

**Action 6: Enhancement outcomes and management**

**Action Goal: Demonstrate that effective enhancement and fishery strategies are in place to address effects of enhancement activities on wild stock(s)**

**PIs 1.3.1, 1.3.2**

**1. The number of hatcheries in Kunashir and fish breeding programs**

According to the Sakhalin-Kuril Territorial Administration (SKTU), 77 fish hatcheries have been put into operation in the Sakhalin Region. In 2023, total release of juvenile Pacific salmon was 1,446.1 million fish, including: Pink Salmon - 315.3 million fish, Chum Salmon - 1,129.8 million fish.

In the fishing area of PCF Yuzhno-Kurilsky Ryibokombinat Co., Ltd. (hereinafter referred to as YKRRK) there are two full-scale operating hatcheries, one of which belongs to the YKRRK – Lagunnoye Lake Salmon Hatchery. The other hatchery belongs to the Individual Entrepreneur (IE) Muravyov, it is Rikorda River Salmon Hatchery. Another salmon hatcheries is being built on the Tropinka River (Fig. 1).



Figure 1. Map of Kunashir Island, indicating the watercourses with possible location of the future salmon hatcheries. Red circles indicate the location of existing fish hatcheries Lagunnoye Lake Salmon Hatchery and Ricorda River Salmon Hatchery, as well as the hatchery under construction on the Tropinka River (according to Tatiana Tochilina’s report)

In the scientific community there are discussions on the effectiveness of the programs for the new fish hatchery construction on Kunashir. The management and managers of fishing companies are willing to invest their own funds in fish hatchery and are convinced that this is the only way to restore the depressed populations of Pink and Chum Salmon on Kunashir, as well as to get additional raw fish for onshore fish processing plants. During the inspection visit to Kunashir Island, all interviewed respondents pointed to the need for fish hatchery programs. Tatiana

Tochilina report provides information that in 2023 fishing companies have already carried out work to expand the juvenile Chum Salmon releases (Table 1).

Table 1. Release of juvenile Chum Salmon by the salmon hatcheries on Kunashir Island from 2018 to 2023, million fish

Name of the hatchery or water body	Release of juvenile Chum Salmon by year, million fish					
	2018	2019	2020	2021	2022	2023
Lagunnoye Lake Salmon Hatchery	1.5	3.4	10.4	18.5	12.5	19.8
Rikorda River Salmon Hatchery	0.0	0.0	14.2	14.6	14.1	17.9
Golovnina River	0.0	0.0	0.0	0.0	2.4	0.5
Khlebnikova River	0.0	0.0	0.0	0.0	0.0	1.0
Sennaya River	0.0	0.0	0.0	0.0	0.0	1.0
Tropinka River	0.0	0.0	0.0	0.0	0.5	2.0
<b>TOTAL:</b>	<b>1.5</b>	<b>3.4</b>	<b>24.6</b>	<b>32.1</b>	<b>29.5</b>	<b>42.2</b>

The release of Chum Salmon juveniles from this hatchery over the past 6 years is presented in Table 2.

Table 2. Release of Chum Salmon juveniles from the Lagunnoye Lake Salmon Hatchery over the past 6 years

Year of fish release	Number of Chum Salmon juveniles released, mil. fish	Dates of fish release	Average weight, g
2018	1.5	From June 15 to June 16	2.6
2019	3.4	From May 27 to June 20	0.8
2020	10.4	From May 25 to July 01	1.1
2021	18.5	From June 10 to July 02	1.2
2022	12.5	From May 24 to June 30	1.0
2023	19.8	From May 21 to June 20	0.952

In 2023, 17.9 million juvenile Chum Salmon were released from the Ricorda River Salmon Hatchery (second hatchery) into the main Ricorda River. In addition, in 2023, this hatchery built a permanent hatchery workshop on the Golovnina River and a temporary hatchery on the Khlebnikova River. There is no hatchery on the Sennaya River, but juveniles are transported there from the hatchery on the Rikorda River.

The third organization (the Island Fish Invest LLC) spent two years purchasing juveniles at the Ricorda River Salmon Hatchery, transporting and releasing them into the Tropinka River. This company is building its own fish hatchery on the Tropinka River.

Thus, in 2023, the total release of Chum Salmon juveniles on Kunashir Island amounted to about 42.2 million fish. These are tiny volumes compared to the neighboring islands of Iturup (Russia) and Hokkaido (Japan). However, according to 2023 results, salmon hatcheries are beginning to play an important role in the reproduction of salmon in Kunashir. Preliminary calculations have shown that the share of hatchery Chum Salmon was 54.4% of the total catch. This gives reason to believe that the future returns of hatchery Chum Salmon will be stable and will serve as the basis for the restoration of depressed wild Chum salmon populations.

Table 3 demonstrates the juvenile release on Iturup and Kunashir Islands. In 2023 the volume of released juvenile salmon from two islands was 547.863 million fish with 152.54 million of juvenile Pink Salmon and 395.323 million of juvenile Chum Salmon; the total share of Kunashir released juveniles was 10.7%.

Table 3. Release of juvenile Pacific salmon from Iturup and Kunashir islands in 2023, million fish

Species	Iturup	Kunashir	Total
Pink Salmon	152.54	0.0	152.54
Chum Salmon	353.103	42.22	395.323
<b>TOTAL</b>	<b>505.643</b>	<b>42.22</b>	<b>547.863</b>

Release of Kunashir Chum Salmon compared to the neighboring island of Hokkaido was approximately equal. According to NPAFC data, in 2022, 1,155.9 million juvenile salmon were released from Hokkaido's salmon hatcheries, including 1,043.4 million juvenile Chum Salmon. 414.65 million of juvenile Chum Salmon were released from the salmon hatcheries on the Pacific side of Hokkaido, which includes the Nemuro area bordering Kunashir.

The values of allowable volumes of hatchery fry release are regularly reviewed by SakhNIRO and VNIRO scientists. Every year data on the maximum allowable juvenile fish release volumes are published on the VNIRO website. In particular, at the link [http://vniro.ru/files/recomend\\_new/dv\\_2024-2026\\_1.pdf](http://vniro.ru/files/recomend_new/dv_2024-2026_1.pdf) it is possible to find the document with recommendations till 2026: for the Lagunnoye Lake Salmon Hatchery, release of 20.0 million fry is permitted, and for the Rikorda River Salmon Hatchery - 25.0 million fry. The document also shows that it is allowed to expand fish breeding programs on Kunashir Island and increase the release volume of Pacific salmon juveniles up to 95 million fish.

## **2. Activities carried out by the PCF Yuzhno-Kurilsky Ryibokombinat Co., Ltd. aimed at reducing the impact of the Lagunnoye Lake Salmon Hatchery on wild Chum Salmon populations.**

Since the stock of Chum Salmon on Kunashir Island is currently at a low level, the artificial reproduction programs used by YKRK company involve the use of both eggs of local origin and eggs imported from other areas in order to form their own brood stock.

Specialists of the Lagunnoye Lake Salmon Hatchery have developed and are carrying out the strategy of reaching the full capacity of their hatchery, the main component of which is the maximum collection of eggs from “hatchery” spawners entering the Pervukhina Stream. In 2023, it managed to collect 29.1 million eggs at the special egg collection point – this was 100% of the planned volume. There was no selective sampling of spawners when collecting eggs – all fish that entered the Pervukhina Stream during the entire spawning season were caught.

In 2023, information on the intensity of Chum Salmon returns to the Lagunnoye Lake system was collected. Peculiarities of the location of the salmon hatchery and its egg collection point allow Chum Salmon spawners entering from the sea into the channel of the Lagunnoye Lake to freely distribute themselves on spawning grounds: if they are recruits of the wild population, then they have the opportunity to stay in Lagunnoye Lake. If these are recruits of the hatchery population, they move up and through the Pervukhina Stream section enter the fishway, where they are caught and used to collect eggs for the fish hatchery.

Counting was carried out twice a day in the morning and evening. The number of Chum Salmon was determined by visual counting. Based on Report No. 2 of the chief fish breeder Dmitry Pastukhov, a graph on the dynamics of the Chum Salmon runs into the Lagunnoye Lake and the Pervukhina Stream was drawn up (Fig. 2). For this purpose, the indicator “average number of counted fish per hour” was calculated for each observation date. Although observations were not carried out around the clock, they allow us to make inferences on the dynamics and intensity of the spawning run.

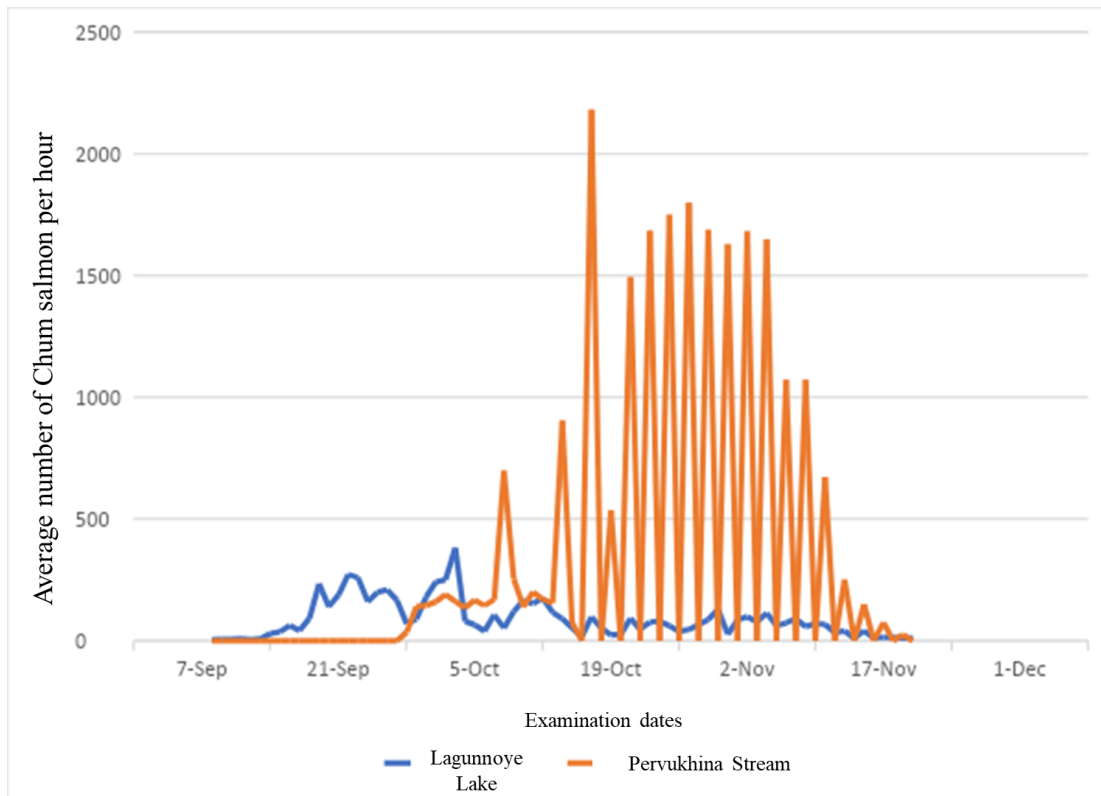


Figure 2. Dynamics of Chum Salmon spawners run in the Lagunnoye Lake and Pervukhina Stream

It is clear that the Chum Salmon runs from the sea to the lake started three weeks earlier than from the lake to the Pervukhina Stream. The highest run intensity from the sea to the lake was observed in late September - early October, and from the lake the stream - from mid-October to mid-November. “Wild” Chum Salmon had unhindered access to spawning grounds. However, according to the results of an examination on November 17, the lake spawning grounds are still have poor escapement; only 3,500 Chum Salmon were counted on the spawning grounds (data from Table 5 of Tatiana Tochilina’s report), which amounted to 8.75% of the optimum (40,000 fish) with the standard of 1.6 fish/m<sup>2</sup>.

During the 2023 season, there was also data collection on the Chum Salmon biological parameters (body weight, body length, age and sex structure). In Tatiana Tochilina’s report, we see that data on the size, sex and age structure of populations was collected during the entire spawning run in various areas of Kunashir, moreover all samples were representative for studies. The obtained results were provided to the SakhNIRO and VNIRO scientific institutes.

Since 2021, YKRC has been initiated tagging eggs program. In December 2023 - January 2024, 24 million Chum Salmon eggs were tagged, which is 82.5% of the total eggs planted for incubation.

In the future, after the beginning of the tagged fish returns (approximately 2025), it is planned to study the otoliths of adult fish. This will provide data for direct assessment of the potential impacts of hatchery fish on wild populations and will allow the effectiveness of established hatchery programs to be assessed.

### **3. Supervision of fish hatchery programs and the level of staff awareness on scientific research and artificial fish reproduction.**

The enhancement process at the Lagunnoye Lake Salmon Hatchery is fully controllable. All stages are carried out in compliance with environmental requirements for the breeding species (Chum Salmon): the hatchery has flow-through systems of river and groundwater supply; the workshops are equipped to simulate conditions of incubation and rearing of larval fish in the

spawning nest; terms of feeding and release of juveniles into Lagunnoye Lake coincide with similar terms for wild populations.

All operations are controlled not only by the fish breeders themselves, but also by employees of the institutions for the control and supervision of fish breeding activities. Direct control is carried out by two government bodies: the Aquaculture Department of the Sakhalin-Kuril Territorial Administration (SKTU) and the Sakhalin Region Veterinary Supervision Department. All instructions of the above-mentioned organizations are carried out unquestioningly.

Fish breeders fill out initial logbooks and submit various reports to the SKTU during the entire fish breeding process: from catching spawners for reproduction purposes to releasing juveniles into their natural habitat.

Representatives of the Veterinary Supervision Department conduct periodic inspections of the fish hatcheries, during which they check the sanitary condition of the workshops and equipment, the presence/absence of diseases of eggs or juveniles, the correctness and timeliness of preventive measures and completion of veterinary documentation (Veterinary and sanitary passport, ichthyopathological log, reports of sanitary and preventive treatment of eggs and juveniles).

Based on materials collected during the periods of FIP visits to the salmon hatcheries in 2021 - 2023, as well as data presented in Tatiana Tochilina's report, we can conclude that all Kunashir hatcheries are well technically equipped. All environmental requirements for breeding species are fulfilled.

The management of YKRRK and specialists of the Lagunnoye Lake Salmon Hatchery know that the scientific basis of fish hatchery programs is constantly supplemented with new research; the efficiency of the fish hatcheries and the influence of the volume of juvenile fish production on wild populations are studied by both Russian and foreign scientists.

Information on salmon reproduction on Iturup Island (Russia) and Hokkaido Island (Japan) is important for understanding the whole situation in the vicinity of Kunashir.

Detailed information on Pink and Chum Salmon breeding programs on Iturup Island is provided in the article "Traditions and innovations in the artificial reproduction of Pacific salmon of the Kuril region" by Litvinenko et al. (Litvinenko et al., 2019). The article by Elnikov and Zelennikov shows data on the collection of biological characteristics on this island. The authors say, in particular, "The hatchery Chum Salmon population formed on Iturup Island over the last 20 years retains all the species and regional characteristics that were formed before, when juveniles were reproduced at only one hatchery (Reidovy Salmon Hatchery), the formation of the population was disproportionately influenced by natural spawning. As before, spawners are characterized by relatively low absolute fecundity, and when comparing fish of two dominant age groups (3+ and 4+) with similar body weight, fecundity is higher in females of the younger age group" (Elnikov and Zelennikov 2023).

Japanese fish breeding programs are also changing. In 2006, Morita spoke of the importance of reviewing fish breeding programs in Hokkaido: "To use these (*fish breeding*) programmes more effectively, it is necessary to evaluate both their river- and species-specific benefits and compare hatchery programmes with other management tools, such as fishery controls and habitat rehabilitation." (Morita K. et al, 2006).

In 2012, another group of Japanese scientists made a very important statement for fish breeding programs: "Harmony with the ecosystem and the coexistence of wild and hatchery populations are extremely important issues for the North Pacific Rim nations" (Mitsuhiro et al).

Salmon reproduction in fish hatcheries in Russia and Japan plays an important role, but it is only one - the first - phase of salmon development, which lasts until the smolt migration from freshwater to the sea. The most critical stages of their life cycle are the early marine and offshore periods, when the young salmon migrate from the coastal zone to open waters. As is known from numerous publications, mortality rates at this stage can range from 70 to 90% or higher. Scientists are studying juvenile Pacific salmon during the feeding period in the Sea of Okhotsk, which plays an important role in understanding the potential fish mortality.

Bugaev and Gerlitz note in their article: "At present, a unique situation has emerged: TINRO's systematic multi-year fish counting works have resulted in a series of abundance estimates for the entire feeding juvenile Pacific salmon in the Sea of Okhotsk basin. Similar experience is available only in the Russian Far East, when fish counting works are conducted practically over the entire feeding range of juvenile salmon of such mass species as Pink and Chum Salmon" (Bugaev, Gerlitz, 2023). Having analyzed a large amount of data, the authors determined the proportions of tagged Pink and Chum Salmon of Russian and Japanese origin in juvenile feeding aggregations and estimated their abundance in the Sea of Okhotsk basin during the autumn period in 2022-2021 (Table 5). Based on these data, we calculated actual mortality rates for both species during the juvenile migration phase from the coastal zone to open waters (Table 6). According to these data, the mortality coefficient ( $\varphi Z$ ) in 2021 for Russian hatchery Pink Salmon was 0.57 and for Japanese hatchery Pink Salmon - 0.83; for Russian and Japanese hatchery Chum Salmon this parameter was 0.76 and 0.77, respectively.

The YKRK management and specialists from the Lagunnoye Lake Salmon Hatchery are sufficiently informed and focus on the latest scientific research when developing their fish breeding programs to minimize the impact of artificial reproduction activities on wild populations.

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