

Action #1 Rebuild local salmon stocks

Action Goal: Rebuild wild Kunashir Island pink and Chum Salmon stocks within five years

PIs 1.1.1, 1.1.2

1. Monitoring of the Kunashir Pink and Chum Salmon stock status

In 2023, scientific work was continued and financed both from the federal budget and from the PCF Yuzhno-Kurilsky Ryibokombinat Co., Ltd (hereinafter – YKRRK).

The complex of ongoing research included studying the dynamics of fish returns to the coast and their biological parameters, determining the number of spawners on spawning grounds and collecting statistical information on catches at various fishing grounds on the island.

In addition to the scientific examinations, a FIP visit to Kunashir Island was organized in autumn 2023. This includes meetings with representatives of all stakeholders, such as: departments of the Sakhalin-Kuril Territorial Administration, SakhRybVod, SakhNIRO, the Association of Fishing Companies of the Sakhalin Oblast, the Kurilsky Nature Reserve, and managers and supervisors of fishing companies on Kunashir.

1.1 Examination of watercourses and water bodies and evaluation of the spawning escapement.

The list of main spawning water bodies of Kunashir includes about 60 rivers, streams and seven lake-river systems. According to modern data, there are up to 260 thousand m² of potential spawning grounds for Pacific salmon. Pink Salmon spawning grounds occupy 145.45 thousand m², and Chum salmon spawning grounds - 114.55 thousand m².

Estimation of the spawner's numbers on spawning grounds was carried out according to their visual count by the employees of the Sakhalin branch of FSBI Glavrybvod (SakhRybVod) during walking tours along rivers (state monitoring). In addition to the state monitoring program, additional examinations were funded by YKRRK. During examinations specialists estimated the quality of spawning grounds, the presence or absence of blockages and debris in estuaries and river channels, as well as the presence of anthropogenic factors.

In 2023, according to data from Tables 3.3.1.1. and 4.2.1. of the Andrey Zhivoglyadov's report:

- 16 watercourses were examined during the Pink Salmon run;
- six water bodies were examined during the Chum Salmon run, including Lagunnoye, Peschanoye and Serebryanoye lakes.

In 2023, the previously obtained data on late returns of Pink and Chum Salmon to the Kunashir coastline were taken into account. Therefore, there was a decision to shift the examination to later dates in order to account for Pink and Chum Salmon groupings from all periods of the run (early, mid and late).

Cumulative monitoring data for the last eight years are compiled and presented in Tables 3.3.1.2. (Pink Salmon) and 4.2.2. (Chum Salmon) of Andrey Zhivoglyadov’s report. Water bodies monitoring data for 2023 are presented in Tables 4 (Pink Salmon) and 5 (Chum Salmon) of Tatyana Tochilina's report. Based on the data from these two reports, the estimated escapement to spawning grounds in 2023 was:

- 2.0% for Pink Salmon;
- 11.3% for Chum Salmon.

The number of fish eaten by predatory animals and birds is not specified, but most likely it is extremely small and therefore this value can be neglected.

Table 1. Average **Pink Salmon** spawner density and escapement to spawning grounds in 2016 - 2023.

Year	2016	2017	2018	2019	2020	2021	2022	2023
Total examined spawning area, m ²	38,727	26,816	42,157	67,376	53,566	70,860	59,880	91,248
Cumulative number of spawners, N of fish	20,962	single	65,346	10,100	80,105	5,598	26,999	3,708
Average density of spawners on spawning grounds, fish/m ²	0.54	-	1.55	0.15	1.50	0.08	0.45	0.04
Escapement - according to the SakhRybVod’s standard of 1.6 fish/m ² , in %	27.1	single	77.5	7.5	74.8	4.0	22.5	2.0

Table 2. Average **Chum Salmon** spawner density and escapement to spawning grounds in 2015 - 2023.

Year	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total number of examined spawning grounds, m ²	19,930	17,410	16,770	18,755	6,455	6,455	42,550	37,440	62,205
Cumulative number of spawners, N of fish	12,580	5,059	887	4,160	310	574	1,294	2,500	11,287
Average density of spawners on spawning grounds, fish/m ²	0.63	0.29	0.05	0.22	0.05	0.09	0.03	0.06	0.18
Escapement - according to the SakhRybVod’s standard of 1.6 fish/m ² , in %	39.5	18.2	3.3	13.9	3.0	5.6	1.9	4.2	11.3

In recent years escapement to spawning grounds by Pink Salmon has been declining for both generations (even and odd years), while the situation for Chum Salmon has been improving (see Tables 1 and 2). However, in 2023, the “minimum

number of spawners on spawning grounds” indicator was not achieved for either Pink Salmon or Chum. As a rule, this indicator is equal to 30% of optimum value and is taken as the Limit Reference Point (LRP). Population status below this point may be unstable as fluctuations in external conditions can significantly reduce the survival of fish eggs, larval fish and smolts during the early marine life stage and survival of growing fish during the marine and oceanic life stages. Therefore, this is the threshold below which fishing should be stopped.

1.2 Catch accounting and calculation of the total numbers of the Kunashir Pink and Chum Salmon in 2023.

In addition to counting fish on spawning grounds, catch records are maintained thoroughly. In 2023 the total harvest of Kunashir Pink Salmon was extremely low – 0.0008 thousand tons. It should be noted that the total harvest of the Iturup Pink Salmon was also extremely low: only 1,889.9 tons were caught on Iturup, which was 17.3% of the forecast (the total allowable catch for the South Kuril fishing zone was 10,927 tons).

The coastal catch of Chum Salmon was 0.206 thousand tons, and it was the lowest value in the last 14 years. This catch was based on a mixed aggregation of local and transit fish. Since 2022, the Kunashir Chum Salmon stock has included artificially reproduced fish released from the Lagunnoye Lake Salmon Hatchery and Ricorda River Salmon Hatchery. In 2023, 164.188 tons of hatchery fish were caught. According to Tatiana Tochilina's report, the total catch of Chum Salmon in 2023 was 0.37 thousand tons (Table 10 from Tochilina's report):

Table 10. Chum Salmon catch on Kunashir Island in 2023

Place of fishing	Fishing companies of Kunashir Island					
	YKRRK / Lagunnoye Lake Salmon Hatchery	Muravyov Individual Entrepreneur / Rikorda River Salmon Hatchery	Island Fish LLC	GOLUBAYA ZVEZDA LLC	Delta LLC	TOTAL
Coastal trap nets	195.287	0	2.672	3.612	4.52	206.091
Salmon hatcheries (at the egg collection points)	109.399	54.789	0	0	0	164.188
TOTAL	304.682	54.789	2.672	3.612	4.52	370.275

In the 12-mile economic zone of the Russian Federation in 2023, Russian and Japanese fishermen were drift-net fishing for Pacific salmon, catching mixed stocks. In the course of this, a certain number of Pacific salmon of the Kunashir Island, mainly Chum Salmon, were caught. However, the presented scientific reports do not contain data on the estimation of the levels of commercial catch and reproduction areas of salmon caught by drift-net fishing.

The abundance of Chum Salmon in the internal island waters was estimated via extrapolation of the fish counting data obtained during walking inspections to some

watercourses for the entire spawning area of the island (Table 2). For calculation we took the average spawner density as 0.18 fish/m² and estimated area of spawning grounds as 114.55 thousand m², and finally obtained the estimated number of Kunashir Chum Salmon entering the spawning grounds in 2023 (20,619 fish).

Totally, in 2023, the estimated returns of Kunashir Chum Salmon was 116,494 fish (Table 3), summarizing the data presented in the researchers' reports and by the YKRR chief fish breeder.

Table 3. Estimated composition and size of the Kunashir Chum Salmon populations in 2023.

Indicator: Population Composition	Tons	Average weight, kg (averaged for females and males of all age groups)	Number of fish
Total catch in coastal waters	206.091	2.546	
including transit Chum Salmon ¹	123.654		
including local Chum Salmon ²	82.437		32,481
Estimated number of spawners on natural spawning grounds ³			20,619
Total catch at the hatchery	164.188		63,394
including Lagunnoye Lake Salmon Hatchery	109.399	2.645	41,361
including Ricorda River Salmon Hatchery	54.789	2.487	22,033
Estimated Kunashir Chum Salmon stock in 2023, TOTAL			116,494

Note: 1 – currently accepted as 60% of the total catch;
 2 – currently accepted as 40% of the total catch;
 3 – estimation is based on the spawning grounds area (114,553 m²) and spawners density (0.18 fish/m²)

Taking these values into account, it can be said very roughly that in 2023 the share of artificially reproduced Chum Salmon was 54.4 % of the total Kunashir stock.

1.3. Collection of biological data

Due to the extremely low abundance of Pink Salmon in 2023, nor fishing for scientific purposes or biological analyses of this species were conducted.

Data collection on Chum Salmon biological characteristics was conducted regularly throughout the run and covered different areas of Kunashir Island. It was found that "In 2023 the average length of fish was 62.4 cm, weight – 2.55 kg, fecundity – 2,002 eggs. One can note a continuing trend towards a decrease in the average weight of Chum Salmon; in 2023, the average weight of Chum Salmon for all samples was lower (2.546 kg) than in 2022 (2.562 kg) and in 2021 (2.777 kg). The value of absolute fecundity also decreased, which is probably connected with a decrease in average body weight." (from Andrey Zhivoglyadov's report).

It is noteworthy that a decrease in the average weight of Chum Salmon was also noted on the neighboring Iturup Island. The average weight of 3+ year old females and males was 2.27 and 2.57 kg respectively, and these values were lower in contrast with Chum Salmon spawners studied during the previous eight years (Elnikov and Zelennikov, 2023).

The age structure of Chum Salmon populations was studied in 2023 in detail by Tatiana Tochilina: "The age composition of Chum Salmon (Kaev, Romasenko, 2017) on Kunashir Island usually has four groups – from 2+ to 5+. However, in 2022, an individual 5+ years old was found in the Ilyushina River, and in 2023, 5+ years old individuals were not encountered at all! Four- and three-year-olds fish dominate in numbers".

The dominance of 3+ years old Chum Salmon (four-year-olds) on the neighboring Iturup Island is also noted in the above-mentioned article by Elnikov and Zelennikov.

2. Investigation of factors affecting the reproductive rates of Kunashir Pink and Chum Salmon.

Studies conducted during 2021 - 2023 showed that the potential for natural reproduction of Pacific salmon on Kunashir far exceeds the actual returns.

During the data collection periods, there were examined different natural and anthropogenic factors that may have influenced the decline in reproduction of Pacific salmon on Kunashir:

- natural factors (storms when spawners entering freshwater bodies from the sea, high water temperatures in rivers, late fall and early spring floods leading to erosion of spawning redds, passive flushing and death of fry in the turbulent water flow, climate changes);

- anthropogenic factors (economic activities, poaching, overfishing).

During the monitoring and interviews with representatives of all stakeholders it was found that the island differs from Sakhalin and Iturup in that many threats are not typical for it. As a rule, fall and spring floods are not so intensive and do not damage riverbeds. In contrast to 2022, in 2023, erosion of river estuaries and lake channels was observed only at the end of August. However, further observations showed that during a storm with a different wind direction this problem disappears, and the estuaries being cleaned by the more powerful water flow generated after heavy rains. Examinations in October and November did not reveal this problem.

In general, anthropogenic impacts are associated with activities such as haying, cattle grazing, plowing, forestry, industrial and domestic wastewater discharge, cattle farming, soil reclamation, water intakes and IUU fishing. All respondents denied the presence of all above-named factors for Kunashir and noted that the quality of spawning grounds in rivers and lakes are good. Currently, there is no threat of large-scale poaching on Kunashir. According to the head of the local Fish Protection Department, this can be explained by the lack of fish. It is not economically profitable for poachers to catch one or two fish.

Doubtless, there is the impact of climate change on Kunashir's Pink and Chum Salmon populations. Changes in air and sea surface temperature are confirmed by various authors. A report on the SakhNIRO website <http://www.sakhniro.vniro.ru/news/856/> describes a 25 years-study on the thermal conditions of the Sea of Okhotsk using satellite data. For the surface water layer

temperature, there is a tendency to decrease in the spring. In contrast, an upward trend prevails in the summer.

In 2023, during interviews on Kunashir, all respondents paid attention to the abnormally hot summer and high coastal water temperatures that could prevent Pink and Chum Salmon from entering spawning water bodies. Tatiana Tochilina reports that this phenomenon continued until the end of October: "In the last days of October, the sea water temperature in the coastal area remained at 14-15°C. Fig. 31. shows data on water surface temperature, and we see that on October 30 (that is the end of the mass Chum Salmon running!) isotherms near Kunashir Island range from 12 to 16°C!"

The discussion of the limiting influence of climatic conditions on the dynamics of Pacific salmon abundance continues and this is reflected in the publications of various scientists. Climate change leads to shifts in water temperature and aquatic biotopes quality, which can negatively affect the formation of salmonid fish populations. For example, *Nature Climate Change* reports on a major study involving more than 50 scientists from government and community organizations across North America <https://www.fisheries.noaa.gov/news/new-research-asks-can-pacific-salmon-keep-pac-e-climate-change> that showed unpredictable shifts in the period of juvenile salmon migration. However, these changes did not apply to all populations of the same species. In response to the same warming level some populations had earlier migration, while others had no change or even migrated later.

Shuntov and Ivanov in their paper "Climate changes and the current state of the biota in Russian waters of the Far Eastern seas" say that "Large-scale movements of migrants between climatic zones can be regarded as planetary events. Smaller but still significant migrations of mobile hydrobionts occur in each sea. These are seasonal changes of biotopes, as well as migrations from one part of the sea to another. In this sense, the situations in different seas may differ significantly. Apparently, in any sea or its part, the ecological plasticity of some species allows them to find internal reserves in their biotope. This was clearly demonstrated by the example of juvenile salmon on the shelf of the eastern Bering Sea in the early 2000s, when the biomass of macroplankton (euphausiids and copepods) decreased there. Young salmon were successfully fed on early juveniles of other fishes and microplankton (mainly decapods at pelagic stages). In addition, their diet was expanded and included lower quality foods such as sagittas and jellyfish."

Finally, the authors express doubts about the traditional conclusions about the dependence of various biological phenomena only on climatic dynamics: "Indeed, there are situations when a significant anomaly of temperature or other abiotic or biotic factor causes a corresponding biological response. But there are also many situations when extraordinary events in biota only coincide in time with the same climatic changes. For example, modern warming has been going on for at least 30 years, and during this period there were many unexpected events that were habitually associated with warming, but everything safely returned to the usual state with continued warming. It can be concluded that the dynamics of populations, communities and biocenoses may be primarily determined by regional conditions in addition to global causes."

Undoubtedly, there are global climatic changes affecting the abundance of Pacific salmon at the present stage. However, in our case they were not the cause of the collapse of Pink and Chum Salmon abundance on Kunashir. All respondents interviewed on Kunashir said that the main reasons for this situation were overfishing in the late 1990s and the first decade of 2000s, and the heavy poaching that prevailed at that time. At the present stage it is a complex of reasons: the negative impact of climate change is superimposed on ambiguous decisions of the fisheries management system. It is clear that Chum Salmon fishing continues and transit stock are expected to appear, but this activity undermines the remnants of the local Kunashir Chum Salmon, which could spawn on the island's high quality spawning grounds and provide a much greater economic benefit in the future.

Climatic changes have a long-period character, but it is obvious that recovery of Kunashir Pink and Chum Salmon populations cannot be expected without seaward smolt migrations from local rivers and lakes (by natural or artificially reproduced fish). The first Chum Salmon returns to the hatcheries proves that local populations can be restored even in ecosystems transformed due to the sea temperature alteration.

List of literature and Internet resources

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Lyudmila Fedorova

Fisheries Eco-Certification Consultant

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