

Salmon biology, habitat conditions and assessment of stock abundance in the Kura River (Sakhalin Island)

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INTRODUCTION

During the last 150 years, the anthropogenic impact caused a drastic deterioration in conditions for Salmonidae reproduction. Currently, despite the comparatively high abundance of these fishes, this process may have substantial economic, ecological and social consequences for the mankind.

The objective of studies was to carry out a complex monitoring of Salmonidae habitat and stock abundance and to reveal possible trends of changes in their abundance and biodiversity in Sakhalin rivers.

To attain the objective, the following tasks were set:

1. Reveal natural features of water bodies, which affect composition and abundance of ichthyofauna.
2. Determine numbers, quality, distribution, and state of salmon spawning grounds in rivers.
3. Assess stock abundance of salmonid fish species in the river basin, biological indices, distribution by spawning grounds and their filling.
4. Obtain data on other ichthyofaunal representatives.
5. Discover the level of economic activities on river basins and salmon spawning grounds.

MATERIALS AND METHODS

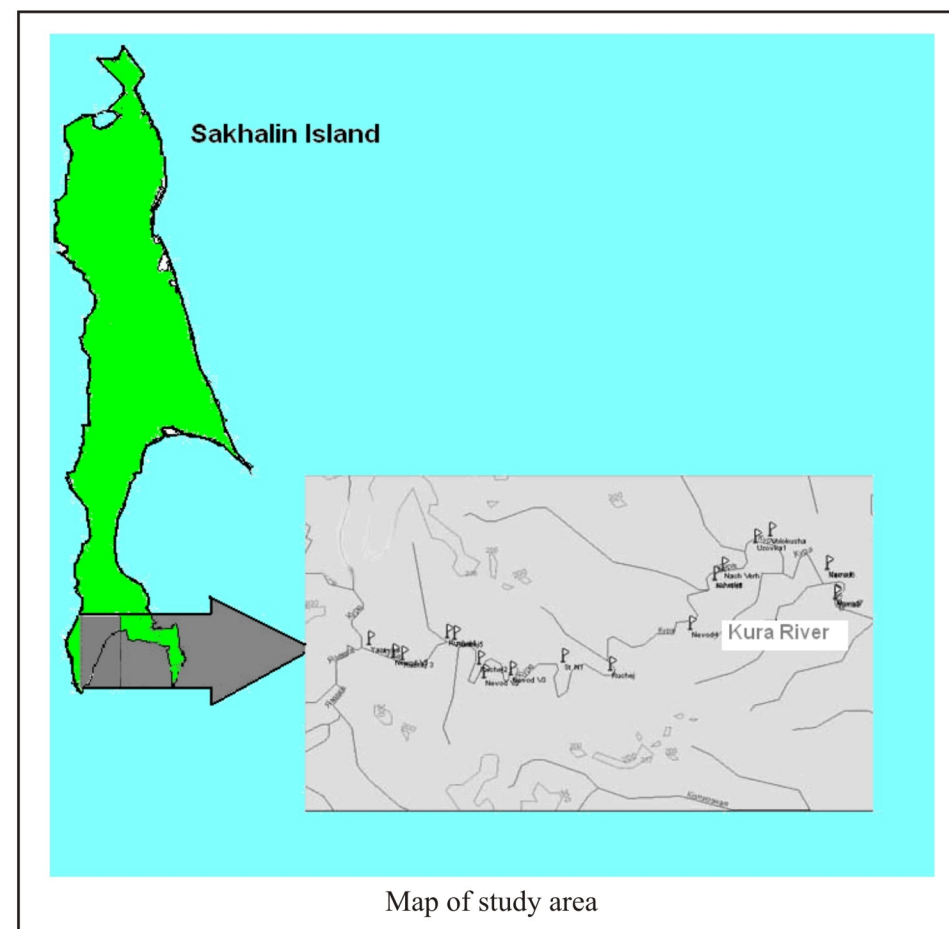
Observations for fry salmon migrating downstream (pink salmon fry migrants have been counted on the Kura River between 30 April and 20 June by the method of sampling fishery (Volovik, 1967)):

- biological indices of juvenile pink, masu and chum salmon were determined using the preserved materials (pink salmon – 5 samples (377 individuals), masu salmon – 3 samples (118 ind.), and chum salmon – 4 samples (114 ind.));
- hydrological regime of the river was observed using a water-gauge rod and spring thermometer (water level was measured 3 times round a clock and temperature 4 times);
- contents of 72 stone-loach stomachs were examined to study influence of predator fishes on juvenile salmon;
- a three-time afoot river observation was performed to count numbers of salmon spawners and their biological indices during spawning migration;
- 4 samples of pink salmon spawners (350 individuals) and 4 samples of masu salmon spawners (118 individuals) were used to study biological indices of Salmonidae.

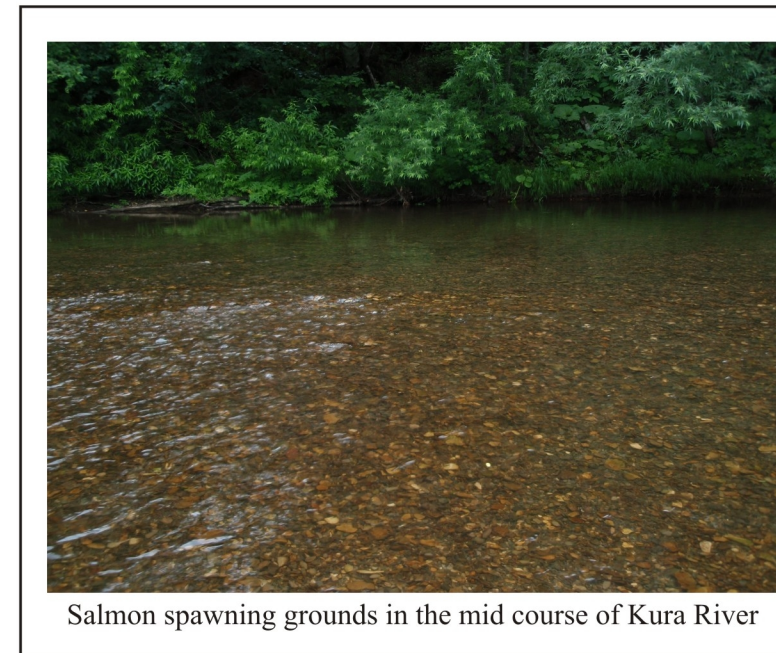
Observations in the post-spawning period:

- in November, a total of 20 spots were opened on the Kura River pink salmon spawning grounds to determine survival in the embryonic life period;
- biodiversity investigations were conducted using a beach seine (length 8 m, mesh 4 mm). In total, 18 seine samplings were performed. A scap net was used for sampling in shallow brooks. Salmon spawners were sampled using a beach seine (length 20 m) and fixed net (mesh 55x55 mm).

RESULTS & DISCUSSION

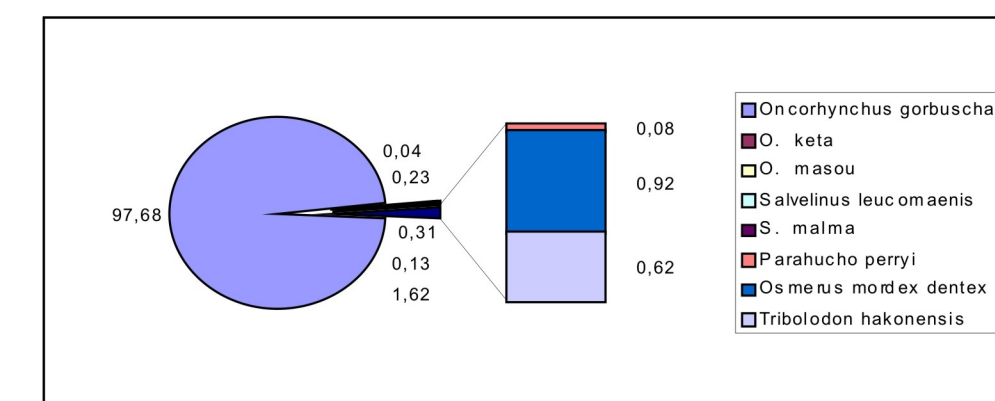


The Kura River begins flowing from the eastern slopes of the South-Kamyshevy Ridge. Its main channel is about 31 km long from source to mouth. The catchment area is 115 km². The river has no tributaries with lengths more than 1 km. The largest tributaries are Yuzovka, Yazevka, and Bely Yar.

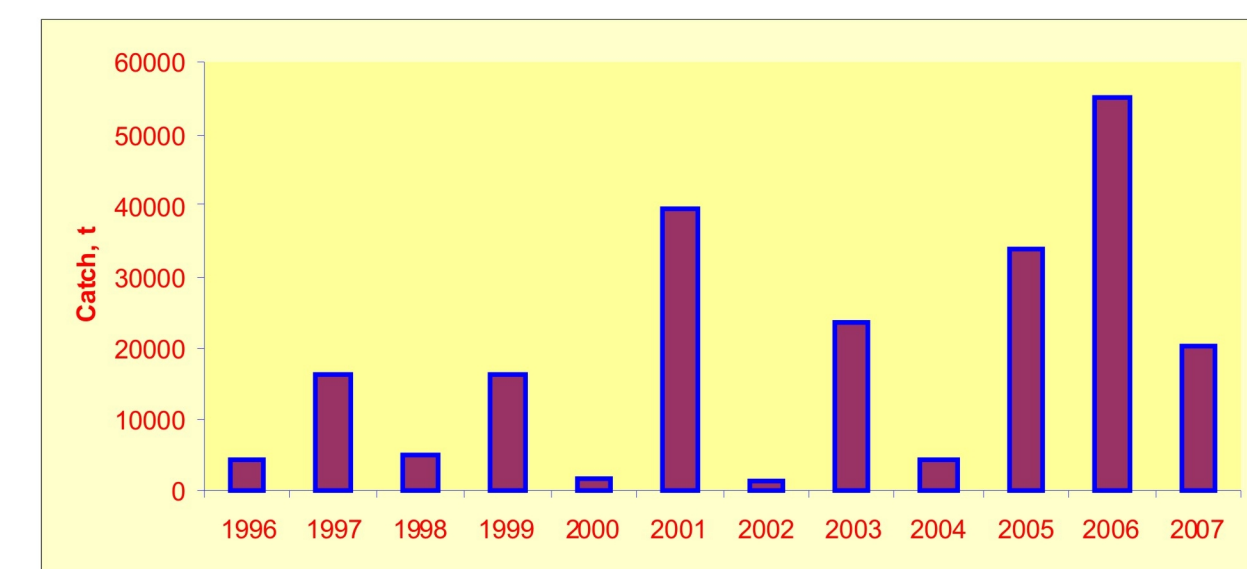


Fish species composition in Kura River between 30 April and 30 October 2008

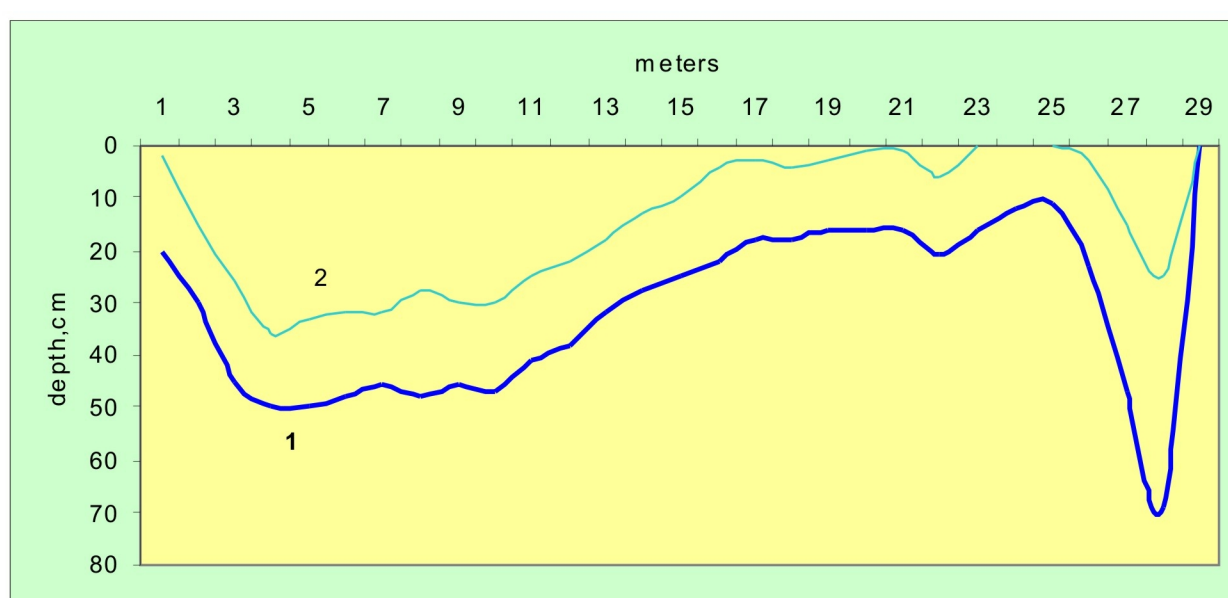
Family	Species	r. Kura
Petromyzontidae	<i>Lethenteron camtschaticum</i>	+
Cyprinidae	<i>Tribolodon hakonensis</i>	+
Balitoridae	<i>Barbatula toni</i>	+
Salmonidae	<i>Oncorhynchus gorbuscha</i>	+
	<i>O. keta</i>	+
	<i>O. masou</i>	+
	<i>Salvelinus leucomaenis</i>	+
	<i>S. malma</i>	+
	<i>Parahucho perrvi</i>	+
Gobiidae	<i>Gymnogobius urotaenia</i>	+
Cottidae	<i>Cottus amblystomopsis</i>	+
Pleuronectidae	<i>Platichthys stellatus</i>	+
Agonidae	<i>Brachyopsis segaliensis</i>	+
Gasterosteidae	<i>Gasterosteus aculeatus</i>	+
Osmeridae	<i>Osmerus mordax dentex</i>	+



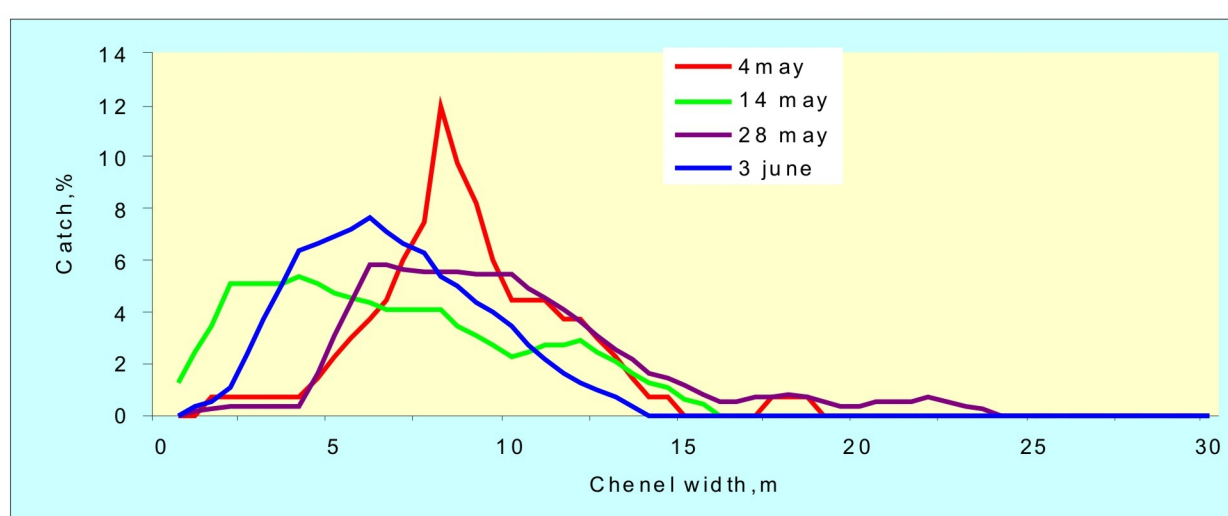
Biomass of common fish species (%) in Kura River in 2008



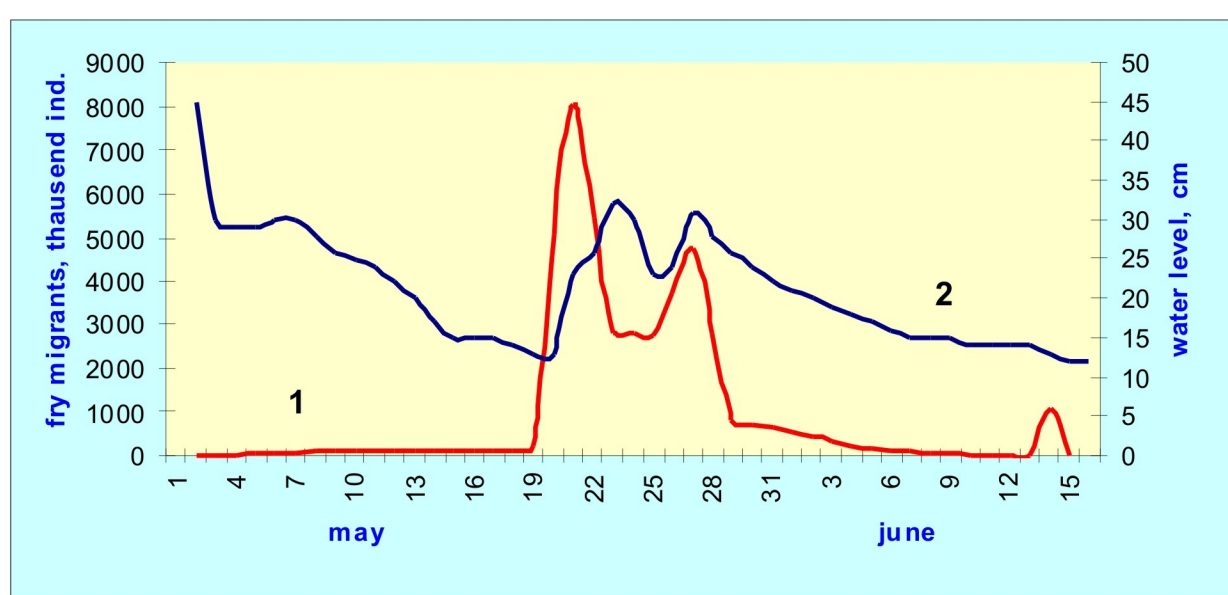
Dynamics of pink salmon catches in Aniva Bay (1996–2007)



Cross profile of the Kura River bed during counting fry salmon migrants in 2008 (1 – 1st May, 2 – 3rd June)



Changes in juvenile pink salmon catches in Kura River during the counting works in 2008



Dynamics of fry numbers (1) and water level (2) during the period of downstream migration in Kura River in 2008

Body length and weight of pink salmon fry migrants in the Kura River in different years

Year	Length AC, mm		Weight, mg		Number	
	M	Lim*	M	Lim*	fish	sample
2004	33.6	33.2–33.9	213	188–225	399	4
2005	34.5	30.0–38.0	232	130–322	500	5
2006	32.8	27.0–53.0	228.7	148–448	300	3
2007	32.5	29.0–35.0	218.1	145–307	500	5
2008	34.5	30.0–43.0	238.8	142–485	377	5

*Averages for individual samples

Numbers of pink salmon spawners filled the Kura River's spawning grounds in 2004–2008

Years	Counted (thousand fish)	Filled (fish per 100 m ²)
2004	300.0	170.7
2005	391.1	222.6
2006	320.0	182.1
2007	220.0	125.2
2008	240.0	136.6
average	294.2	167.5

Biological indices of pink salmon spawners from Kura River in 2008

Date	Sex	AC, cm	AD, cm	Weight, g	Fulton's condition factor (FCF)	AIF, eggs	Number
2008	Male	Mean	47.5	45.0	1335	1.45	217
		SD	2.89	2.66	260	0.128	
	Female	Mean	47.0	44.5	1308	1.48	1380
		SD	1.96	1.75	178	0.103	
28 Jul	Both	Mean	47.2	44.8	1321	1.46	450
		SD	2.46	2.25	222	0.117	
	Male	Mean	46.3	43.9	1258	1.47	63
		SD	2.43	2.23	236	0.126	
9 Aug	Female	Mean	47.0	44.3	1297	1.49	37
		SD	1.96	1.82	175	0.079	
	Both	Mean	46.6	44.1	1273	1.48	100
		SD	2.28	2.09	215	0.111	
16 Aug	Male	Mean	47.6	45.2	1378	1.48	48
		SD	2.42	2.26	233	0.090	
	Female	Mean	46.9	44.4	1326	1.51	1405
		SD	1.73	1.65	161	0.099	
26 Aug	Both	Mean	47.3	44.8	1351	1.50	100
		SD	2.11	2.00	200	0.096	
	Male	Mean	46.2	44.0	1284	1.49	33
		SD	2.51	2.22	234	0.098	
9 Aug	Female	Mean	46.6	44.3	1314	1.50	1379
		SD	1.83	1.54	177	0.095	
	Both	Mean	46.5	44.2	1304	1.50	100
		SD	2.07	1.79	197	0.096	
26 Aug	Female	Mean	51.2	48.3	1642	1.46	18
		SD	1.99	1.99	227	0.156	
	Both	Mean	48.5	45.6	1361	1.43	32
		SD	2.08	1.95	190	0.102	
Both	Mean	49.5	46.5	1462	1.4	50	
	SD	2.43	2.35	243	0.123		

Pink salmon eggs survival on the Kura River's spawning grounds in 2008

N ₀ *	Live	Dead	Total	Survival, %	Ground thickness, cm
3	120	200	320	37.5	25
10	95	47	142	66.9	45
11	80	1	81	98.8	30
12	42	2	44	95.5	40
15	60	100	160	37.5	30
18	100	50	150	66.7	25
average	26.15	21.58	47.74	67.1	32.5

* – ground spots with found eggs.

During monitoring on the Kura River in 2008, the first masu spawners were found in late May. Their run was stretched. Masu salmon have been observed in the lower course of the river up to the 3rd decade of August. In 2008, the abundance of masu salmon was rather low, composing about 1500–2000 individuals. Fishermen-amateurs have caught about 1000 individuals.

Biological indices of masu salmon from Kura River in different years

Years	Length AC, cm			Weight, g			AIF, eggs
	male	female	both	male	female	both	
1996	40.9	42.0	41.2	811.1	883.3	829.2	–
1997	39.3	40.0	39.6	890.0	910.0	898	–
2000	39.2	40.4	40.0	908.0	963.5	943.0	–
2004	42.3	41.4	41.6	1202.6	1161.4	1169.7	1264
2007	42.0	42.4	42.3	1163.3	1204.7	1196.6	1271
2008	38.9	40.4	39.8	880.6	1015.0	958.9	1306

Biological indices of masu salmon fry migrants from Kura River in 2008

Age	Sex	Length AC, cm	Weight, g	Clark's condition factor	Fish numbers
1	male	10.81	15.07	1.26	15
	female	10.93	14.73	1.23	18
1+	male	11.15	16.48	1.31	17
	female	11.01	16.42	1.16	16
1 and 1+	male	10.99	15.81	1.28	32
	female	10.97	15.55	1.20	34
Average		10.98	15.68	1.25	65

Chum salmon entries into Kura River differ by years, and their abundance varies from several tens to 1000–2000 individuals. In 2007, we estimated chum salmon abundance in the river as 700–800 individuals. In 2008, the decline in their abundance has been observed as in the Kura River so integrally in the bay. From the results of river survey, this species of Pacific salmon composed 50–70 spawner pairs.



Biological indices of juvenile chum salmon in Kura River in May–June 2008

	Length AC, mm	SD	Length AD, mm	SD	Weight, mg	SD	FCF	SD	n
16 May	39.60	3.62	35.80	3.35	513.70	175.10	1.08	0.14	46
lim	33–48		30–44		302–1000		0.70–1.61		
28 May	40.80	6.72	36.68	6.39	603.40	424.02	1.08	0.13	25
lim	32–57		28–52		277–1672		0.85–1.35		
07 June	45.20	7.07	41.10	6.80	957.40	563.76	1.24	0.16	22
lim	36–60		32–56		313–2246		0.73–1.43		
20 June	52.10	5.44	47.50	5.17	1380.40	450.05	1.23	0.09	21
lim	37–60		33–55		392–2337		1.08–1.41		

A total of 15 fish species from 9 families are river residents or those who enter for spawning. Pink salmon are the most abundant. Besides pink salmon, representatives of the genera *Salvelinus*, *Osmerus* and *Tribolodon* are abundant too. The natural (mainly climatic) features of this water body, affecting composition and abundance of ichthyofauna, have been revealed. The number and state of salmon spawning grounds in the Kura River were determined. They occupy 175.7 thousand m². About one fourth of them are masu spawning grounds. Currently, salmon abundance in Aniva Bay is at the high level, providing the mean catch of 19.7 million fish (3.5–47.4 million). Biological indices of pink salmon (length, sex ratio) vary between the beginning of runs and end of spawning migration and depend on ratio of fish approaches from different groupings. Numbers of pink salmon filled spawning grounds (2004–2008) varied from 220 to 391 thousand spawners, average 294.2 thousand fish. The mean density was 167.5 fish per 100 m² of spawning grounds (125 to 223 fish/100 m²). The masu salmon abundance in the river basin is at the comparatively high level, composing 1000 to 10000 individuals. However, the sports and amateur masu fishery in recent years appeared to be on a threatening scale. The estimates of 2008 show that fishermen-amateurs have caught about 1000 masu salmon from the Kura River, despite the fact that it is not included into the list of water bodies where sports and amateur fishery is permitted. The abundance of chum salmon was low in 2008. From our estimates, about 100–140 chum salmon have spawned in the river.

Because of using trap nets for coastal salmon fishery and catching different fish species in the coastal sea zone and estuarine river zone, a declining stock trend becomes evident for Asiatic smelt. Compared to the early 1990s, the abundance of redfins declined significantly (however, this could be caused not by commercial fishery but by the intra-population processes). Fishery liberalization on rivers of the Kurylov Peninsula for fishermen-amateurs has led to the decline in Sakhalin chum abundance practically in all rivers of this region.

Of course, one year is not enough to elucidate completely a character of changes in salmon abundance. Continued studies on salmon monitoring in the Kura River will allow obtaining the more reliable data.