

Tagging of chum and humpback (pink) salmon, being reproduced at ZAO “Gidrostroy” (Closed Joint-Stock Salmon hatchery Company), was carried out to evaluate the proportion between natural and artificial fish reproduction in the hatchery-origin spawning stock, to estimate the ratio of natural and artificial fish reproduction in the annual catch, as well as to estimate the proportion of hatchery-origin straying in natural spawning grounds.

First release of salmon, tagged on the otoliths, labeled at “Kurilskiy” and “Reidovoy” hatcheries, was performed in 2009. Production volume amounted to 76 million salmon. Out of this number, 2.3 million chum salmon and 7.3 million humpback salmon were released at “Kurilskiy” hatchery, and 23.9 million chum salmon and 42.2 million humpback salmon were released at “Reidovoy” hatchery (Table 1).

Table 1

Volume of tagged salmon juveniles released at Iturup Island hatcheries, 2009

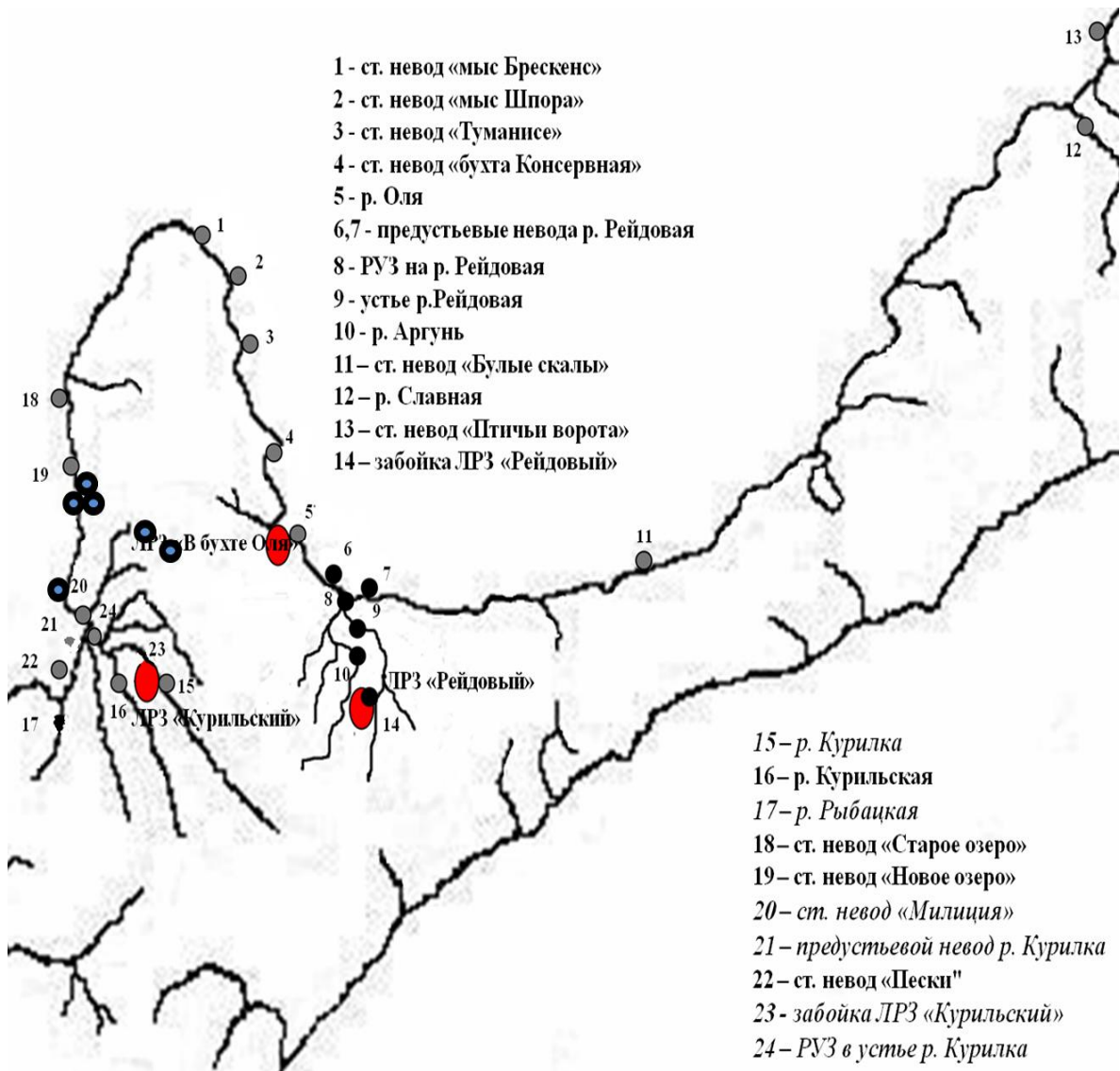
Hatchery Name	Specimen	Total release, million specimens	Tagged juveniles, million specimens	Tagged juveniles, %
«Reidovoy»	humpback	42.24	42.24	100
	chum	23.89	23.89	100
«Kurilskiy»	humpback	67.4	7.32	10.86
	chum	18.7	2.3	12.30
Total	humpback	109.64	49.56	45.20
	chum	42.59	26.19	61.49
	Total number of juveniles	152.23	75.75	49.76

The return of the salmon generation of 2008 took place in 2010, which allowed the beginning of investigations connected with the identification of hatchery-origin fish. The first stage of work included the collection of material for identification of tagged spawners in the base rivers of hatcheries, in stationary nets, located in the vicinity of hatcheries in Kurilskiy and Prostor Bays, as well as in the water areas beyond the base system of rivers. At the second stage otoliths of chum and humpback salmon from the approaches to “Reidovoy” hatchery were prepared to carry out the analysis of their microstructure and to receive digital photos of the central part of the otolith, where the tags, formed during periods of incubation and breeding of juveniles at the hatcheries, were localized. At the third stage, the processing and the creation of digital photos of the tagged otoliths from the approaches to “Kurilskiy” hatchery was carried out. At the final, fourth stage, preparation

for analysis of microstructure of the salmon otoliths from fixed net catches, located in the Kurilskiy and Prostor Bays, was performed.

Description of the material. To identify hatchery-origin spawners in the return of 2010, otoliths of 3,340 chum and humpback salmon specimens were selected.

The points of collection of the material for identification of the tagged fish are shown in the diagram (Fig. 1).



1 - “Cape of Breskens” fixed net; 2 - “Cape of Shpor” fixed net; 3 - “Tumanice” fixed net; 4 - “Konservnaya Bay” fixed net; 5 - Olya River; 6,7 - Reidovaya River foremouth net; 8 - hatchery at Reidovaya River; 9 - Reidovaya River mouth; 10 - Argun River; 11 - “Bulye Skaly” fixed net; 12 - Slavnaya River; 13 - “Ptichyi Vorota” fixed net ; 14 - Zaboyka* “Reidovoy” hatchery; 15 - Kurilka River; 16 - Kurilskaya River; 17 - Rybatskaya River; 18 - “Staroye Ozero” fixed net; 19 - “Novoye Ozero” fixed net; 20 - “Militiya” fixed net; 21 - Kurilka River foremouth net; 22 - “Peski” fixed net; 23 - Zaboyka* at Kurilskiy hatchery; 24 - hatchery at Kurilka River mouth

Figure 1. Diagram of the area of material collection for identification of the tagged chum and humpback salmon in the 2010 return at Iturup Island; otoliths collection sites, the identification of

which was performed at the first stage of the research, and are marked in black; material for the second stage of identification are marked in blue; otoliths collection places investigated at the third stage are marked in grey.

* ZABOYKA - A number of stakes or pilings driven into a river bottom. (Translator's note)

Material for identification was selected according to the volume of humpback salmon that approached the area of investigation: within a period from the 1st ten days of July until the last ten days of September for humpback salmon, and within October - for chum salmon. They began to select material from fixed nets. During the period that salmon moved into the rivers, they continued to collect material from catches in fixed nets and made a selection of otoliths of humpback salmon in the mouths of base rivers, then in the approaches to the hatcheries and the spawning grounds.

The results of the processing and analysis of the microstructure of salmon otoliths.

Humpback salmon

To identify the tagged humpback salmon, otoliths of 1739 specimens were selected. In the course of the processing of the otoliths it appeared that some of them turned out to be destroyed during selection and transportation to the laboratory, and were not suitable for identification due to the lack of the central part, where the tag is located. They managed to use 3,282 otoliths for identification. All in all, 1,641 specimens of humpback salmon were identified: 909 from "Kurilskiy" hatchery area, and 732 from "Reidovoy" hatchery area. Data on the number of identified and tagged spawners is shown in the table (Table 4).

Table 4

The results of the identification of tagged humpback spawning salmon that returned to Iturup Island in 2010

Collecting ground	Number of hatchery detected tags		Total number of tags	without tags	Total count
	"Kurilskiy"	"Reidovoy"			
"Reidovoy" hatchery area	4	187	192	541	732
"Kurilskiy" hatchery area	31	5	37	873	909
Total	35	192	229	1414	1641

The results of the identification of tagged humpback salmon spawners, according to otoliths collection points is shown below (Tables 4, 5).

Table 4

The results of identification of hatchery-origin humpback salmon at "Reidovoy" hatchery area in the 2010 spawning return

Date of collection	Place of collection	Number of hatchery tags (spec.)	Amount of	Point in the
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		"Kurilskiy"	"Reidovoy"	sampling	diagram
Sea fixed nets at "Reidovoy" hatchery area					
07/20/2010	Shpor, Breskens fixed nets	0	0	96	1,2
08/09/2010	Konservnyi fixed net	1	2	96	4
08/18/2010	Bulyie Skaly fixed net	1	11	47	11
08/22/2010	Slavnaya, Ptichyi Vorota fixed net	0	7	49	13
08/27.2010	Fixed net at Reidovaya River	1	7	43	6,7
Total		3	27	331	
Spawning grounds at "Reidovoy" hatchery area					
07/24/2010	Slavnaya River	0	0	37	12
09/19/2010	Argun River	0	0	47	10
09/20/2010	Olya River	0	2	48	5
Total		0	2	132	
Base river and mouth nets at "Reidovoy" hatchery area					
08/10/2010	Reidovaya River mouth	0	15	48	9
08/19/2010	Reidovaya River mouth	0	12	50	9
09/14/2010	Reidovaya River zaboyka	0	39	41	14
09/14/2010	Reidovaya River mouth	0	21	45	9
09/22/2010	Hatchery at Reidovaya River mouth	1	28	41	8
09/24/2010	Zaboyka of Reidovaya River hatchery	0	43	44	14
Total		1	158	269	
Total at "Reidovoy" hatchery area		4	187	732	

Table 5

The results of identification of hatchery-origin humpback salmon at "Kurilskiy" hatchery area in the 2010 spawning return

Date of collection	Place of collection	Number of hatchery tags (spec.)		Amount of sampling	Point in the diagram
		"Kurilskiy"	"Reidovoy"		
Sea fixed nets at "Kurilskiy" hatchery area					
07/31/2010	Peski, Militsiya fixed nets	0	0	98	22, 20
08/06/2010	Staroye Ozero fixed net	0	0	88	18
08/13/2010	Militsiya fixed nets	0	0	56	20
08/24/2010	Peski fixed net	2	1	45	22
08/30/2010	Peski fixed net	3	2	48	22
09/05/2010	Peski fixed net	2	1	47	22
09/10/2010	Novoye Ozero fixed net	5	0	50	19
09/17/2010	Kurilka River foremouth area	10	0	43	21
Total		22	4	475	
Base river and mouth nets at "Kurilskiy" hatchery area					

08/17/2010	Kurilka River mouth	2	0	49	24
08/30/2010	Kurilka River mouth	0	0	47	24
09/08/2010	Zaboyka at “Kurilskiy” hatchery	1	0	46	23
09/22/2010	Kurilka River mouth	4	0	50	24
09/25/2010	Zaboyka at “Kurilskiy” hatchery	0	0	50	23
10/04/2010	Zaboyka at “Kurilskiy” hatchery	1	0	46	23
Total		8	0	288	
Spawning grounds at “Kurilskiy” hatchery area					
09/10/2010	Kurilka River	1	0	48	15
09/10/2010	Kurilskaya River	0	0	48	16
09/13/2010	Rybatskaya River mouth	0	1	50	17
Total		1	1	146	
Total at “Kurilskiy” hatchery area		31	5	909	

The majority of tagged humpback salmon (84% of the observed tags) was recorded in “Reidovoy” hatchery area and its vicinity (Fig. 3). Within the area of the “Kurilskiy” hatchery, and in the nets of Kurilskiy Bay waters, 16% of the total number of spawners with otoliths tags, were found.

The prevalence of “Reidovoy” hatchery-origin tags among the observed tagged spawners, as well as the prevalence of the tagged fish at “Reidovoy” hatchery area correlates to the significant release of labeled juveniles at this hatchery (100% of the hatchery-origin release) compared with the release at “Kurilskiy” hatchery (10.86% of the hatchery-origin release).

Discussion of findings

When calculating the number of hatchery-origin spawners according to the data obtained from tagged specimens, it is necessary to note that the proportion of tagged juveniles in the release at “Kurilskiy” hatchery was 10.86% in 2009. Thus the actual portion of “Kurilskiy” hatchery fish in the samples taken, is significantly higher than the portion of the tagged specimens.

However, calculation data for such small portions of the tagged juveniles and the absence of more long term data collected in specific locations during the spawning run season, will be of a probabilistic nature.

It should be noted that the collection of the material during the first year of study was carried out in a somewhat random, observational manner, and therefore does not give a

complete picture of the migratory direction of humpback salmon, and does not reflect the dynamics of the number of approaches to a hatchery, and thus may be used only for a very approximate calculation. First of all, this is due to the lack of long term data at certain points during the whole spawning run. The objective for the first year was the determination of data collection points in order to carry out the correct calculation of the number of hatchery-origin spawners in the fixed net catches, and the approaches to the hatchery, and beyond to the spawning grounds.

Prostor Bay. Sampling in the waters of Prostor Bay has been carried out from July 20th until August 27th by the one-time sampling in the direction from the Cape of Shpor to Slavnaya Bay. The samplings were collected irregularly, at first every 10 days, and then at the end of the observation, period every 5 days. The portion of hatchery-origin fish in the samplings tended to increase from 0% on July 20th to a maximum of 23.4% on August 18th, followed by a more gradual reduction. Humpback salmon tagged at “Reidovoy” hatchery is marked by a single fish showing up in a Konservnaya Bay net catch. The same sample at Konservnaya Bay also revealed specimens tagged at “Kurilskiy” hatchery. This probably indicates that part of “Reidovoy” hatchery spawners migrate outside the base river. However, a single sample does not allow a proper estimate for the volume of straying fish. Taking into account the absence in the samplings of spawners tagged at Sakhalin Island hatchery, we may assume that its volume is insignificant. Previous studies which showed the absence of tagged Japanese humpback salmon spawners in 2007-2009 samples from Iturup Island confirms this assumption.

The collection of material from the catches in Reidovaya River was more consistent, however no samples were collected from mid-July to mid-September. Four samples from the river mouth, and two samples from hatchery zaboykas were selected. The characteristic feature for the mouth of the river is a tendency to increase the number of hatchery-origin spawners with “Reidovoy” tags. It was close to 100% at zaboykas within the last 10 days of September. During this period one humpback salmon specimen with a “Kurilskiy” hatchery-origin tag was registered in the Reidovaya river mouth, which indicates the possibility of straying of the two hatchery’s spawners. However, it is impossible to estimate the volume of the tagged juveniles under the conditions of a small release.

Samples from the spawning grounds at “Reidovoy” hatchery area were selected in various, incomparable periods of the spawning run – one sample in Slavnaya River in July,

and one sample each in Argun and Olya Rivers at the end of the second 10 days of September.

Kurilskiy Bay. No tagged spawners were collected in samplings from the fixed net catches at Kurilskiy Bay, during 7 days in mid-August. The first humpback salmon with a Iturup Hatchery-origin tag was registered while sampling on August 24th. Unfortunately, an interval in the sampling collection took place from August 13th to August 24th and the exact date of the beginning of the approach of the hatchery-origin humpback salmon could not be determined.

Samples collected within the period August 24th to September 5th were made at one point (Peski fixed net). The portion of tagged fish in the catches varied from 4.3 to 6.3%.

Later, however, the observational series was interrupted and the next sample dated September 10th, was collected from the opposite side of the bay – Novoye Ozero fixed net - where the number of tagged fish reached 10%. This is a rather high volume considering the amount of tagged juveniles may be up to 90%. In July samples, collected from this side of the Bay, no tagged fish were observed. In this case, the result can be explained both by an increase in the number of the approaching hatchery-origin fish, and by the direction of migration from the north, and consequently by the initial larger number of the approaching hatchery-origin spawners from the Cape of Shpor and Prostor Bay.

In samples from the base river catches, the tagged spawners were registered on a singular basis, but in the mouth of the river they registered a much higher number compared with zaboykas. First samples with “Kurilskiy” hatchery tags were noted quite early in the second 10 days of August, and their portion in the samples was much lower than from Peski fixed net catches. Within the period from 8 to 22 September when, according to the data from “Reidovoy” hatchery area, it would be reasonable to expect a higher number of hatchery-origin spawners in the base river, samples were not collected from the “Kurilskiy” hatchery area. Thus, the absence of valuable observations did not allow the determination of trends in temporal distribution of hatchery-origin spawners during the spawning migration in 2010.

One tagged specimen with a “Kurilskiy” hatchery tag was registered in the spawning grounds of Kurilka River above the location of the hatchery. In addition, one spawner with a “Reidovoy” hatchery tag was registered in Rybatskaya River.

Conclusion

1. The conducted studies confirmed the proposed working hypothesis:

a) *Hatchery-origin spawning stock includes some number of naturally reproduced fish, which reduces the risk of domestication;* Among the spawners selected at the zaboyka of “Reidovoy” hatchery, some naturally reproduced specimens were registered.

b) *In the natural spawning grounds of the rivers, not connected with the hatcheries base rivers, hatchery-origin spawners of humpback salmon are present in insignificant numbers;* The tagged specimens are observed singularly in the spawning grounds.

c) *With ever increasing distance from the mouths of rivers with hatcheries, the number of hatchery-origin fish is reduced;* The highest concentration of tagged spawners was registered in the catches at the mouths of rivers, and in the neighboring sea nets.

2. To correctly estimate the portion of hatchery-origin spawners in the total catch of salmon in various areas under investigation, it is necessary to collect material for identification at the permanent collection sites with a frequency of **once every 5 days, in an amount of not less than 100 specimens.**

3. To estimate the portion of hatchery-origin spawners in the second year of research it is necessary, apparently, to carry out a more detailed collection of materials in the nearest bodies of water, in order not to waste efforts by arranging research with the catches in distant nets. It is clear that the hatchery-origin spawners are concentrated while approaching the spawning ground.

On the basis of the research findings we suggest to conduct a biological analysis at the following collection sites:

1. in the mouths of the base rivers and in hatchery zaboykas (to register spawners coming to spawn);

2. in catches from nets near the mouth of a base river (registration of spawners in the fresher waters of the bays);

The selection of otoliths caught in sea nets far away from the base river, without biological analysis:

a) in catches from one fixed net in every area under observation. For example, Zheltaya River fixed net at Kurilskiy Bay and Konservniy fixed net (or a fixed net at Olya Bay) at Prostor Bay. From these nets one can select otoliths of spawners (100 specimens in 5 or 7 days) without any biological analysis;

b) in catches from a fixed net at Cape Shpor area (to identify migratory humpback salmon from remote areas of reproduction).

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