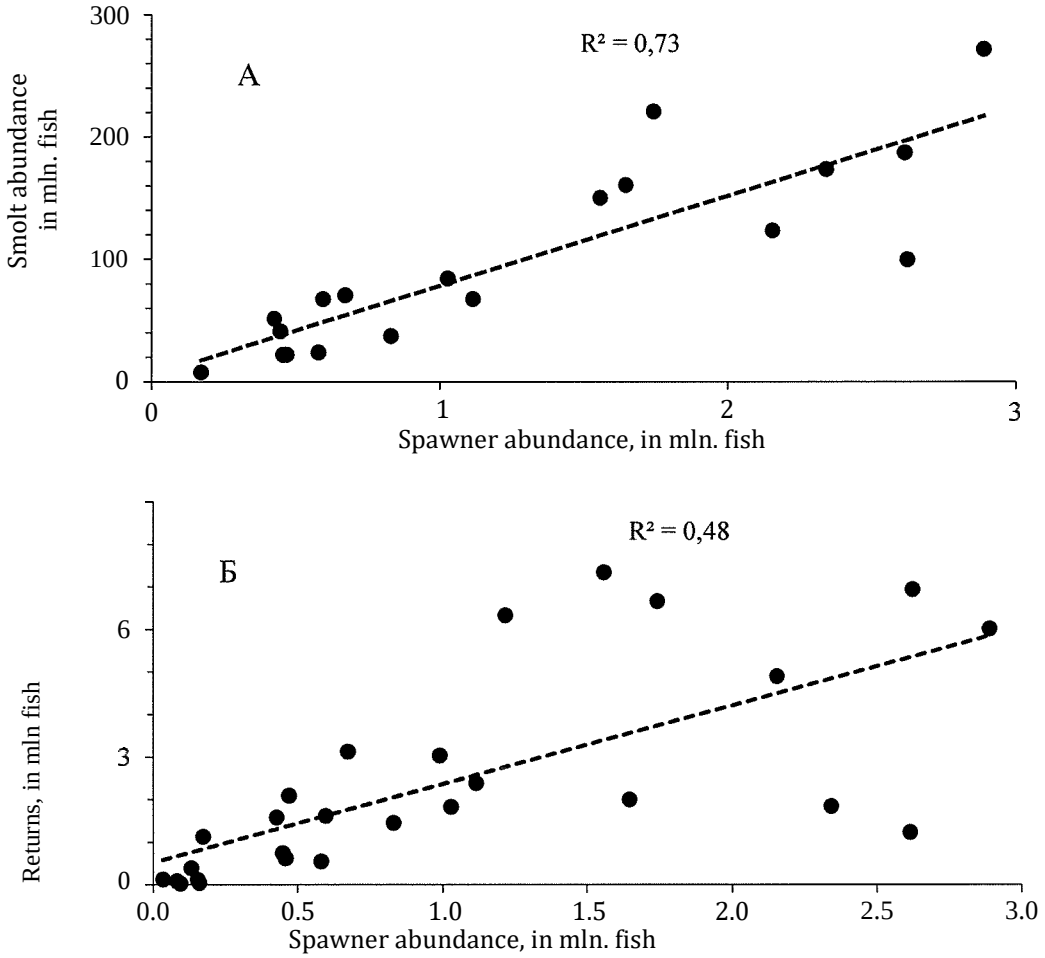

Figure 3.1.3 — Correlation of smolt abundance (a) and returns (b) to spawner escapement into the Kunashir Is. Rivers, 1990-2016.

In spite of this, a relatively moderate growth rate is typical for the Kunashir Island Pink Salmon during their early marine stage; frequent weak brood years have also been noted when spawning took place in only party utilized spawning grounds. This is probably related to the specific Pink Salmon habitat conditions on the island given the proximity of the spawning boundary of its distribution [23-26].

The period of the highest catches for both generational lines (odd and even years) fell on late 20 — early 21st centuries. As for the odd years, Pink Salmon stocks reached their peak in 2007, after which they declined abruptly. At this time, the decline is also observed for even years.

In the last 55 years, Pink Salmon harvest has varied from almost nonexistent to 7.72 thousand tons (Figure 3.1.4).

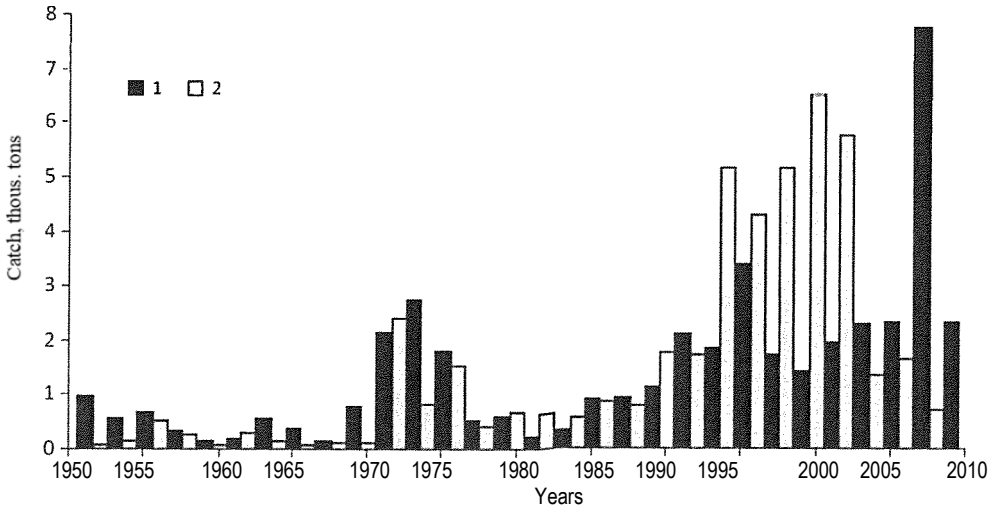

Figure 3.1.4 — Kunashir Island Pink Salmon harvest dynamics in 1951-2009: 1 — odd years, 2 — even years [22]

From 2009 to 2019, Pink Salmon catches fluctuated from 0.004 to 1.401 thousand tons with the average of 0.448 thousand tons.

During the 2019-2021 fishing season, opening of commercial Pink Salmon fishery on Kunashir Island. was deemed not possible from the start. Harvest with six nets off a limited section of the coast was recommended for the purpose of monitoring the state of the Pink Salmon stocks.

3.2 Chum Salmon

Kunashir Island Chum Salmon is represented by two distinct ecotypes: lake and river forms. The proportion of the lake spawning Chum Salmon is approximately half of the reproductive capacity of the island water bodies. The Chum Salmon population abundance in the river and lake systems of the island is not huge. In 2000-2010, Chum Salmon escapement into the Kunashir Island rivers was from 12 to 79 thousand spawners producing 1.5 to 40.2 million Chum juveniles, 10 million fish on average [19]. Over the course of the following decade, escapement numbers declined (Table 3.2.1).

Table 3.2.1 — Spawner escapement into the Kunashir Is. rivers in 2011-2020 (data from the Sakhalin Branch of FSBSI «Glavrybvod»)

Stream	Spawning area m2	2011	2012	2013	2015	2016	2017	2018	2019	2020
Ilyushina R.	4,000	520	300	1,000	1,780	650	206	320	210	250
Tropinka R.	375	100		50	-	280	26	-	-	-
Filatova R.	700	300	40	370	900	442	38	236	46	142
Pervukhina R.	240	-	6	-	-	-	18	-	-	-
Treugolnyi Creek	510	-	40	-	-	-	-	-	-	-
Prozrachnyi Creek	200	-	-	32	80	-	15	20	-	-
Luchevoy Creek	1,755	-	-	-	1,300	627	154	214	54	182
Severyanka R.	2,000	-	-	-	2,050	-	-	1,400	-	-
Tropinka R.	375	-	-	-	500	-	-	-	-	-
Lake Valentiny	9,500	-	-	-	4,360	2,400	430	1,640	-	-
Polynova R.	480	-	-	-	530	250	-	-	-	-
Ilinskaya R.	320	-	-	-	380	-	-	-	-	-
Lake Ilinskoye	600	-	1 -	-	700	410	-	330	-	-

Spawning Migration and Spawning. In terms of abundance, Chum Salmon of the *Oncorhynchus* genus is surpassed only by Pink Salmon on Kunashir Island The first reports concerning Kunashir Chum Salmon biology were produced by Ivankov and Bronevsky [27].

Chum Salmon are distributed throughout most of Kunashir Island. Such widespread distribution is possible most likely thanks to the deep circulation and active emergence of ground waters in the island river and lake beds [24]. The only spawning locations Chum Salmon avoid are those with extreme environments, although even there individual schools of salmon have been observed during rainfalls.

Abundant Chum Salmon runs tend to enter even the smallest streams, where some spawning grounds are located in the tidal zones [21].

A distinguishing feature of Kunashir Island is the lack of relatively large watersheds. Only the Tyatina River in the northeastern part of the island is comparable in size to such Iturup Is. rivers as the Slavnaya, the Reidovaya, the Kurilka, and the Kuibyshevka.

At the same time, Kunashir Island carries many lake-river systems with lake form of Chum Salmon spawning (lakes Peschanoye, Serebryanoye, Lagoonnoye, Ilinskoye and Valentiny). The lake Chum Salmon of Kunashir accounts for about half of the total reproduction of the species on the island.

Fall Chum Salmon spawning grounds are located in the southern Kuril islands, which, considering the geographic location of Kunashir in the southern-most

distribution area of the species, explains the late timing of their spawning migration. Individual adult Chum salmon appear in the rivers in September, although the peak run does not occur until October - early November for most rivers. By mid-November intensive entry of spawners into the island rivers slows dramatically. Yet, in some rivers of the southern tip of the island flowing into Izmeny Bay, the main portion of the run occurs in November and continues until January, as local residents report.

Compared to Pink Salmon, the emergence of Chum Salmon in net traps does not indicate the start of the spawning run. The first small-numbered schools of spawners can be found in the island rivers only in the second half of September. There are many lake-river systems on Kunashir (Peschanoye Lake, Serebryanoye, Lagoonnoye, Ilinskoye and Valentiny), where lake form of Chum Salmon return to spawn; some low quantities of Chum are also known to spawn in lakes Mikhailovskoye and Dlinnoye. Overall, the proportion of lake Chum Salmon is about a half of the reproductive capacity of the species in the island water systems [26].

Most adults return to the rivers exhibiting physical body changes associated with prespawning characteristics, as well as the gonadal maturation at the IV, IV-V and even V stage, explained by the spawning grounds location in the lower and middle sections of the island rivers. The maximal distance from the mouth to the upper river spawning site was found to be 2.5 - 12 km, whereas the lower river spawning grounds were in some cases located just 20-50 m from the mouth [21]. Nevertheless, even the Chum Salmon spawning in lake-river systems enter freshwater with similarly mature reproductive products. As an example, in 1995, 12.3% of female fish sampled from the mouth section of the Ilyushina Creek were at stage V of the gonad development, while there was no such level of maturation found in the Sernovodka R.: most gonad samples displayed stage IV [19]. Mass scale Chum spawning continues from mid-October to mid-November.

The shallow character of many of the island rivers and streams makes fish vulnerable to predation of birds and animals. The results of the 1977-1979 inspection of the 665 female carcasses showed that average pre-spawning mortality in various rivers was near 20%. It was suggested that such high mortality level was the result of fish drying out and their vulnerability to the attacks of gulls in shallow sections of streams and rivers [27]. It is also possible that such a high mortality rate could be

triggered by dense aggregation of spawners in the rivers. This view is supported by the decline of pre-spawner mortality in the Ilyushina Creek once spawner density went down: from 17% in 1977 (14 thousand spawners) to 5.7% in 1998 (5 thous.) [19].

Size, Weight and Age Structure. The size and weight measurements have revealed a relatively small size of the Ilyushina Creek Chum Salmon: length AC ranging from 61.8 to 67.7 (average 64.7) cm, body weight – from 2,486 to 3,573 (average 3,086) gr with males measuring a bit larger than females and their dimorphism increasing with age [19].

The key biological Chum Salmon data obtained in 2021 are shown in Table 3.2.2.

Table 3.2.2 — Main biological data for the Kunashir Is. Chum Salmon, 2021.

Date	Stream	AC, cm	Weight, gr	AIF	N, fish
9/12/2021	Coastal area	64.7	3,014.9	2,444.0 100	100
9/17/2021	Coastal area	63.6	2,983.7	2,481.7 100	100
9/23/2021	Coastal area	63.7	2,825.6	2,275.5 100	100
9/28/2021	Coastal area	65.1	2,864.1	2,337.8 50	50
11/9/2021	Pervukhina R., Lake Lagoonnoye basin	61.8	2,195.0	- 37	37

Age structure is usually comprised of four groups from 2+ to 5+. Four and five-year-olds dominate the run with the proportion of three and six-year-olds being within 10%. Only in 1996 the proportion of six-year-old fish was found to be 15%, which was the result of the 1990 generation returns significantly exceeding the adjacent generations in abundance levels. This also explains the higher rate of three-year-olds' presence in the returns of 1997 and 2006 (11.0 and 11.9%, respectively). In this case, however, during the years completing the return of these generations, there was no noticeable increase in the proportion of fish 5+ (Figure 3.2.1).

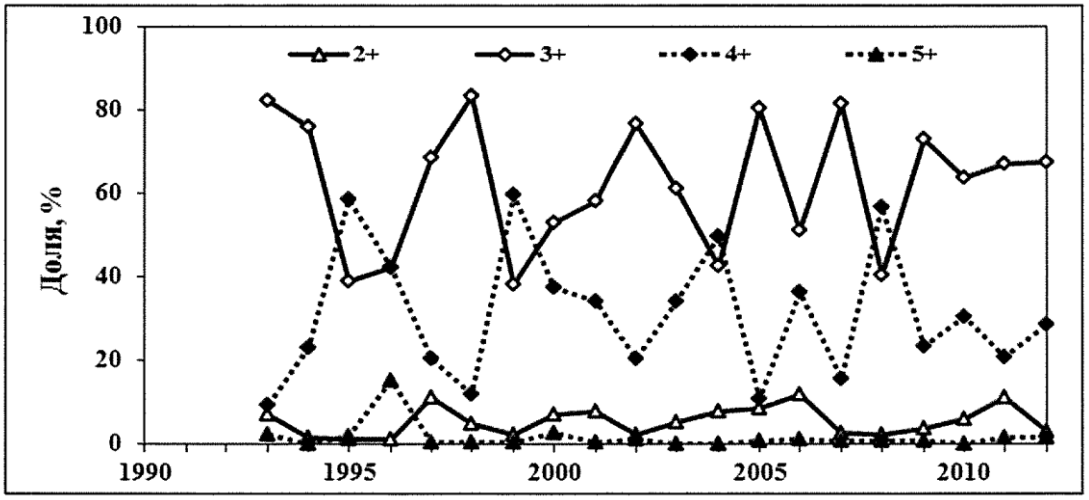

Figure 3.2.1 — Age structure dynamics in the Chum Salmon composition in the Ilyushina R. in 1993-2015 [19].

In 2021, the age composition of the Chum Salmon stock of the Pervukhina R. (Lagoonnoye Lake basin) was dominated by the fish of the ages 3+ (60%, 09.24.2021) and 2+ (69%, 11.09.2021). See Table 3.2.3. The number of age groups — three (2+; 3+; 4+). Table 3.2.3 — Age composition of the Pervukhina R. Chum Salmon, 2021

Date					N
		2+		4+	
9/24/2021	fish	14	29	5	48
	ratio, %	29	60	10	100
11/9/2021	fish	24	10	1	35
	ratio, %	69	29	3	100

Smolt migration of Chum Salmon is relatively well studied but only for river-origin fish of the Ilyushina. Juveniles begin their migration starting in April, during the dark part of the day. The main portion of smolts migrate over the period of 48 (40 to 108) days. In some years, smolt migration is complete in the second half of July.

Over the years of monitoring, there were anywhere from 245 to 4,155 thousand Chum smolts migrating out of the Ilyushina Cr. An increase of the Chum Salmon egg to smolt survival has been observed for this stream tied to the parents' age [28].

State of the Stocks and Fishery

Coastal Chum Salmon fishery on Kunashir Is. is based on the mixed stocks of both local and "transit" fish. In the period from 1995 to 2017, harvest ranged from 0.3 to 3.4 thousand tons. In recent years, the proportion of the local Chum Salmon catch does not exceed 40% of the total harvest [19].

Kunashir Island fishery differs from a number of other Sakhalin area fisheries by the almost absolute absence of hatchery Chum in catches – no hatcheries in the main rivers. Since early 1990s, Chum Salmon, as well as Pink Salmon fishing has been conducted on Kunashir almost exclusively by means of net traps. Harvest levels have varied over the last 55-years from almost total lack of fish to 3.24 thousand tons.

Beginning in 1950, commercial catches of Chum Salmon have varied in the range of 0 – total absence of harvest in 1959-1966 – to 3.24 thousand tons in 2002 (Figure 3.2.2).

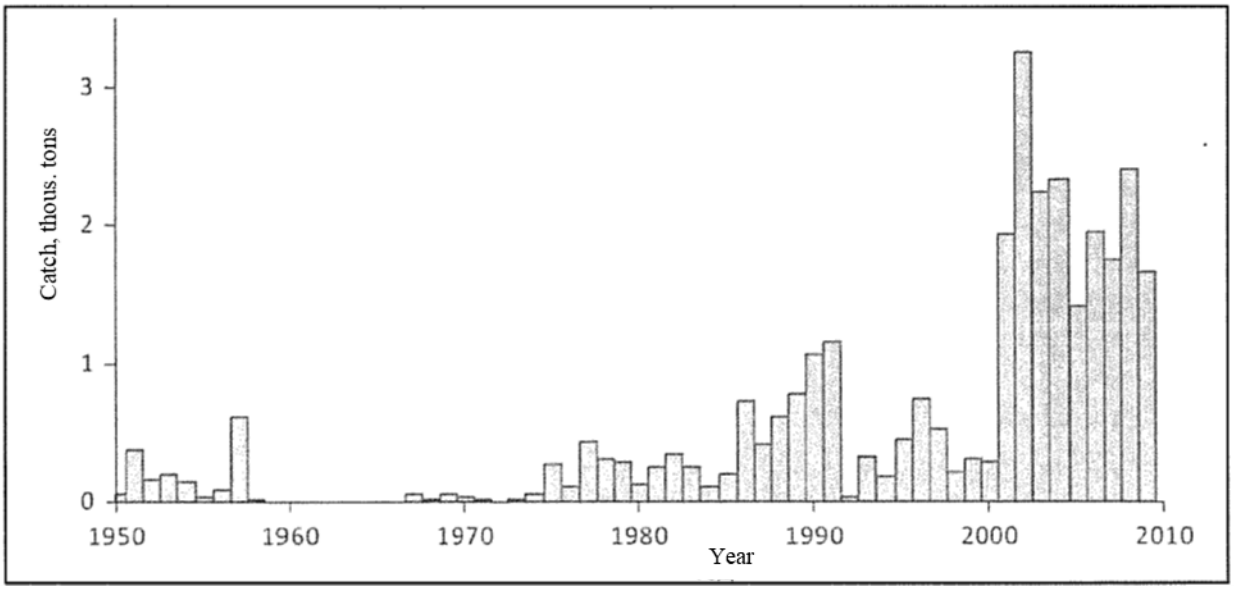

Figure 3.2.2 – Chum Salmon catches on Kunashir Is. In 1950-2009 [22].

Due to seasonal fall storms, Chum Salmon was harvested mainly during the month of October in the river mouths. Since 1990s, the fishery is conducted predominately by means of set net traps, which led to the majority of the harvest to be taken during the second half of September – first half of October.

The distribution of Chum catch along the coastal line is as irregular, as it is for Pink Salmon. In the southern part of the island (Izmeny Bay), abundance of salmon is low, hence no fishery operations. On average, small catches, as well as a low number of set traps occur on the coastal line of the Sea of Okhotsk side of the island.

As a rule, by November 10, the last traps are taken down because their further use can be jeopardized by intense weather. Beach seining takes place in the mouths of some island rivers only when the threat of over-escapement of fish to spawning grounds exists, but this gear brings in only a fraction of a percent of the total harvest.

Abundance of the local Chum Salmon is not great. The percentage of the local Chum Salmon harvest has been below 40% in recent years. The majority of the catch is “transiting” Chum Salmon that does not originate in the island rivers.

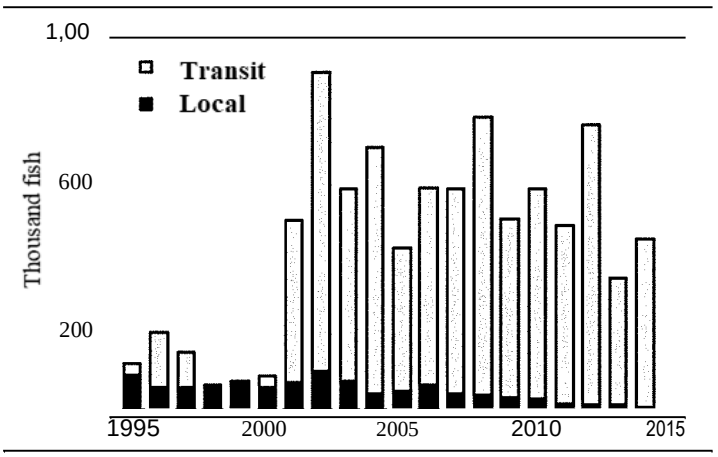

Figure 3.2.3 — Ratio of the local and transiting fish in catches during Chum Salmon commercial fishery in the coastal zone of Kunashir Is., 1995-2014

In the period from 2008 to 2017, the volume of Chum Salmon catch on Kunashir stayed within the range from 1.2 to 2.4 thousand tons (Table 3.2.4).

Table 3.2.4 — Chum Salmon harvest on Kunashir Is., 2008-2017

Indicator	Years									
	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Catch, thous. tons	2.40	1.67	1.96	1.45	2.03	1.214	1.56	1.683	1.498	1.227

4 ASSESSMENT OF PACIFIC SALMON (PINK AND CHUM) REPRODUCTION RATE IN THE PERVUKHINA R., LAKE LAGOONNOYE, AND LAKE ILINSKOYE

The list of the main spawning water bodies of the island includes 30 rivers and seven lake-river systems, providing 266 thousand m^2 of Pink Salmon spawning grounds and 51 thousand m^2 Chum Salmon spawning grounds in total [19]. Over 40% of them are located on the territory of the Kuril Reserve and its protected zone, including the Sennaya R.

Kunashir Island has five lake-river systems (lakes of Peschanoye, Lebedinoye, Lagoonnoye, Ilinskoye and Valentiny) where lake-type Chum Salmon spawning takes place. At the same time, it is only the Tyatinka River that can be called large, which is the "Pink Salmon" type river. The overall fraction of the lake type Chum reproduction is approximately half for the Kunashir Island species [21].

The Pervukhina R.

The Pervukhina R. survey was conducted on 09.23.2021. The total length of the river is about 3 km. A major part of the river channel is located in the valley 100-150 m wide. The left slope of the valley is steeper than the right one. The relief is covered with conifer trees with the admixture of deciduous and bamboo undergrowth. Alder and willow trees are found in the floodplain.

The river itself is 6.0 meters wide and 0.5-1.0 meters deep in the lower section and the mouth; current velocity is 0.3 m/sec. The riverbed in this section of the river consists mainly of pebble rocks — up to 70%, with gravel and boulders constituting another 20%, and sand —10%. Water clarity is high. The riverbanks are low consisting mainly of rocks and rocky soils and covered with high grasses and broad-leaf forests. Fragments of coniferous forests are also present; the soil is boggy in places.

In the middle part of the river, the channel narrows to 3.0 meters. Shallow sections are predominant (up to 70% of the water surface area) with the gravel-lined riverbed suitable for Pink Salmon spawning (Figure 4.1). The average depth in such places is about 0.2 m, with holes of up to 0.7 m in depth.

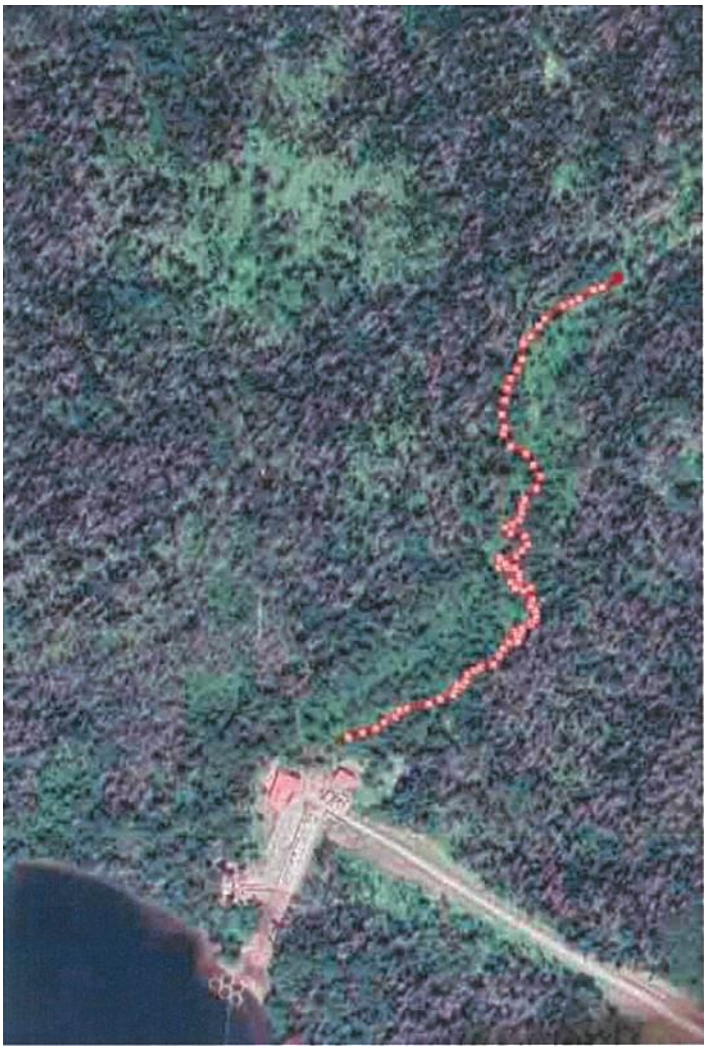

Figure 4.1 — The Pervukhina River channel course

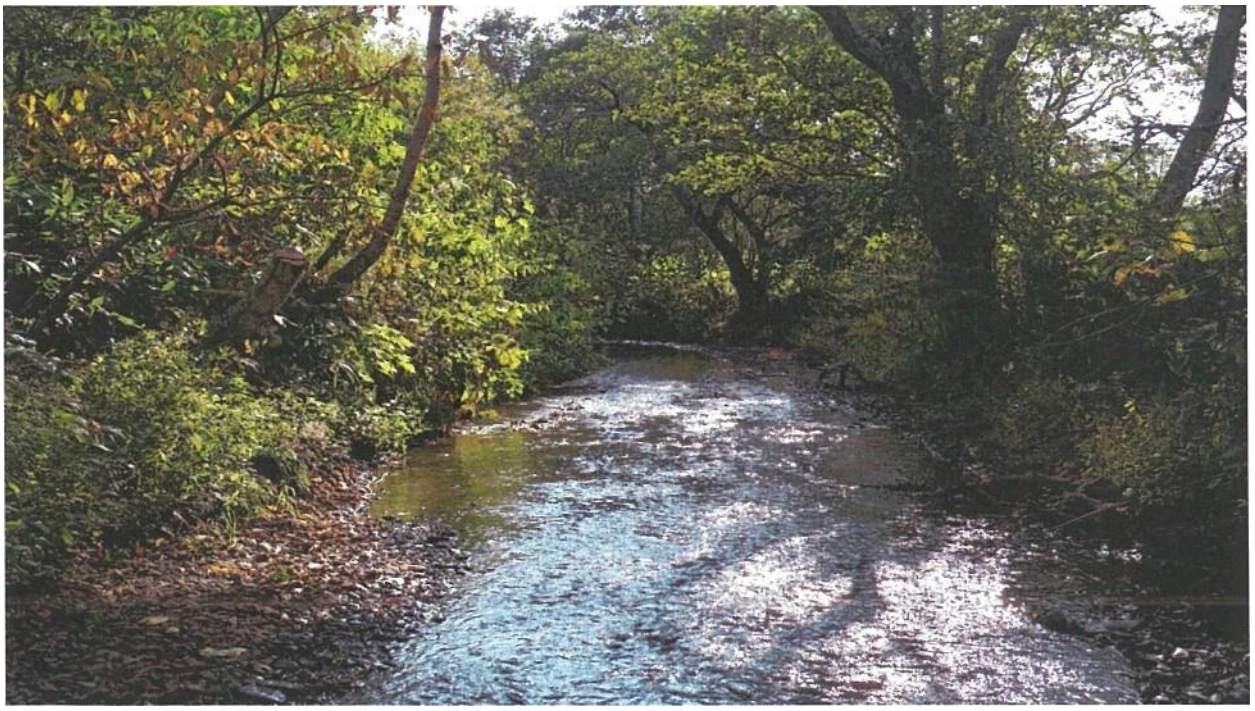

Figure 4.2 — Section of spawning grounds in the Pervukhina River

Figure 4.3 — Wood debris in the Pervukhina River channel

Logs and wood debris brought by the current during flooding are encountered in places within the main river channel. In some locations they create log jams blocking the entire river from shore to shore.

The channel gradient in the locations of rapids is not high, only about 0.2-0.3 m. At the cross-section, the riverbed is predominantly flat, 0.1-0.3 in depth and acquiring an asymmetric profile only at the bends with the maximum depths found along the undercut banks.

Salmon spawning grounds begin from the mouth of the river and continue until the 1.2 km point taking up in some places up to 70% of the riverbed area. Pink Salmon spawning area in the Pervukhina River amounts to 750 m^2, whereas Chum spawning area is 242 m^2 (letter from the Sakhalin Branch of FSBA «Glavrybvod» #20-2141 dated 06.03.2019).

Potentially suitable Chum Salmon spawning grounds are located at the distance of 700 m from the river mouth, where ground water upwelling can be found (Figure 4.4). Riverbed consists of gravel with a considerable amount of sand and silt.

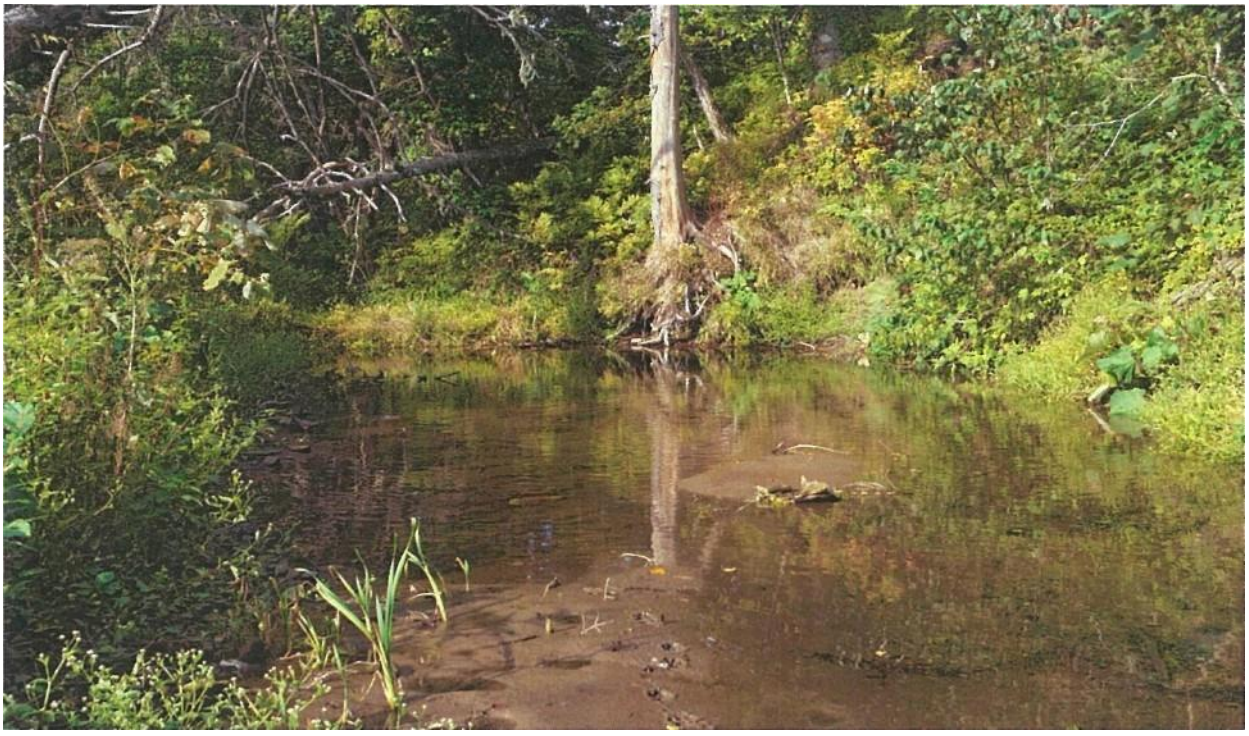

Figure 4.4 — Limnocrene on the Pervukhina R., potential Chum Salmon spawning site

At the 1.2 km distance from the river mouth, spawning grounds were not found. Here the channel acquires a prominent mountainous relief with large boulders lining the river bottom. The banks are covered with coltsfoot, willow and the forest is predominantly coniferous (Figure 4.5).

Figure 4.5 — Mountainous section of the Pervukhina River channel

At the point of 1.2 km from the mouth, the river channel splits into two arms.

At 2:30 pm we took water temperature, oxygen level, current velocity, and water discharge measurements at one of the in-channel spawning grounds.

The channel width at the test site was 3.1 m. Water temperature read 11.5°C, dissolved oxygen – 9.11 mg/l, average current velocity – 0.2 m/sec., and the water discharge rate was 1.1 m^3/sec.

We found high quality spawning grounds with no silt cover. The riverbed soil consists mostly of river pebble substrate of various sizes. Neither Pink Salmon spawners, nor spawned-out fish were detected. At the time of inspection, the escapement to spawning grounds was at 0%. The fish fauna of the Pervukhina includes whitespotted char (*Salvelinus leucomaenis).*

At 1.1 km from the river mouth, there is a water collection dam; main spawning areas are located below the site.

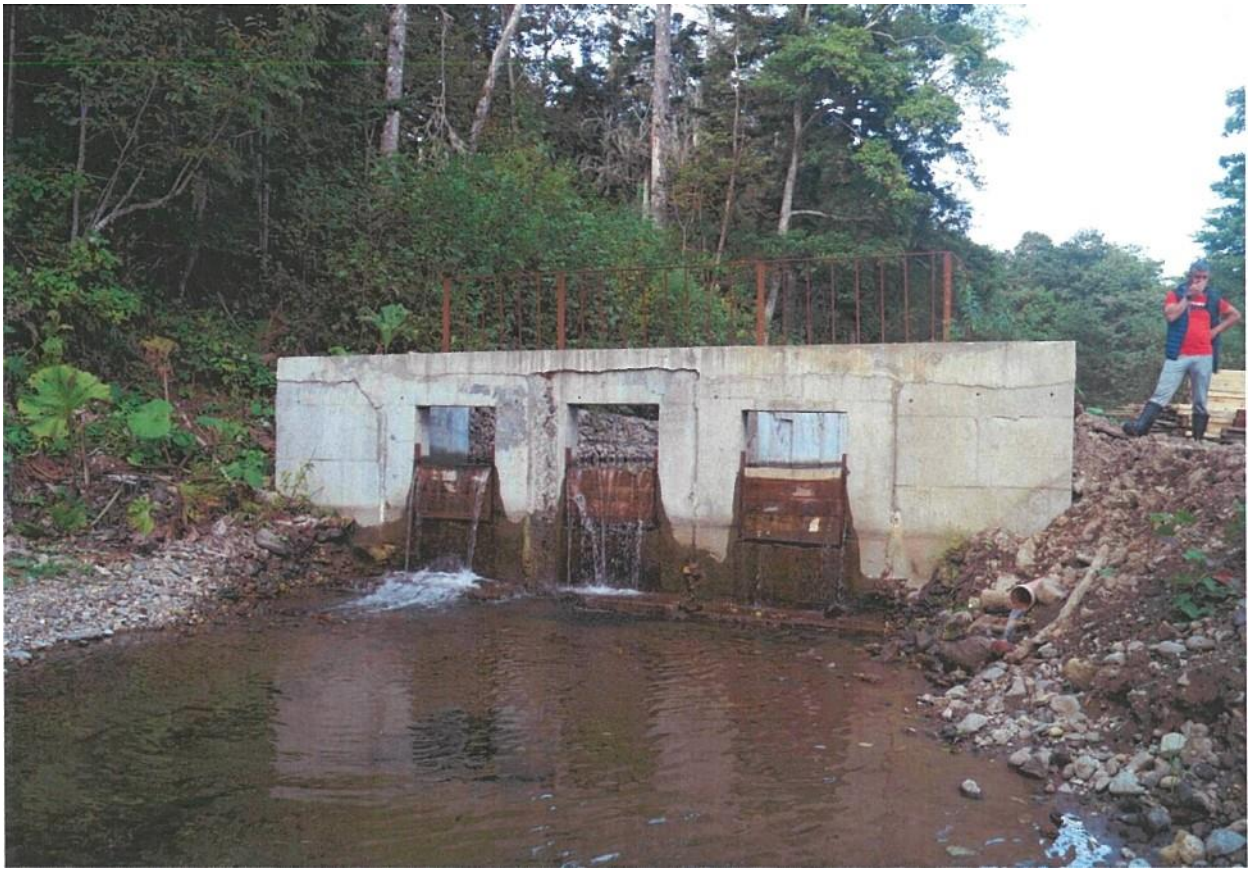

Figure 4.6 — Water collection dam on the Pervukhina R.

During the second inspection of the Pervukhina R. (11.05.2021), entry of Chum Salmon into the river was again not observed, signs of Chum or Pink Salmon spawning not found.

Lake Lagoonnoye

Field inspection was conducted on 11.05.2021. The lake is located in the central part of Kunashir Is., which constitutes a residual fragment of the deepest part of an ancient strait cut off from the sea by sediment layers of marine and lagoon origin. The lake surface shape is that of an irregular oval (Figure 4.7), complicated by a few points protruding in the north, went and east of the lake. The maximum depth of Lagoonnoye is 23.4 m. The lake is 2.6 km long and 1.5 km wide with the area of 3.5 km^2 and the watershed area – 20.4 km^2.

Figure 4.7 — View of Lake Lagoonnoye

The lake is a drainage lake, connected with the Sea of Okhotsk by a short channel (Figure 4.8). The Pervukhina R. flows into the lake from the north.

Figure 4.8 —Lake Lagoonnoye channel

The distance to Yuzhno-Kurilsk from here is 12 km. The lake has soft aquatic flora. A few springs have been located on shores.

The surrounding area is hilly, and the soil type can be described as clay loam and rocky. The lake shores are covered in mixed broad-leaf and conifer forest, bamboo forest and in places – high grasses.

The area of the Chum Salmon spawning grounds in the lake amounts to about 25.0 thousand m^2 (letter from the Sakhalin Branch of FSBA «Glavrybvod» #20-2141 dated 06.03.2019).

These sites are concentrated along the shoreline stretching 5 to 20 m in width (average – 10 m), with the width in the deeper areas being 0.3-1.5 m.

Figure 4.9 — The Lagoonnoye Lake outline Points indicate Chum Salmon spawning areas

The main Chum Salmon spawning grounds (about 22.0 thous. m^2 in area) are located along the northeastern side of the lake (Figure 4.9, Chum Salmon spawning grounds are marked with blue points). Spawning sites smaller in area (3.0 thousand m^2, indicated on Figure 4.9 by a point and an arrow) are found in the northwestern apical part of the lake. The spawning areas are all associated with the sites of ground water release.

The soil at the spawning site consists mainly of large pebbles mixed with sand, leaf and wood debris with occasional thickets of rigid aquatic flora (Figure 4.10).

Figure 4.10 — Typical Chum Salmon spawning site, Lake Lagoonnoye, northwestern part of the lake

Abundance of Chum Salmon in Lake Lagoonnoye is not huge. Our count of spawners at one of the northeastern spawning sites came to 200 fish (including some near-shore groupings of Chum not participating in spawning at the time of the survey). 170 fish were seen as engaged in spawning activities at the time.

Northwestern spawning sites revealed 14 Chum Salmon spawners.

The total quantity of Chum Salmon counted at the time of our inspection was 214 fish.

The lakebed soil in the southeastern side of the lake was mainly sandy and silty; in the southwestern part – rocky. The were no spawning grounds found in those locations, as well as no signs of spawning activities.

Figure 4.11 — Chum Salmon at a Lagoonnoye Lake spawning site

At 11:20 am, the water temperature at a northeastern spawning site was 12.1°C, oxygen content – 8.9 mg/l. A significant algae bloom was observed on the lake (Figure 4.12), partly extending into the spawning grounds in the northeast; a large portion of the algae cover was concentrated in the southern part of Lagoonnoye.

Figure 4.12 — Lagoonnoye Lake algae bloom

Groupings of swan mussels *(Kunashiria sp.)* were found on the flats of the southern part of the lake (up to five organisms/m^2).

The intensity of Chum Salmon run in the channel connecting the lake with the sea was low. At the time of the survey, no new spawners were detected entering the freshwater system. Five matured Chum Salmon were recorded in the channel overall. As revealed from interviews with locals, the typical intensity of Chum Salmon run here does not exceed several individuals per day.

In addition to Chum Salmon, Lake Lagoonnoye spawning grounds are known for the reproduction of whitespotted char *(S. Leucomaenis).*

Lake Ilinskoye

Lake Ilinskoye was surveyed on 11.06.2021. The water surface of the lake has the shape of an irregular rectangle. The maximum length of the lake is 0.9 km, width – 400 m, the circumference of this body of water is 2 km, water surface area is 0.21 km^2 with the watershed area encompassing 20.4 km^2. Maximum depth is 13 m.

Figure 4.13 — Lake Ilinskoye outline. Marks indicate Chum Salmon spawning sites

The shores of the lake are predominantly steep with occasional cliffs. The lake bottom is clean, the lake being of drainage type connected with the sea by a channel. An unnamed creek, as well as the Ilinsky Creek enter Lake Ilinskoye from the southeast (the latter being 4 km in length and 8 m in width).

Figure 4.14 — View of Lake Ilinskoye

The main Chum Salmon spawning sites (about 600 m^2 total) are located in the northeastern part of the lake (Figure 4.13, points indicate the recorded Chum Salmon spawning sites). The observed spawning sites are associated with the release of ground water. The soil in such locations mainly consists of large pebble rocks with an admixture of coarse sand; some insignificant amounts of rigid aquatic flora was also found (Figure 4.14).

Abundance of Chum Salmon in the spawning sites in this lake was extremely low: only 30 fish were found. No entry of new spawners through the water body connecting the lake with the ocean was observed, just as there were no spawned out salmon in this channel.

The soil in the northern portion of the lake is predominantly rocky; no spawning salmon was found.

At 1:10 pm, water temperature at a spawning location was 10.1 °C, oxygen content was 9.5 mg/l, the water was clear with no signs of algae bloom.

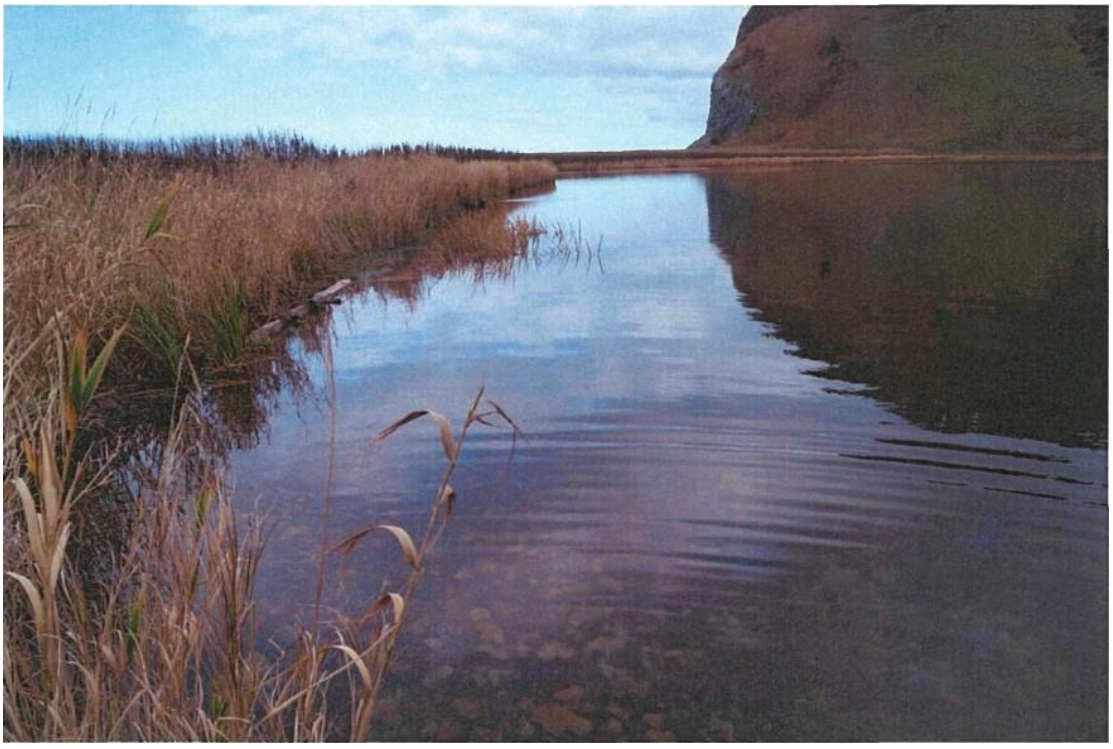

Figure 4.15 — Typical Chum Salmon spawning site, Lake Ilinskoye

Figure 4.16 — Spawned-out Chum Salmon in Lake Ilinskoye

CONCLUSION

The most abundant Pacific salmon species reproducing in the water bodies of Kunashir Island are Pink Salmon, followed by Chum Salmon. These two species enter almost all of the island rivers and lake-river systems.

Kunashir Island fisheries are conducted at eight fisher sites with higher catches traditionally taken along the Sea of Okhotsk coast of the island and less so – in the south in Izmeny Bay.

Beginning in 1950s, Pink Salmon catches have varied in the range from almost absolute lack of harvest to 7.73 thousand tons of Chum Salmon — from 0 to 3.24 thousand tons.

The period of the highest catches for both Pink Salmon generational lines (even and odd years) was between the end of the 20th century and the beginning 21st century. As for the odd years, Pink Salmon stocks reached their peak in 2007, after which they declined abruptly. At this time, the decline in abundance is evident for the even year generations as well.

The abundance of the local (native) Chum Salmon populations in the island rivers is not high. In recent years, the proportion of catch of the locally reproducing fish has been below 40% of the total catch volume. About half of that is the Chum Salmon of lake form. The majority of the catch is “transiting” Chum Salmon that do not originate in the island rivers. The highest Chum Salmon catches were recorded in 2002; in 2019, the fishery experienced an abrupt decline in run intensity and harvest.

During the Pervukhina R. (Lake Lagoonnoye basin) surveys conducted on 09.23.2021 and 11.05.2021, Pink Salmon and Chum Salmon spawners were not observed; consequently, spawning activity was not found.

On the Lake Lagoonnoye spawning grounds (11.05.2021), 214 fall Chum Salmon spawners were accounted, and signs of spawning activity detected. Entry of spawners from the ocean was at an extremely low intensity level – no more than several fish per day.

On 11.06.2021, the abundance of fall Chum Salmon spawners in the Ilinskoye Lake spawning grounds did not exceed 30 fish. Signs of spawning activity were found. Migration of additional spawners through the channel connecting Lake Ilinskoye with the sea was not observed.

LITERATURE SOURCES

1. Uglova, T.Y. 2020. Biology, structure of spawners, and Pink Salmon (*Oncorhynchus gorbuscha*) fishery on Iturup Is. (South Kuril Islands): Synopsis of doctorate thesis. - M. VNIRO. — P. 26.

2. Kaev, A.M., Romasenko, L.V. 2003. Comparative characteristics of Chum Salmon of the river and lake-river systems of Kunashir Is. (Kuril Is. Chain) // Readings in Honor of Vladimir Yakovlevich Levanidov. — № 2. — P. 478-483.

3. Zlobin, T. K. 2004. The Kuril Islands (environment, geology, earthquakes, volcanoes, history and economy). / T.K. Zlobin, I. P. Farhutdinov, M. S. S. Vysokov, N. L. Litenko, et al. — Yuzhno-Sakhalinsk: Sakhalin Press. — P. 228.

4. Kanaev, K. F. 1959. Geomorphological observations on the Kuril Islands / K. F. Kanaev // Academy of Sciences of the USSR. — Vol.32. — P. 215-231.

5. Chupakhin, V.M., Kaev, A. M. 1980. Distribution and some biological characteristics of Pink and Chum Salmon of the coastal waters of Iturup Is. // TINRO Bulletin. — Vol. 104. — P. 104-121.

6. Kaev, A. M., Chupakhin, V. M. 2002. The early marine period of Pink Salmon *(Oncorhynchus gorbuscha)* and Chum Salmon *(Oncorhynchus keta)* of Iturup Is. // SakhNIRO — Vol. 4. — P. 116-132.

7. Kaev, A. M., Chupakhin, V. M. 2003. Pink Salmon *(Oncorhynchus gorbuscha)* abundance dynamics for Iturup Is. (the Kuril Islands) /Journal of Ichthyology. — Vol. 43. — № 6. — P. 801-811.

8. Resources of the surface waters of the USSR. 1973. — Vol. 18: Far East Press. Issue 4: Sakhalin and the Kuril Islands. — S-Pb. “Gidromedizdat”. — P. 1-264.

9. Fooks, V.R. 1997. Sources of the Oyashio / V.R Fooks, A. N. Miiurin, A. A. Bobkov, et al. — S-Pb.: Saint -Petersburg University Press. — P. 248.

10. Chernyavsky, V.I. 1993. Oceanic explanations for the formation of zones of high biological productivity in the Sea of Okhotsk / V.I. Chernyavsky, I. A. Zhigalov, V.I. Matveev // Hydro-meteorology and hydrochemistry of seas — Vol. 9: The Sea of Okhotsk. — Issue 2: Hydrochemical conditions and oceanic basis of biological productivity. — S-Pb.: “Gidromedizdat”. — P. 157—160.

11. Verkhunov, A. V. 1997. Development of the large Sea of Okhotsk Gyre Theory / A. V. Verkhunov // Comprehensive research of the Sea of Okhotsk ecosystems. — M.: VNIRO. — P. 8-19.

12. Moroz, I. F. 2011. Special characteristics of the water exchange between the Sea of Okhotsk and the Pacific ocean through the Kuril Islands Straits./ I. F. Moroz // Marine Fisheries Issues. — Issue 8. — № 1. — P. 224—239.

13. Brodsky, K. A. 1959. Zooplankton of the marine waters of South Sakhalin and southern Kuril Islands / K. A. Brodsky // Studies of the Far Eastern Seas of the USSR. — Issue 6. — P. 6—46.

14. Kusakin, O. G. 1971. Institute of Marine Biology studies in hydrobiology of the littoral zones of the Far Eastern Seas of the USSR / O. G. Kusakin // Scientific Community of Institute of Marine Biology — Issue 2. — P. 134—135.

15. Pinchuk, V. I. 1976. The ichthyofauna of the Kuril Islands littoral zone / V.I . Pinchuk // Marine Biology. — № 2. — P. 49—55.

16. Pravdin, I. F. 1966. The guide to the study of fishes / I. F. Pravdin. — M.: Food Industry Press. — P. 376.

17. Volovik, C. P. 1967. Methods of monitoring and some behavioral characteristics of Pink Salmon smolts in the rivers of Sakhalin Is. / C.P. Volovik // TINRO Bulletin. — Vol. 61. — P. 104-117.

18. Romasenko, L.V.. 2012. Dynamics of the Kunashir Island Pink Salmon *(Oncorhynchus gorbuscha)* stocks //TINRO Bulletin. — Vol. 168. — P. 67-75.

19. Kaev, A. M., Romasenko, L.V. 2017. Kunashir Island Chum and Pink Salmon (population structure, reproduction, and fishery): research //Yuzhno-Sakhalinsk: SakhSU. — P. 124.

20. Ivankov, V. N. 1967. The local Kuril Island Pink Salmon stocks / V.N. Ivankov // Journal of Hydrobiology. — Vol. 3. — № 1. — P. 62-67.

21. Kaev, A. M., Strukov, D. A. 1999. Some Pink Salmon *Oncorhynchus gorbuscha* and Chum salmon *Oncorhynchus keta* reproduction parameters for Kunashir Island //Fishery studies in the Sakhalin-Kuril region and adjacent water bodies. — Yuzhno-Sakhalinsk: SakhNIRO — Vol. 2. — P. 38-51

22. Fishes of the Kuril Islands. 2012 / ed. O. F. Grizenko. — M.: VNIRO. — P. 384.

23. Kaev, A. M., Ardavichus, A. I. 1984. Topographic features of the South Kuril Chum Salmon spawning grounds.— Report 2. River and lake spawning grounds in the water bodies of Iturup and Kunashir islands. //Research findings on the effective use and conservation of biological resources of Sakhalin and the Kuril Islands. — P. 111-114.

24. Kaev, A.M., Romasenko, L.V. 2001. Spatial and temporal differentiation between the groupings of Pink Salmon in the Sakhalin-Kuril region based on scale samples analysis //Issues in Fisheries. — Vol. 2. — № 4. — P. 8 - 15.

25. Kaev, A. M. 2007. Possible causes and effects of shifts in trends of Pink Salmon abundance on Kunashir Island, a southernmost population in Asia / A. M. Kaev, L. V. Romasenko // Bull. NPAFC. — № 4. — P. 319-326.

26. Kaev, A. M. 2016. The new data to the discussion of local and fluctuating Pink Salmon *Oncorhynchus gorbuscha* stocks/ A. M. Kaev, L. A. Zhivotovsky // Bulletin TINRO. — Vol. 187. — P. 122-144.

27. Ivankov, V. N. 1974. Biological characteristics of Chum Salmon reproducing in lake spawning areas / V.N. Ivankov, A. M. Bronevsky // Management and Information. — Vladivostok: FESC Academy of Sciences of the USSR. — Issue 10. — P. 265-268.

28. Kaev, A.M., Romasenko, L.V. 2003. Comparative analysis of river and lake-river systems of Kunashir Island (Kuril Islands) // Reading in Honor of Vladimir Yakovlevich Levanidov. — № 2. — P. 478-483.