

Injuries of Salmon in the Amur River and its Estuary as an Index of the Adult Fish Mortality in the Period of Sea Migrations

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During 1994–2000 we have observed injures on salmon in the Amur River Estuary to assess the salmon sea mortality. In the Amur River Estuary the portion of salmon injures made by marine mammals in 1994–2000 was large and accounted for 32.2–87.7% of total number of injured fishes. However, the portion of injured fishes made up only 1.7–13.9% of total salmon number. The number of slashes caused by drift nets and pelagic long-line fisheries was insignificant during the same period.

The predation is the second largest cause of mortality after the fishing mortality in the sea.

On the migration path from the Pacific ocean to the Amur River Estuary (Fig. 1) salmon can be consumed by different predators: killer whale; northern sea-lion and northern fur seal; among predator fishes: *Alepisaurus ferox*, daggertooth (*Anotopterus pharao*) and salmon shark.

In the Sakhalin Bay and in the Amur River Estuary white whale, harbour seal and kaluga sturgeon (among fish) eat salmon. The abundance and the distribution of white whale and habour seal in summer are connected with the salmon spawning migration in the Amur River Basin, as salmon is the main food for these animals during summer.

In Russia drift nets are not used for salmon fishing and injures due to drift nets are considered as an influence of the Japanese fleet. Slashes made by marine mammals were fresh and related to harbour seal in the estuary. Sores can be made by different gear or by parasites.

Healed wounds are related to *Alepisaurus ferox* and daggertooth (*Anotopterus pharao*), (Fig. 2a) that attack salmon in the Pacific. We have begun to assess healed wounds since 1999. We suggest that northern fur seal does not make slash marks on salmon because they catch them successfully. We think that salmon shark and kaluga sturgeon swallow salmon without marks. Others predators eat salmon rarely.

In Tables 1–3 is presented some data on wounded salmon in the Amur River Estuary during last 7 years.

Proportionately, the most injured salmon in the Amur River is pink salmon, the smallest Amur anadromous salmon weighing on average 1.2 kg. In years of low abundance of any salmon species, the portion of injured fishes increases. The number of slashes caused by drift nets (Fig. 2b) in our catches (1994–2000) was insignificant. Some years this type of slashes did not occur. We believe that low frequency of marks is synonymous with low marine mortality during this time. The insignificant proportion of injuries made by drift nets and the absence of pelagic long-line hooks reveal the current weakness of marine drift and long-line fishing of salmon.

In the Amur River Estuary the portion of salmon injures made by marine mammals (Fig. 2c,d) in 1994–2000 was large and accounted for 32.2–87.7% of the total number of injured fishes.

Fig. 1. Direction of Pacific Salmon Migration to Amur River.

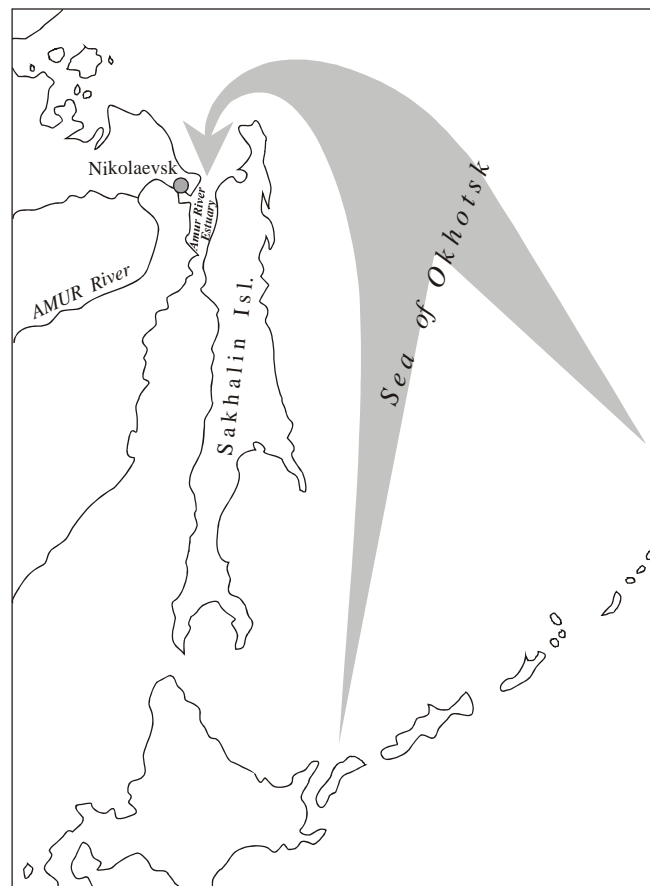


Fig. 2. Wounds of Salmon in the Amur River Estuary.

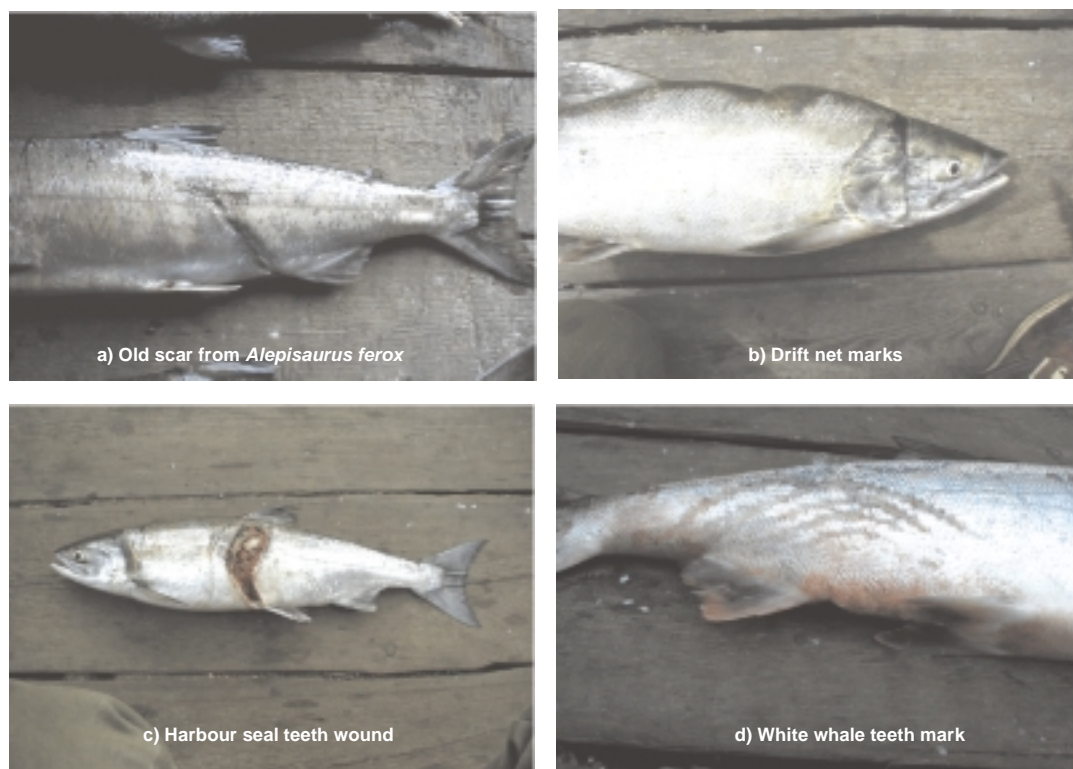


Table 1. Wounded pink salmon in the Amur River Estuary, 1994-2000 (in percentage terms of total number of wounded fish).

Year	Wound type										Number of wounded fish	Number of surveyed fish	Wound %
	Drift nets		Sea mammals		Lamprey wounds		Sores and absence of fins		Healed wounds				
	fish	%	fish	%	fish	%	fish	%	fish	%	fish	fish	%
1994	2	0.8	82	35.1	144	61.5	6	2.6	-	-	234	3000	7.8
1995	0	0	63	39.6	94	59.1	2	1.3	-	-	159	1650	9.5
1996	0	0	174	32.2	362	67.0	4	0.8	-	-	540	8800	6.1
1997	0	0	246	44.0	296	53.0	17	3.0	-	-	559	4010	13.9
1998	2	0.5	192	51.9	155	41.9	21	5.7	-	-	370	6530	5.7
1999	0	0	58	38.7	79	52.7	5	3.3	8	5.3	150	2650	5.7
2000	10	1.7	302	52.5	226	39.4	26	4.5	11	1.9	575	8900	6.5

Table 2. Wounded summer chum salmon in the Amur River Estuary, 1994-2000 (in percentage terms of wounded fish total number).

Year	Wound type										Number of wounded fish	Number of surveyed fish	Wound %
	Drift nets		Sea mammals		Lamprey wounds		Sores and absence of fins		Healed wounds				
	fish	%	fish	%	fish	%	fish	%	fish	%	fish	fish	%
1994	0	0	123	59.1	73	35.1	12	5.8	-	-	208	2600	8.1
1995	0	0	150	61.2	77	31.4	18	7.4	-	-	245	4400	5.6
1996	0	0	19	52.8	17	47.2	-	-	-	-	-	-	5.5
1997	0	0	302	83	53	14.5	9	2.5	-	-	364	4765	9.7
1998	0	0	104	76.4	24	17.7	8	5.9	-	-	136	2670	5.1
1999	0	0	125	63.5	30	15.2	30	15.2	12	6.1	197	4500	4.4
2000	3	0.8	219	60.2	55	15.1	37	10.2	50	13.7	364	4249	4.6

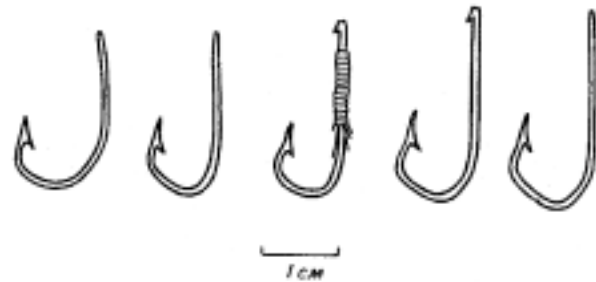
Table 3. Wounded fall chum in the Amur River Estuary, 1994-2000 (in percentage terms of wounded fish total number).

Year	Wound type										Number of wounded fish	Number of surveyed fish	Wound %
	Drift nets		Sea mammals		Lamprey wounds		Sores and absence of fins		Healed wounds				
	fish	%	fish	%	fish	%	fish	%	fish	%			
1994	0	0	106	78	23	16.9	7	5.1	-	-	136	5100	2.7
1995	0	0	48	50	43	44.8	5	5.2	-	-	96	2000	4.8
1996	0	0	39	62.9	17	27.4	6	9.7	-	-	62	2200	2.8
1997	0	0	43	87.7	4	8.2	2	4.1	-	-	49	1500	3.3
1998	1	3.7	20	74.1	5	18.5	1	3.7	-	-	27	1200	2.3
1999	1	0.7	69	46.6	33	22.3	18	12.2	27	18.2	148	2500	5.9
2000	0	0	105	57.7	22	12.1	14	7.7	41	22.5	182	2370	1.7

However, the portion of injured fishes made up only 1.7–13.9% of the total salmon number. The number of white whales and harbour seals in the Amur River Estuary and in the Sakhalin Bay is large. Their abundance is not regulated by man as hunting for them has been prohibited for a long time. In this conditions we suggest the predation and fishing are largest causes of the adult Amur River salmon mortality.

We conclude that the investigations of wounds are necessary for the standard biological analysis of salmon in the main fishing regions of the Pacific, as this data gives additional information about the relative abundance of marine mammals, salmon mortality in the feeding period and the dynamics of fishing by some gear on the ways of sea migrations.

In comparison to the 1950s (Yeutina and Krykhtin 1957) when Japanese long line hooks were abundant on Amur River salmon, there were no long line hooks (Fig. 3) on Pacific salmon in Amur River Estuary during 1990–2001.

Fig. 3. Long line hooks from Pacific salmon in Amur River Estuary in 1956 (Yeutina and Krykhtin 1957).

REFERENCES

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