Goal 4. PI 1.2.4.

Assessing the proportion of Amur River salmon in the Okhinskii District fishery catch. According to the SakhNIRO laboratory of otolithometry, 2018.

In 2018, for the first time over the entire period of scientific observations, purposeful work on identifying the origin of pink and chum salmon was carried out in Okhinskii district during fishing season. During the expedition in 2018 in Okhinsky region, 1949 pairs of otoliths were collected from the fishery, including:

pink – 725 pair; chum – 1224 pairs.

Also, within the frame of agreement, 277 pink and 600 chum otolith pairs were collected in Rybnovsk settlement in 2015 and stored in SakhNIRO.

The amount of otoliths collected to identify marked fish is presented in Table 1.

Table 1. The amount of otoliths collected to identify hatchery marked pink and chum salmon fish in the age of 2015, 2018.

Date	Pink			Chum		
	Sakhalin Island			Sakhalin Island		Amur river (fish weir)
	north-west	north	north-east	north-west	north-east	
2015						
24.07.2015	98	--	--	100	--	--
31.07.2015	--	--	--	100	--	--
03.08.2015	100	--	--	--	--	--
08.08.2015	79	--	--	100	--	--
22.08.2015	--	--	--	100	--	--
30.08.2015	--	--	--	100	--	--
09.09.2015	--	--	--	100	--	--
Total:	**277**			**600**		
2018						
09.07.2018	--	--	--	97	--	--
25.07.2018	--	99	--	--	--	--
04.08.2018	--	--	92	--	--	--
08.08.2018	--	--	92	--	--	--
13.08.2018	--	--	92	--	--	--
17.08.2018	--	--	97	--	--	--
19.08.2018	95	--	--	--	208	--
24.08.2018	--	--	99	--	--	--
26.08.2018	--	--	--	--	93	--
27.08.2018	59	--	--	--	--	--
28.08.2018	--	--	--	98	--	--
01.09.2018	--	--	--	98	--	--
03.09.2018	--	--	--	96	--	142
04.09.2018	--	--	--	--	--	148
05.09.2018	--	--	--	47	--	--
08.09.2018	--	--	--	98	--	--
13.09.2018	--	--	--	99	--	--
Total:	**154**	**99**	**472**	**633**	**301**	**290**
Grand total:	**1002**			**1824**		

Since it was the first year of carrying such work, so-called " benchmark" data on otolith structure of fish in Okhinsky district was obtained. It was the first step to estimate the proportion of Amur chum in catches on the north of Sakhalin island.

After processing otoliths and studying their structure, the following 3 main results were obtained:

1. No marked **pink** salmon was found.
2. There were 10 **chum** salmon identified with Khabarovsk region hatchery marks.
3. Chum salmon were classified into 4 local regional groups based on early growth patterns in the otolith structure.

A summary of the SakhNIRO report on all 3 findings is presented below.

1. **Pink identification.**

In 2014 and 2017, 222.8 and 70.4 million pink salmon juveniles respectively were otolith-marked and released from the Far Eastern hatcheries (*LRZ in Russian*). Majority of released fish (80%) were juveniles from sakhalin region hatcheries. The rest were released from Magadan's hatcheries. The volume of pink salmon hatchery reproduction in Khabarovsky region is insignificant. In 2017, only 6.2 million juveniles were released, but they were not marked.

In samples of pink salmon from coastal catches in the north of Sakhalin in 2015 and 2018 marked fish were not detected. There is a possibility that fish released from Khabarovsky region hatcheries were present in pink salmon catches in this area, but no marks were found because these hatcheries did not otolith-mark pink salmon. Relatively small volumes of pink salmon released from the Amur hatchery and absence of fish marked in hatcheries from other regions in samples, suggest that pink salmon catches in Okhinskii district predominantly consist of wild fish.

2. Chum identification.

Chum salmon spawning run to the north coast of Sakhalin island in 2015 contained fish of the 2012–2009 generation; in 2018 it contained fish of the generation of 2012–2015.

Total release of marked fry from the Far Eastern hatcheries in 2010–2016 ranged from 258.6 to 399,4 million fish with an average of 282.4 million.

Volumes of released marked juveniles from hatcheries from different regions of the Russian Far East in 2010–2016 is shown in table 2.

Table 2. Releases of marked chum salmon from hatcheries from different regions of the Russian Far East in 2010–2016.

Region / year of release	Chum, million fish						
	2010	2011	2012	2013	2014	2015	2016
Sakhalin region.	249.1	274.5	305., 0	327.6	363., 3	328	221., 6
Magadan region.	6.,0	5.5	9.9	6.0	7.3	6.2	9.7
Kamchatka region	28.3	29.0	-	27.6	28.3	28.3	20.1
Khabarovsky region	4.7	17.1	28.2	0.3	0.5	5.7	7.2
TOTAL	**288.1**	**326.1**	**343.1**	**361.5**	**399.4**	**368.2**	**258.6**

In the samples of 2015 (600 fish), marked fish in chum salmon catches in the coastal area of northwestern Sakhalin were not found.

Out of 633 chum salmon fish caught in the coastal area of northwestern Sakhalin in 2018 only 5 fish had mark (0.8% of the total sample size), and out of 301 chum salmon fish in the coastal catches in the north-east of the island also only 5 marked fish were detected (1.7% of the total sample size). All fish were released from Khabarovsky region hatcheries (Figures 1 - 3).

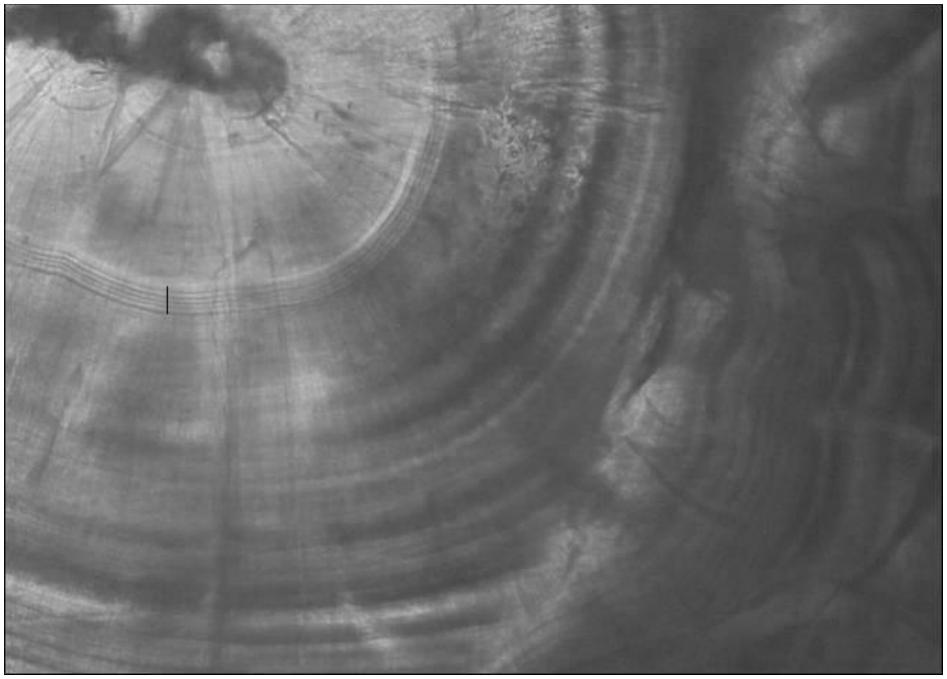

Figure 1. «Anyuisky» hatcheries mark (5nH) on chum otoliths (generation 2015) in the age of year 2018.

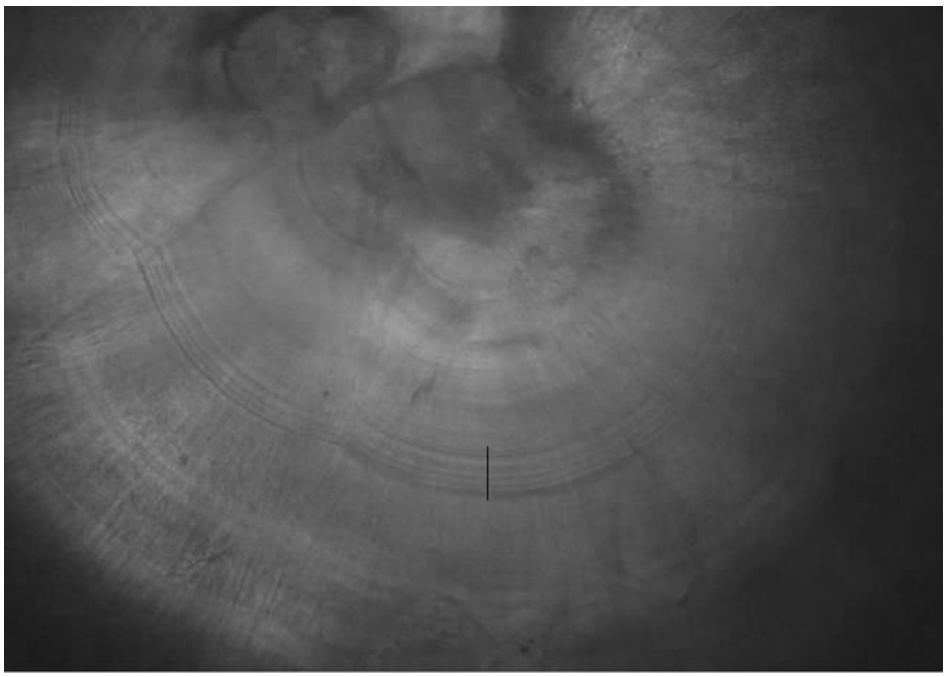

Figure 2. «Anyuisky» hatcheries mark (1,4nH) on chum otoliths (generation 2014) in the age of year 2018.

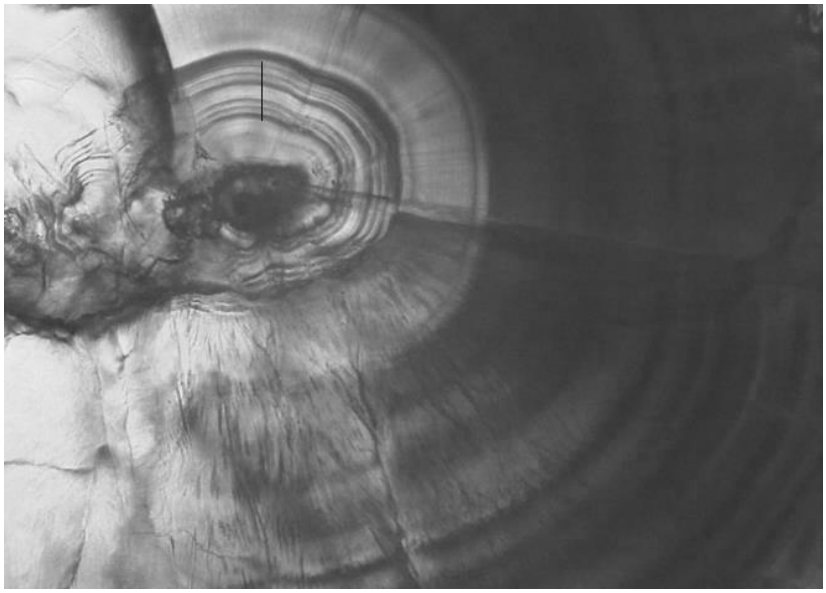

Figure 3. «Kometa» hatcheries mark (3-3H) on chum otoliths (generation 2014) in the age of year 2018.

The results of marked fish (chum) identification are presented in the Tables 3 and 4.

Table 3. Identification results of marked fish from coastal chum salmon in the northeast of Sakhalin (RPU No. 65-06-57-2, 65-06-57-5) in 2018.

Sampling date	Sampling volume, fish	Number of identified hatchery marks, fish				Marked fish total	Non-marked fish total
		«Anyuisky»		«Kometa»	Other		
		1,4nH	5 nH	3-3H			
19.08.2018	208	1	0	0	0	1	207
26.08.2018	93	2	1	1	0	4	89
TOTAL	301	3	1	1	0	5	296

Table 4. Identification results of marked fish from coastal chum salmon catches in the northwest of Sakhalin (RPU No. 65-6-21-2) in 2018.

Sampling date	Sampling volume, fish	Number of identified hatchery marks, fish				Marked fish total	Non-marked fish total
		«Anyuisky»		«Kometa»	Other		
		1,4nH	5 nH	3-3H			
09.07.2018	97	0	0	0	0	0	97
28.07.2018	98	0	0	0	0	0	98
01.09.2018	98	2	0	0	0	2	96
03.09.2018	96	1	1	1	0	3	93
05.09.2018	47	0	0	0	0	0	47
08.09.2018	98	0	0	0	0	0	98
13.09.2018	99	0	0	0	0	0	99
TOTAL	633	3	1	1	0	5	628

Thus, as a result of the analysis of the microstructure of otoliths of 934 chum sampled from catches in the coastal area of the Okha region in 2018, 10 had hatchery marks from the Khabarovsk Territory, which once again confirmed the mixed nature of the concentrations of salmon caught in the area. No fish with marks of hatcheries from other regions (Kamchatka and Primorsky Krai, Magadan and Sakhalin regions) were found.

3. Local chum groups

Analysis of the microstructure of chum otoliths allowed to identify local groups.

Numerous studies have shown that in rivers of different Far Eastern regions (usually large ones) chum salmon of two ecological-temporal (seasonal) races reproduces: the early (summer) and late (autumn) races. The early chum salmon spawns in the areas with a well-defined sub-stream flow, and the late race - in creeks with groundwater outlets.

The peculiarities of the hydrological regime of spawning grounds determine differences in the rate of embryonic-larval development, including the width of daily otoliths microgrowth. High water temperature in the spawning grounds of early chum salmon during summer months (9–13°) is the cause of the high development rate on the initial stage of embryogenesis, which is completely unusual for late chum salmon, whose temperature range in the spawning grounds is lower during the initial stage (7–8°).

In the rivers of some regions, several temporal groups among both summer and autumn chum races are found.

Based on otoliths analysis from samples obtained from chum salmon catches in Amur river near Rybnovsk settlement (north-western Sakhalin) and in Tropto Bay (north-eastern Sakhalin), there were identified four groups, conventionally designated as groups A, B, C, D.

The otoliths of group “A” in their central part are characterized by the presence of a continuous series of clearly delineated microgains, the width of which gradually decreases from the otolith core to the periphery.

The otoliths of the “B” group have a fundamentally similar pattern in the central part, but microgains in them are located in separate groups interspersed with “clean” zones. In general, the zone with described increments on otoliths of group “B” ends earlier than on otoliths of group “A”.

The otoliths of group “C” are distinguished by the absence of any noticeable structures except for the pigmentation rings of the eyes and the ring of hatching, which are common for all otoliths.

The otoliths assigned to the “D” group had different number of elements in the microstructure that are not differentiable into groups.

As a result of statistical analysis of biological characteristics of individuals belonging to these groups, significant differences ($p < 0.05$) in weight, linear sizes between fish from groups “C” and “D” were revealed. Fish from these groups are significantly different from fish classified in groups “A” and “B” (Table 5).

Table 5. Biological characteristics of chum salmon, classified in different groupings, from catch in the coastal area in the north of Sakhalin and near the mouth of Amur River in 2018.

Group		Length AC, cm	Weight, g	Gonad weight, g	Absolute fertility, fish.	Maturation coefficient, %
A	male	53.8	1764	87	1335	4.6
	female	52.0	1541	165		10.9
	both	52.5	1604			
B	male	51.6	2058	99	1337	6.3
	female	54.4	1888	140		12.4
	both	53.6	1604			
C	male	63.4	3151	134	1994	4.6
	female	55.7	2749	237		10.9
	both	59.3	2937			
D	[illegible]le	61.2	2622	124	2007	4.6
		58.2	2276	242		10.9
		59.2	2399			

As it can be seen from Figure 5, in all groups, with the exception of group “A”, three ages are represented, but the relative number of each age group is different.

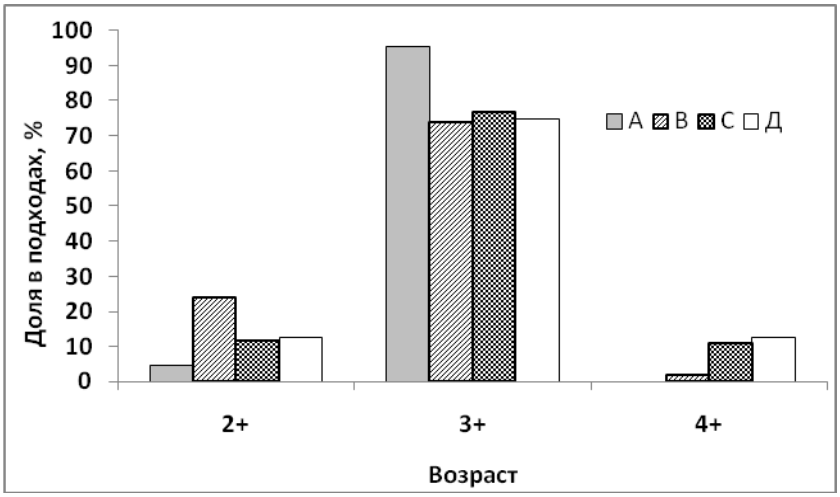

Figure 5. The age composition of fish, classified in different groups, from chum salmon catches in the coastal area in northern Sakhalin and near the mouth of the Amur River in 2018. X axis - age, y axis percent of run, %

The ratio of fish of different ecological forms changed during the course of spawning run and varied in runs to northeast, northwest Sakhalin and to the continental coast of the Amur estuary (Figure 6). From Figure 6 it can be seen that chum, referred to the “C” group, prevailed in the catches of all three regions. But in the coastal catches of continental coast of the Amur estuary, its share was significantly higher than those of the Sakhalin coast. Early chum form near the continental coast (unlike the Sakhalin coast) was not observed at that time.

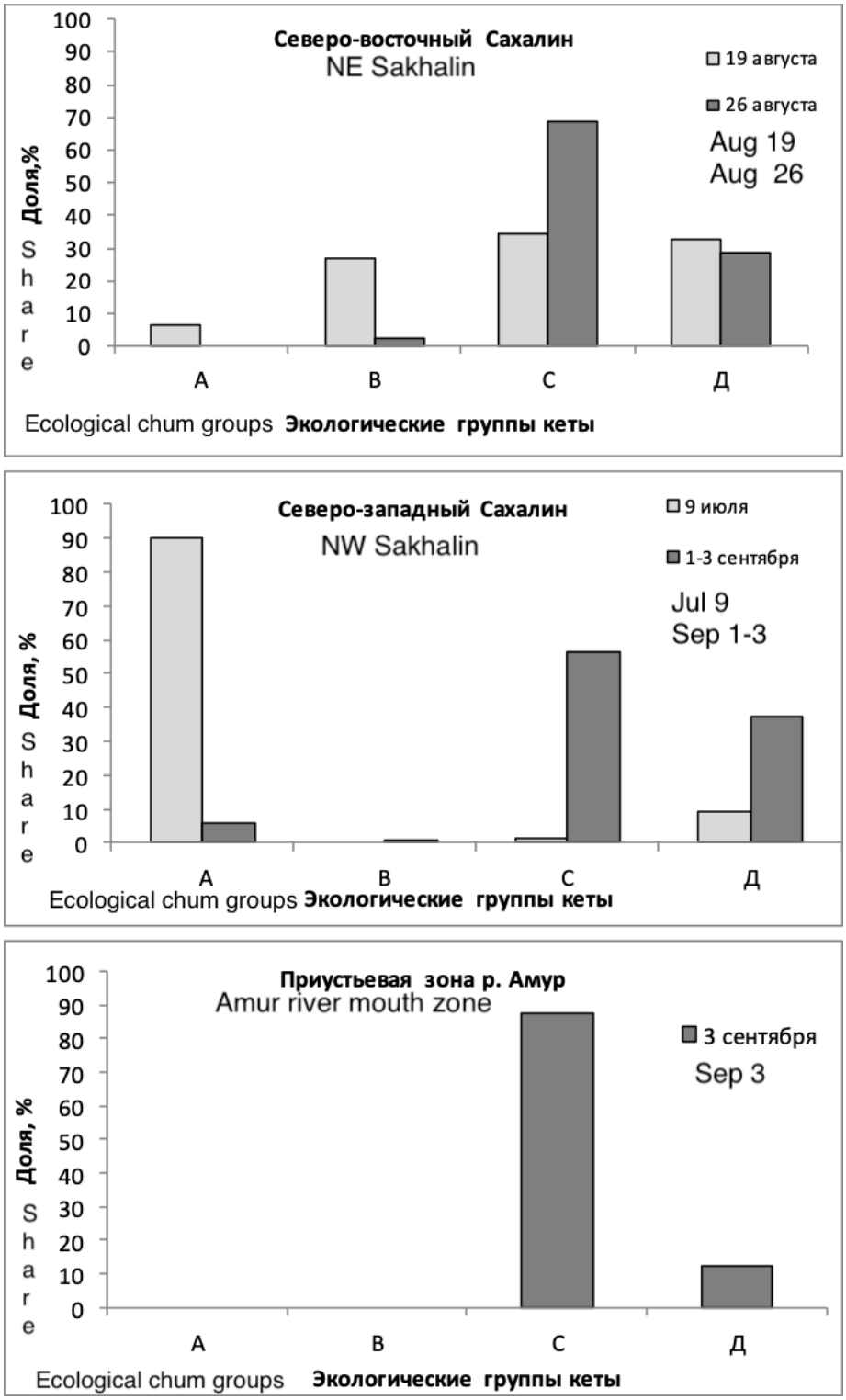

Figure 6. The ratio of different ecological forms of chum in spawning runs to the continental coast of Amur Estuary and to the northern coast of Sakhalin island in 2018

It is not possible to estimate the abundance of chum salmon of various ecological forms in the catch of Okhinskii district in 2018 due to the fact that chum spawning run was not fully observed.

In 2019, work on collecting samples of otoliths and studying their microstructure is planned to be continued.