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Pacific salmon distribution in the southern Okhotsk Sea during autumn of 1998 and pink salmon catch forecast for 1999 fishery season

by

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INTRODUCTION

Chum and pink salmon are the most abundant salmonid species in the Sakhalin-Kuriles region (Shuntov et al. 1993). In last years, several expeditions have been conducted in the far-eastern seas with the objective to estimate these juvenile salmon abundance before the beginning of first oceanward migration. Data collected in these expeditions allow an estimation of pink salmon stock spawning success for chief fishery regions and develop the salmon harvest forecast for next years.

Immature and juvenile Pacific salmon distribution, abundance and biological indices are regarded in this paper, basing on results of pelagic trawl survey. This survey was carried out in upper layer of the southern Okhotsk Sea and Pacific waters near the Kuril Islands in the second half of October 1998. Autumnal pelagic trawl survey is the second stage of annual salmon study cycle in the Sakhalin-Kuril region. During the first stage, anadromous migration, distribution and biology of salmonid species are the main studied issues. For 1998 and 1999, general results of such studies were presented in NPAFC Doc. 432 (Melnikov et al. 1999).

MATERIAL AND METHODS

Pelagic trawl survey has covered an expanded area (about 457,4 thousand km^2) in the Sakhalin-Kuriles region and consisted of 46 trawl stations. It was executed in relatively short terms – about two weeks (from October 14th to November 1st). First, the surveys were began in Pacific waters, further continued in the southwestern Okhotsk Sea, and then latitudinal sections were executed northward up to 53° N.

Traditional survey methods were applied in this research cruise. Research vessel "TINRO" have used common commercial pelagic trawl net with vertical openings from 38 to 42 m in dependence from towing velocity. Towing velocity of the trawl varied from 4,0 to 4,5 knots. Square method was applied to the salmon abundance calculation with trawl net catch-ability factor expertly estimated as 0,3 (Shuntov, 1994).

RESULTS AND DISCUSSION

Pink salmon

During survey, pink salmon juveniles occurred in the Okhotsk Sea only. All maximal catches (above 1000 fish per one-hour haul) have appeared eastwards from 150° E. Juvenile pink salmon did occur neither near the southeastern Sakhalin coast nor near the southern Kuril Islands (Figure 1a). Like to late August, water flow from the southwestern corner of survey area was well expressed and directed northeastwards. The transformed Soya Current waters chiefly contributed in that flow. Pink salmon did not occur in limits of this flow up to 47° N latitude. It seems that juvenile pink salmon migration pathway was situated along this flow in waters off the Terpeniya Bay up to 47° N. In zone of the transformed Soya Current flow and Eastern-Sakhalin Current convergence, pink salmon migrated offshore.

In deepwater Kuril Basin, juvenile pink salmon of the Sakhalin stocks have mixed with pink from other regions and gradually moved eastwards and southeastwards. Proceeding from pink salmon length distribution in trawl catches

(Figure 2) and data on its abundance (Table 1), the western Kamchatka pink salmon stocks' progeny was not abundant in autumn of 1998. These pink salmon usually leave the Okhotsk Sea through the northern Kuril Straits. More abundant pink salmon of the Sakhalin and Kuril Islands stocks mostly migrated through the middle and southern straits of the Kuril Arc.

It must be noted that discrepancies in seaward migration term and growth rate for pink salmon juveniles in different regions smooth distinctions in their length/ weight characteristics in the southern Okhotsk Sea. One-peak shape of juvenile pink salmon length/ weight distribution curves proves this suggestion (Figure 2). In average, salmon body length differed no more than by 2 cm between southern and northern areas. Juvenile pink salmon body size increased southwards with the distance from coast, since their growth rate was rather high in first months at sea. In September – October, mean length of pink salmon juveniles was 22.68 cm in the northern Okhotsk Sea, and in November – 26.4 cm in the southern part. Monthly growth exceeded 3,5 cm, in average.

Juvenile pink salmon abundance was estimated at 1070 mln. fish, or 209,6 thousand tons in autumn of 1998. The Sakhalin stocks were presented there by 700-800 million fish, as proceeding from the pink distribution and scale pattern analysis.

Beside juveniles, five pink salmon aged 0.2+ were sampled during survey. These fish had body length 39,9-43,6 cm (mean 41,3 cm) and their eggs were under resorption. Such pink salmon abundance was estimated at 0,5 mln. fish, or 0,35 thousand tons. Remains of disoriented pink salmon aggregations, which could not find suitable conditions for spawn, likely present it.

Alternative pink salmon forecast was developed for the eastern Sakhalin fishery region basing on the autumnal survey on juveniles. It was considered that pink salmon natural mortality rates grew significantly during oceanic phase in second part of 1990s (Radchenko 1998). Died fish portion from estimated juveniles' abundance was assessed for salmon broods of 1995-1997 at 71,5 – 74,8% at time of anadromous salmon return in the Russian economic zone limits, or 80,0 – 86,2%, mean 82,9% at time of mature fish entrance into coastal zone. (First figure set is calculated as ratio of pink salmon abundance during summer and autumnal surveys; second – as ratio of pink salmon catch + escapement abundance to estimations of juveniles number, both with minus of 100%).

It was supposed that about 268,5 million fish will return in the southern Okhotsk Sea and adjacent Pacific in summer of 1999, if natural mortality rates (from 1998 autumn to 1999 summer) would be close to average value for second half of 1990s. It means about 298 thousand tons with the pink salmon mean weight 1,1 kg in years of high-yielded broods' return. Accordingly, about 170,7 mln. fish (or 190 thousand tons) will migrate to river deltas and consist catch + escapement.

From long-term catch data series, it was suggested that pink salmon approach to coast would be distributed by regions as follow: to the Hokkaido Islands - about 10 million fish (Japanese catch); on the northern Okhotsk Sea coast – 4.7 million fish as harvest and 11.8 million fish – as escapement; on the western Kamchatka – 12.2 million fish as escapement only but about 0,3 million – as bycatch during other salmon fishery operations; on the southern Kuril Islands – 14,8 million fish as harvest and 2,2 million fish as escapement. Therefore, 114,7 million fish ,approximately, will migrate

to the eastern Sakhalin coast. Planned escapement value is established at 22 mln. fish. MSY of pink salmon can be estimated as 92,7 million fish, or about 102 thousand tons for the eastern Sakhalin fishery region.

With achievement of quantitative ratio of pink salmon outmigrants from diverse river groups in 1998, we can roughly estimate expected anadromous pink salmon run by main fishery areas. Of course, large-scale re-distribution is rather possible between areas on the late stages of anadromous pink salmon migration. So, presented ratio had an expert character. It was forecasted that in the Terpeniya Bay pink salmon catch would total 48,4 thousand tons, on the southeastern part – 16,2 thousand tons, in the Aniva Bay – 10,8 thousand tons. Unfortunately, on the northeastern Sakhalin pink salmon harvest exceeds 1-2 thousand tons very rarely due to objective reasons.

Therefore, in 1999 pink salmon harvest has been expected at 77,4 thousand tons, or 70,4 million fish on the eastern Sakhalin coast. It was higher than official forecast of the Sakhalin NIRO in 1,8 fold. In reality, 80,1 thousand tons of pink salmon was harvested there during fishery season (103% of previously predicted value).

Chum salmon

As well as at late August, in October chum salmon were present in the catches by several age cohorts: 0.0+, 0.2+ and elder mature fish. Juvenile chum salmon were caught on the same areas as pink salmon. However, maximal catches (678-1088 fish per one-hour haul) of this salmon were received noticeably eastwards. It can be explained by relatively low chum stock abundance in the southeastern Sakhalin rivers' populations. Almost all occurred juvenile chum likely belonged there to the northern Okhotsk Sea stocks. Chum juveniles from Japan and southern Kuril Islands probably immediately migrated in the ocean and only partly moved into the southern Okhotsk Sea (Figure 1b). Chum salmon length distribution curve had one-peaked shape in the southern Okhotsk Sea but several peaks – in the Pacific waters (Figure 2b). Average fork length of chum juveniles was less in the southern Okhotsk Sea than on northern areas (23,3-23,7 cm versus 25,1-26,4 cm). Growth rates of chum salmon at the initial sea life period were noticeably less than one for pink salmon.

Low growth rate of chum salmon juveniles can be connected with the high velocity of their oceanward migrations. As it is known, chum salmon leave the Okhotsk Sea earlier than pink salmon. The mean length of these salmon juveniles was larger on areas adjacent to the Kuril Islands. Inshore in Pacific waters of Kuril Islands chum and pink salmon juveniles were absent. It indicated on distant stock belonging of these juveniles.

Total juvenile chum numbers was estimated at 517,6 million fish, and biomass - at 87,7 thousand tons in the southern Okhotsk Sea, respectively. It can be supposed that not all chum juveniles migrated in offshore areas of the Sakhalin-Kuriles region at the end of October. Juvenile chum salmon migrations from the northern Hokkaido likely occur in later terms.

Beside juveniles, other chum salmon age groups occurred in trawl catches (Table 1). The mature chum salmon belonging to "autumnal" race was caught in Pacific waters and in the southern Okhotsk Sea not far northward than 50° N latitude. Maximal catch of mature chum salmon was occurred in Pacific waters near the middle

Kuril Islands (Figure 3a). In the southern Okhotsk Sea, chum catches did not exceed 5-9 fish per one-hour haul. In the contrary, maximal catches of immature chum salmon were observed in the southeastern Okhotsk Sea (up to 64 fish per haul). In adjacent Pacific waters, immature chum catches were slightly less and reached 15-23 fish per haul too (Figure 3b). As it is evident from the chum distribution map (Figure 4b), immature chum salmon leave Sea for the Pacific ocean through the middle Kuril Straits at the time of survey.

The mature chum salmon were characterized by high gonad maturity coefficients (females – up to 18 %, males – up to 12%). These high values contradicted with sufficient distance of nearest possible spawning rivers. Observed mature chum salmon with such high maturity coefficient can not probably reach their natal river for spawn. It allows to suppose that some part of observed chum aggregation will spawn beyond natal rivers or will die before. The numbers and biomass of such fish was estimated in 3,02 million fish and 7,97 thousand tons in the southern Okhotsk Sea, accordingly. This noticeable abundance of spawners being potentially lost for population can be explained by anomalous hydrological conditions in late autumn of 1998. It can led to disorientation of the anadromous chum salmon during migrations.

Other salmon

Sockeye salmon was presented in the catches by immature specimens during autumnal survey. Single juvenile (fork length 29 cm) was caught in the northern Kuril Islands waters from the Okhotsk Sea side. Larger sockeye salmon occurred mainly in Pacific waters off the Kuril Islands. Sockeye body length varied from 38 to 57 cm, mean 48,52 cm. Sex ration was close to 1:1 among caught fish (21 females and 22 males). Discrepancy was not found between sexes in the fork length and body weight. Sockeye salmon numbers and biomass were estimated at 0,29 million fish and 0,37 thousand tons, accordingly.

Chinook salmon is species with the longest sea life period from all salmonids. In the Sakhalin-Kuriles region, immature chinook salmon only occurred in the catches (fork length 66-85 cm). Four specimens were caught during the survey: three from waters around the Kuril Islands and one – on the Sakhalin shelf.

Significant increase of coho salmon numbers was occurred during this survey. Main aggregations of this fish (with catches 70 and more fish per haul) occurred in the northeastern part of studied area. As it is well known, coho salmon spend 1-2 years in fresh water and mostly one year - at the sea. Beside coho from different rivers of the Okhotsk Sea coast can migrate through the Sakhalin-Kuriles region, mean length of coho salmon widely varied there - from 16 to 63 cm.

Coho salmon sized 27-37 cm (fork length) mostly occurred in the deep-sea zone, while larger fish were caught closer to the Sakhalin coast and in southwestern part of the survey area. Mature fish were not sampled there that supposed finish of coho salmon anadromous migration in the southern Okhotsk Sea by the end of the October. The immature coho salmon numbers were estimated at 11,21 million fish and biomass - 4,61 thousand tons, accordingly (Table 1). The numbers and frequency of occurrence in trawl catches allow us to set this species for a third place after pink and chum salmon among salmonids.

As well as coho, masu salmon occurred in catches through the whole southern Okhotsk Sea to 55° N (mainly along the eastern Sakhalin seaside). The catches of this salmon did not exceed 8-9 fish per one-hour haul (usually 1-3 fish).

The masu salmon is more abundant is the Japan Sea, but it has spawn in the western Kamchatka and eastern Sakhalin rivers too. However, masu salmon spend a noticeable part of their sea life period in the southern Okhotsk Sea during annual feeding migration route, including fish belonging to the Japan Sea stocks. Migrations of masu salmon in the Okhotsk Sea probably begin in the August-September. Presence of masu salmon of different age classes from many regions in survey catches is well reflected by variable body length distribution.

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Fig. 1 Distribution of trawl catches of juveniles pink salmon (a) and chum salmon (b) in Sakhalin-Kuriles region 14.10 - 01.11.1998. Numbers given in circles mean the catches of pink and chum salmons in fish per one-hour haul. Triangles show the fish 0.2 age. Solid lines mark generalized scheme of geostrophic surface currents (a) and water temperature on surface (b).

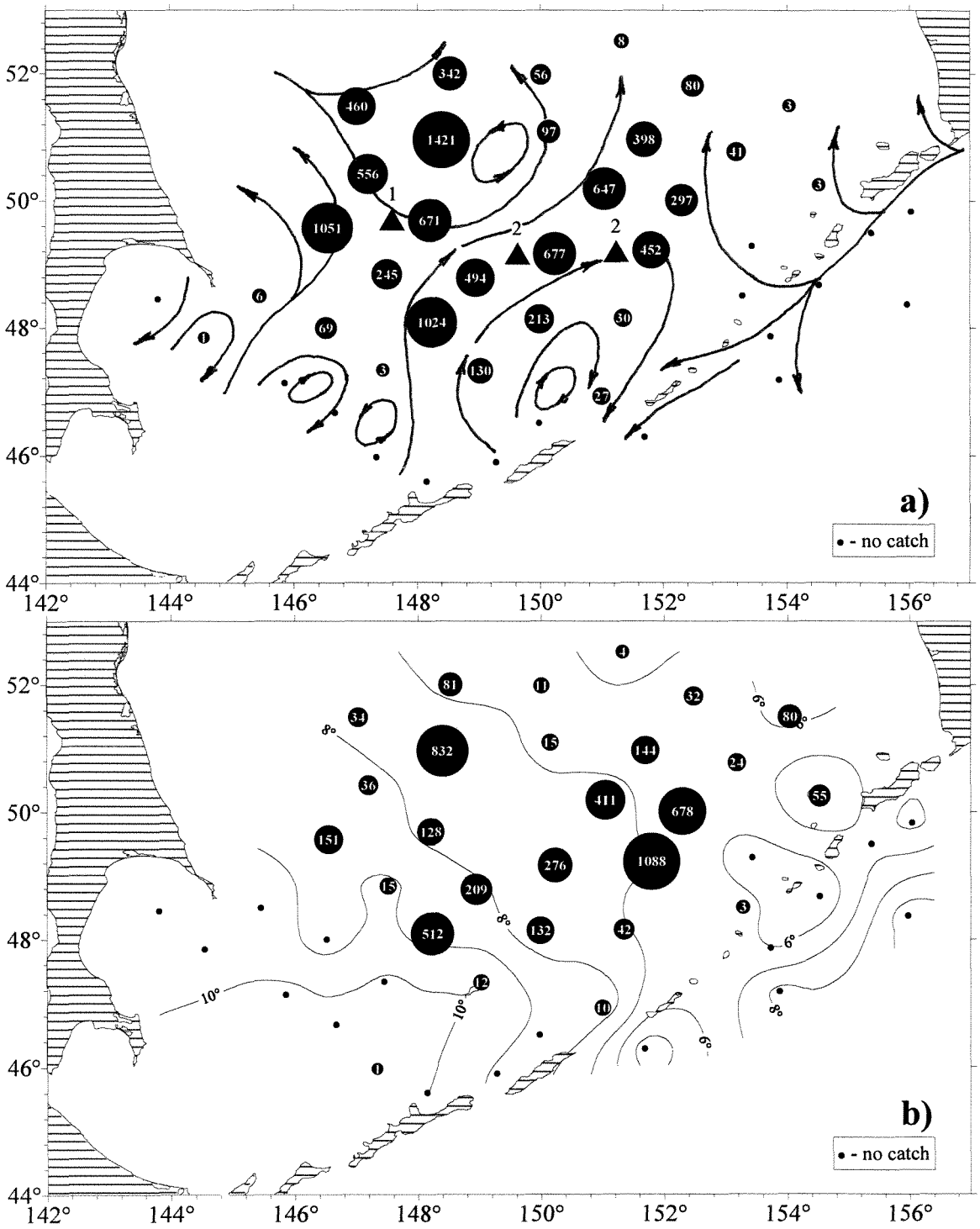

Fig. 2 Length distribution of juvenile pink (A) and chum (B) salmon abundance in the southern part of Okhotsk sea 14.10-01.11.1998

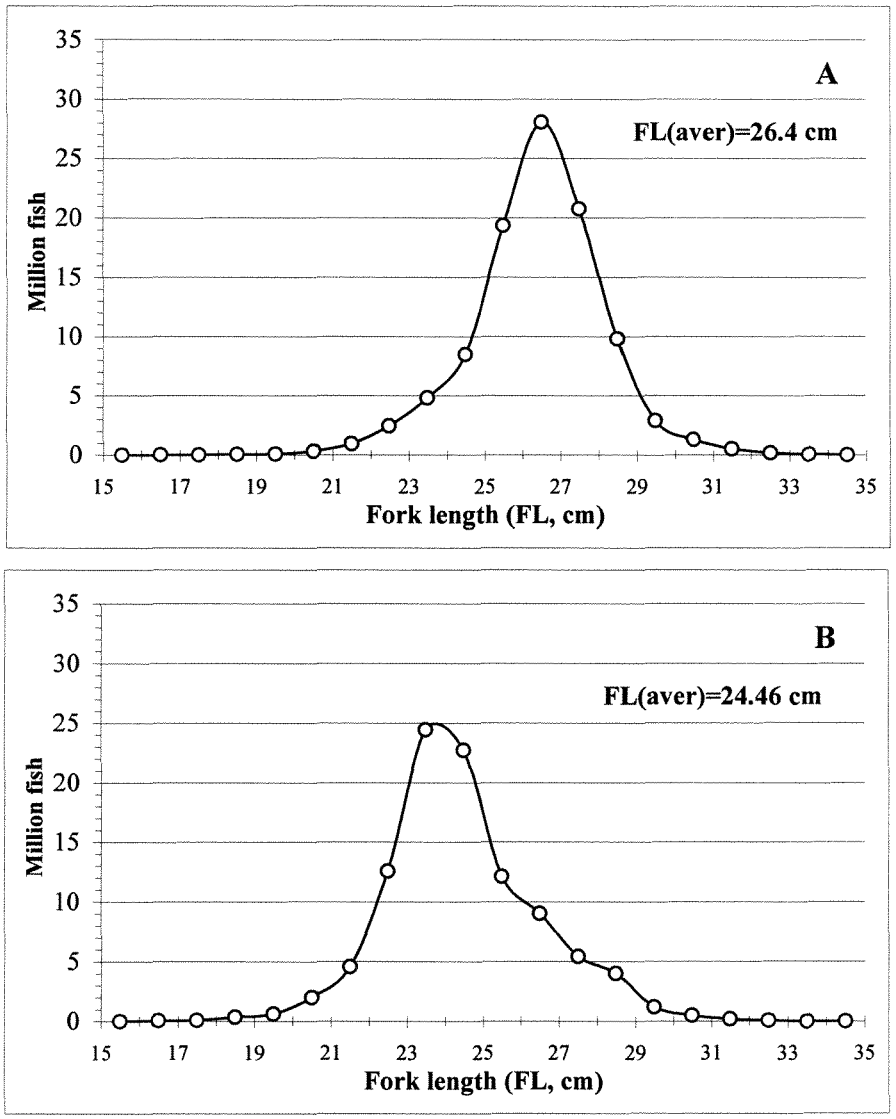

Fig. 3 Distribution of trawl catches of mature (a) and immature chum salmon (b) in Sakhalin-Kuriles region 14.10 - 01.11.1998. Numbers given in circles mean the catches of chum salmon in fish per one-hour haul. Solid lines mark generalized scheme of geostrophic surface currents (a) and water temperature on surface (b).

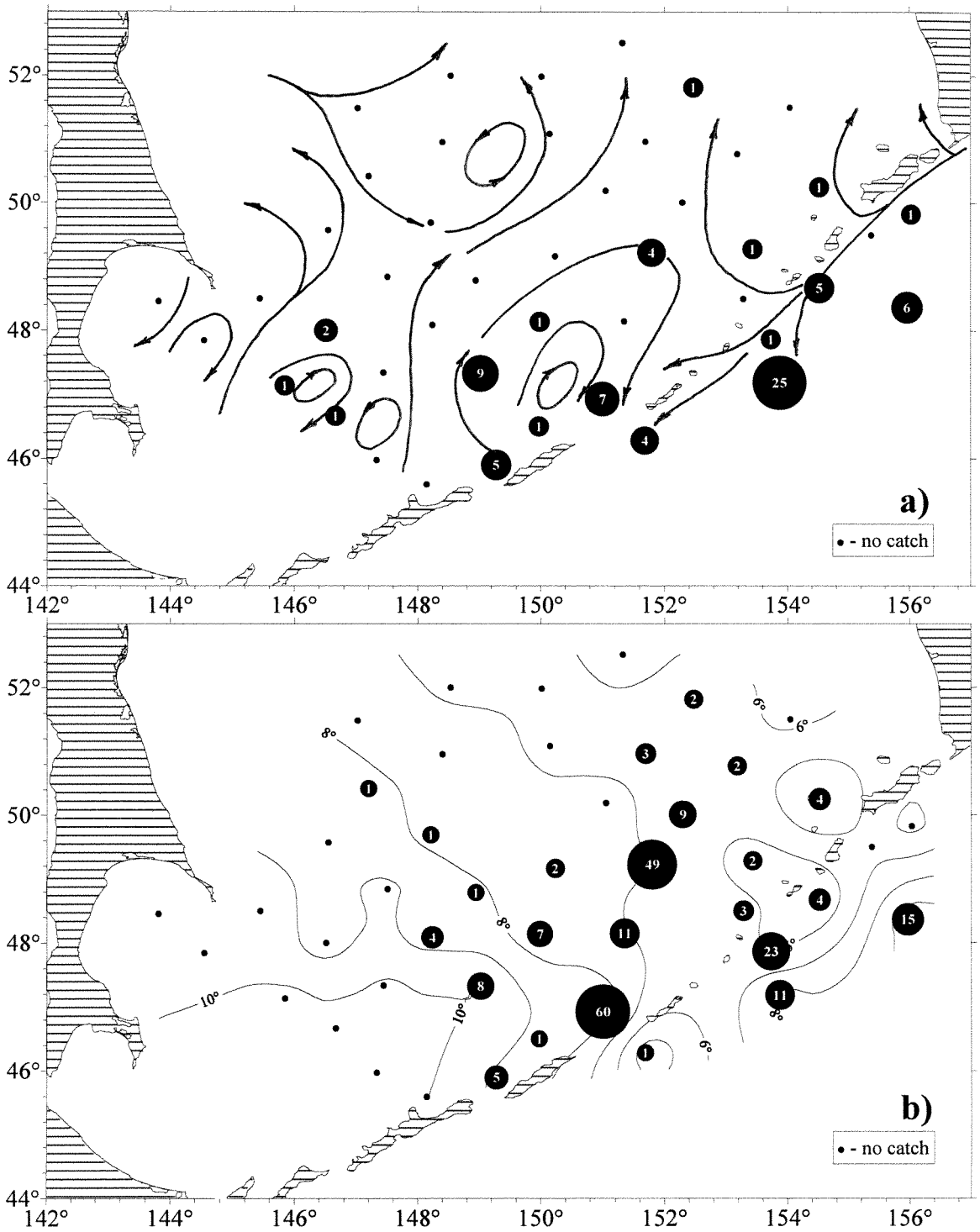

Table 1 Abundance, biomass and relation of Pacific salmon in Sakhalin-Kuril region 26.08-01.10.1998

Species of salmonids	Date of surveis 26.08-05.09.1998				Date of surveis 14.09-01.10.1998			
	Mln. sp.	**%**	**Th. tons**	**%**	**Mln. sp.**	**%**	**Th. tons**	**%**
Pink salmon (juvenils)	1.198	1.95%	0.068	0.07%	989.030	64.04%	198.634	60.72%
Pink salmon (mature)	30.232	49.17%	34.332	33.38%	0.500	0.03%	0.347	0.11%
Pink salmon (total)	**31.430**	**51.12%**	**34.400**	**33.45%**	**989.530**	**64.07%**	**198.981**	**60.82%**
Chum salmon (juvenils)	6.843	11.13%	0.405	0.39%	517.570	33.51%	87.672	26.80%
Chum salmon ("autumn")	20.538	33.40%	63.880	62.11%	3.020	0.20%	7.972	2.44%
Chum salmon (immature)	1.238	2.01%	2.471	2.40%	17.050	1.10%	24.149	7.38%
Chum salmon (total)	**28.619**	**46.55%**	**66.756**	**64.90%**	**537.640**	**34.81%**	**119.793**	**36.62%**
Coho salmon	**0.355**	**0.58%**	**0.210**	**0.20%**	**11.210**	**0.73%**	**4.606**	**1.41%**
Masu salmon	**0.661**	**1.08%**	**0.199**	**0.19%**	**5.530**	**0.36%**	**3.147**	**0.96%**
Sockeye salmon	**0.133**	**0.22%**	**0.208**	**0.20%**	**0.290**	**0.02%**	**0.374**	**0.11%**
Chinook salmon	**0.287**	**0.47%**	**1.080**	**1.05%**	**0.190**	**0.01%**	**0.245**	**0.07%**
Total salmonids	**61.485**	**100%**	**102.853**	**100%**	**1544.4**	**100%**	**327.146**	**100%**