<u>Okha Comprehensive FIP Workplan – Action 4</u>: Assess the proportion of Amur River salmon in the Okhinskii District fishery catch
PI 1.2.4 (pink and chum)

Update Information December 2020

To achieve Goal 4, two activities were included in the Okha Comprehensive FIP Workplan for the pink and chum salmon fisheries:

A. Develop a long-term plan to estimate the percentage of salmon originating from the Amur River Basin (for example, based on otolith analysis) in the Client's catches. The deadline is no later than May 15, 2018.

B. Implement a plan to estimate the percentage of Amur salmon in the Company's catches. The deadline is no later than June 15, 2018.

To find out the percentage of Amur salmon in the Okhinskii district catches (Northern part of Sakhalin Island) a special Plan was developed that includes the study of available literature data, carrying out expedition work by researchers involved in collecting biometric data and otoliths, processing collected otolith samples, and studying alternative methods for identifying fish by their place of origin. The Plan was submitted by May 15, 2018, so **Point A** was completed.

To fulfill **Point B**, in March 2018, an Agreement was signed with SakhNIRO to assess the occurrence of pink and chum salmon from other reproduction areas in the catches of the Okhinskii district. The work was carried out during two seasons – 2018 and 2019. Also, during 2018-2020, literature and scientific data indicating the origin and proportions of various components of chum salmon stocks fished off the coast of northwestern Sakhalin were studied, and alternative methods of population identification were investigated for possible applying in the Okhinskii district.

A summary of the **Point B** implementation is provided below.

Literature Data Studying

Pink salmon

Previously, it was believed that the share of transit pink salmon in catches in this area is about 70%, the share of native salmon is 30% (according to the report by N.V. Klovach, 2017, VNIRO, Moscow).

However, at present, most researchers (Kaev, Zhivoglyadov, Antonov) agree that the pink salmon fished off the coast of the Northern part of Sakhalin Island within the Okhinskii district is a fish of local reproduction. Below are excerpts from articles by these authors:

A.A. Zhivoglyadov with co-authors, 2017: "Some features of the pink salmon run and its biological characteristics in the coastal area and rivers of North-Western Sakhalin suggest that the bulk of the salmon spawners caught in the coastal area are generatively related to the rivers of this area".

A.M. Kaev, 2019: "Judging by the dynamics of catches and biological parameters of fish, the fishery for pink salmon is based mainly on the returns of fish of local origin, but different temporal forms".

A.A. Antonov, 2020: "Pink salmon is mainly fish of local reproduction, but of different temporal forms: the early running is provided by the Sea of Japan pink salmon, coming to the North of Sakhalin from the South, from the Strait of Tartary. The later returns are the returns of the Sea of Okhotsk pink salmon, coming from the North through the Schmidt Peninsula."

Chum salmon

All authors confirm the mixed composition of chum salmon populations fished off the coast of Northern Sakhalin. All authors agree that the **summer chum salmon** migrating through the coastal area of the district in July-mid-August almost completely belongs to the Amur stock, while the **autumn chum salmon** run (the second half of August-September) is represented by fish of mixed origin. A.A. Zhivoglyadov, 2017: "Salmon migrate through the coastal area from three reproduction areas: from the rivers of the northwestern coast of Sakhalin, from the Amur River and from the rivers flowing into the Amur Estuary, the so-called "estuary" rivers of the mainland coast - Sakhalin Gulf, Ulbansky Bay and Nikolaya Bay."

However, the same authors point out that in different years there may be a different proportion of Amur chum salmon. This depends on the peculiarities of the hydrological characteristics of the Amur Estuary, and on the amount of Amur runoff in certain years.

Estimates of the share of Amur chum salmon in catches vary widely.

So, Natalia Klovach (Moscow, VNIRO) in 2017 provided the following data: "Also, according to expert estimates, the share of Amur summer chum salmon migrating through the coastal area in July-August and found in catches in the northwestern part of Sakhalin is approximately 88 %. The autumn chum salmon harvest (the second half of August−September) is represented by fish of mixed origin. Moreover, according to some data, in these catches, the share of autumn chum salmon reproduced in the rivers of the Northern part of Sakhalin can range from 33 to 44 %."

However, there is data on genetic studies conducted in 1990-1992, indicating that the share of autumn chum salmon of Sakhalin origin in catches in the area of the village of Rybnovsk may be 72.4 %.

In 1994, the Journal of Ichthyology published a joint article by employees of several institutes, "Genetic Identification of Origin of Chum Salmon *Oncorhynchus keta* Obtained in the Sea off Northwestern Sakhalin". The origin of the individuals was determined based on the analysis of the gene frequencies of eight allozyme loci. Samples were collected in the area of the village of Rybnovsk: in 1990 and 1991, samples were taken in July and August, in 1992 – in September and compared with the already known data on Amur chum salmon.

Based on the results of the work, the authors concluded that the summer chum salmon fished in this area coincides with the Amur summer chum salmon in terms of genetic characteristics and timing. Amur chum salmon predominated in the catches of autumn chum in 1990 and 1991, and Sakhalin chum salmon predominated in the catches of autumn chum in 1992. The authors attributed the variability in the composition of catches of autumn chum salmon migrating along the Sakhalin coast of the Amur Estuary to changes in the migration routes of autumn chum, which in turn were caused by changes in the hydrological situation in the estuary itself: in August-September 1992, the Amur runoff was below the long-term average annual value.

However, a deeper analysis of the data provided in the article shows that the samples used to determine the composition of autumn chum salmon in 1990 and 1991 were taken only once: in 1990 – on August 24; in 1991 – on September 06. Herewith, the share of the Sakhalin component was determined as: 1990 - 7.0%; 1991 - 25%.

These data, in fact, well demonstrate the fallacy of the authors' conclusions, since the samples cover only the beginning of the chum running. As we know, the mass running of autumn chum salmon of Sakhalin origin in the area under consideration falls in mid-September and its spawning run continues at least until mid-October. This is confirmed by Aleksander Antonov (SakhNIRO), who observed several chum salmon fishes on October 15, 2020, in the coastal area and in the mouth of the Langry River.

This is also evidenced by the data provided by the authors of the article for 1992: according to samples collected from September 1 to September 16, 1992, autumn chum harvested off the coast of northwestern Sakhalin has 72.4 % of chum salmon of local Sakhalin origin in its composition.

Pink and Chum Salmon Structure Otoliths Studying

During the 2018 and 2019 fishing seasons, otolith samples were collected during biological analyses of pink and chum salmon, which were then analyzed in the SakhNIRO otolithometry laboratory. As part of the Agreement, the otoliths of 277 pairs of pink salmon otoliths and 600 pairs of chum salmon otoliths collected near the village of Rybnovsk in 2015 and stored in SakhNIRO were also examined.

A total of 1,982 pairs of pink salmon otoliths and 2,523 pairs of chum salmon otoliths were processed from both the Eastern and Western coasts of the Okhinskii district:

Таблица 1. The volume of the investigated samples of otoliths of pink and chum salmon collected in the Okhinskii district, pairs of otoliths.

Fish species	Otolith collection year			TOTAL, pairs of otoliths
	2015	2018	2019	
Pink	277	725	980	1,982
Chum	600	1,224	699	2,523

In the samples of **pink salmon** from coastal catches in the north of Sakhalin Island in 2015 and 2018 no marked fish were found. In 2019, only in one case, 2 tags of the Pugachevsky fish hatchery were found in a sample of 97 fishes of pink salmon caught on August 11, 2019 at the Kolendo site (northeastern Sakhalin).

A mosaic pattern was observed in the **chum salmon** samples. In the 2015 sample from the catches of chum salmon off the coast of northwestern Sakhalin (600 fishes), no marked fish were found.

Of the examined 633 chum salmon caught off the coast of **northwestern** Sakhalin in **2018**, 5 marked fish were found (0.8 % of the total sample size). In a sample of 301 chum salmon from coastal catches in the **northeast** of the island, 5 tagged fish were also found (1.7 % of the total sample size). All fish were released from salmon hatcheries of the Khabarovsk Territory: 4 tags from the hatchery located in the Amur River Basin (Anyuisky hatchery) and 1 tag from the Kometa hatchery located south of the Amur River, near the town of Sovetskaya Gavan.

In 2019, out of 699 pairs of chum salmon otoliths examined from both coasts of the Okhinskii district, only one mark of the Ado-Tymovskii hatchery was found. The tag was found in a sample of chum salmon caught on September 04, 2019 at the Odoptu site on the northeast coast. No tags of the hatcheries of the Khabarovsk Territory or other regions were found.

The absence of tags from other regions in the examined samples of pink salmon and the discovery of the tag of the Pugachevsky hatchery in 2019 may confirm the version that pink salmon catches mainly consist of native populations and that in recent years the pink salmon has shifted to more northern distribution areas.

The detection in 2018 of chum salmon tags of Khabarovsk origin on August 19 and 26 on the northeastern coast and September 01-03 on the northwestern coast confirms the presence of individuals from this region in the catches of autumn chum. We can also trace the migration routes: we see that in the second half of August the chum salmon of the Amur River and the rivers of the mainland part of the Amur Estuary migrate through the northeastern coast of Sakhalin and appears in catches of the northwestern coast in early September. However, the small percentage of marked juveniles released from Khabarovsk hatcheries does not allow determining the share of Amur salmon by the occurrence of fishes with tags from Amur hatcheries in catches in the Northern Sakhalin.

The absence of marks from Khabarovsk hatcheries in 2019 may indicate a change in the migration routes of chum salmon associated with changes in hydrological conditions in the

coastal area. The detection of the Ado-Tymovskii hatchery tag may indicate that the chum salmon, like the pink salmon, tends to spread to the more northern parts of its range.

From the information received from Aleksander Antonov, the External Fisheries Management System takes into account the specifics of fishing in this region: "Based on the fact that the populations of both pink salmon and chum salmon are significantly mixed in the Amur Estuary, in recent years two institutes of SakhNIRO and the Khabarovsk branch of TINRO have been working together to determine the possible size of the catch of these species by Sakhalin and Khabarovsk fishermen. This takes into account the mutual catch of part of the populations by both sides: Khabarovsk fishermen catch part of the Sakhalin populations and vice versa."

New methods for Population Identification Overview

Identification of fish by otoliths of individuals marked in hatcheries is the most common method today. However, there are other directions as well. We have studied four more methods of fish identification, which in the future could be offered to Client Companies to solve problems for the set Goal 4:

1) Method of microchemical analysis of calcified fish structures (New Zealand experience with trout; co-author - Pavel Mikheev, a Russian scientist from Perm);
2) Measurement of the ratio of strontium isotopes in water samples, otoliths of juvenile and adult fish (Japan experience with taimen);
3) Identification of local chum salmon groups based on analysis of otolith microstructure (works of SakhNIRO);
4) Collection and extraction of DNA from the aquatic environment (experiments of Russian and foreign scientists, including those on the Baikal omul, on the fish of Lake Khanka, etc.).

The first method seems to us the most acceptable for the Okhinskii district. Moreover, it is known that Pavel Mikheev collaborates with the Khabarovsk branch of TINRO and conducts a number of experiments with young chum salmon from the Anyui River of hatcheries and wild origin. In 2020, it was planned to study it in more detail. For these purposes, a trip to the city of Perm in March-April 2020 was envisaged, including a personal acquaintance with Pavel Mikheev, and obtaining information about the laboratory and the equipment used. The plan was disrupted due to the coronavirus pandemic, but personal contacts have been established and information exchange continues.

List of literature and Internet resources:

Zhivoglyadov A.A., Ignatyev U.I., and Zhivoglyadova L.A. Dynamics of the abundance and conditions of reproduction of mass species of pacific salmons (*Oncorhynchus*) on the northwestern coast of Sakhalin. Journal of Ichthyology, 2017, Vol. 57, No. 4, pp. 435–444. (in Russian)

Klovach N. V. Tikhookeanskie lososi r. *Oncorhynchus* Okhinskogo rayona Sakhalinskoy oblasti (severo-vostochnoe i severo-zapadnoe poberezhiya ostrova Sakhalin). Pacific salmon of the genus *Oncorhynchus*, Okhinskii District, Sakhalin Oblast (northeastern and northwestern coasts of Sakhalin Island). Literature review, Moscow, 2017. (in Russian)

Kaev A.M. Some Results from Studies on Number Dynamics of Pink *Oncorhynchus gorbuscha* and Chum *O. keta* Salmons on the Northwest Coast of Sakhalin Island. Journal of Ichthyology, 2019, Vol. 59, No. 5, pp. 567–577. (in Russian)

Mikheev P.B., Sheina T.A. Application of the analysis of trace elements composition for calcified structures of fish to solve fundamental and applied scientific tasks: a review. Izvestiya TINRO. Vol. 200, No. 3, Vladivostok, 2020. (in Russian)

Omelchenko V. T., Salmenkova E. A., Ivanov A. N., Afanasyev K.I., Savushkina K.I., Rosly Yu.S. Genetic Identification of Origin of Chum Salmon *Oncorhynchus keta* Obtained in the Sea off Northwestern Sakhalin. Journal of Ichthyology, 1994, Vol. 34, No. 6, pp. 820 – 826.
(in Russian)

Information received during personal participation in the video conference on October 20, 2020, dedicated to the issues of the escapement of the Okhinskii district rivers in 2020 with pink and chum salmon spawners, as well as some aspects of the SakhNIRO report: "Determining the optimal escapement for the rivers of the northern part of Sakhalin Island".

http://www.sakhtaimen.ru/ru/news/99/
http://sakhtaimen.ru/ru/news/51/
http://www.smakeev.com/news/117/

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