Russian Research on Pacific Salmon in 1997

by

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TO THE SALMON INVESTIGATIONS ON RV «PROFESSOR LEVANIDOV» IN THE SEA OF OKHOTSK IN SUMMER 1997

RV «Pr. Levanidov» cruise was carried out by order of Department of Agriculture and Foodstuffs Ministry (Minselkhozprod) on complex studying of the north Okhotsk shelf to determine the basic parameters of many species fisheries in given area.

Epipelagic survey in June-August 1997 covered all areas of the northern part of sea. The results of this survey concerning Pacific salmons are shown in table 1. For convenience in materials processing and outline, the Okhotsk sea was divided into the biostatistical regions: 1. Shelikhov Bay; 2. Yamsko-Tauiskiy; 3. Okhotsk-Lisyanskiy; 4. Ayano-Shantarskiy; 5. Iono-Kashevarovskiy; 6. TINRO-basin; 7. North-western Kamc/';[p-0hatka shore; 8. South Kamchatka; 9. Central deepwater basin; 10. Eastern Sakhalin; 11. South-eastern Sakhalin shore; 12. South deepwater basin; 13. Adjacent Kuril area.

Table 1.

Biomass of Pacific salmons in different areas of the northern part of the Okhotsk sea in July - August 1997

Species	Areas								Total
	1	2	3	4	5	6	7	10	
Chum	3.7	3.0	24.2	2.3	15.5	2.8	2.7	3.2	57.4
Pink salmon	0.2	0.4	-	2.6	1.4	+	1.0	0.7	6.3
Area, thous/km^2	100	62	92	114	160	120	56	57.5	761.5
N trawling	14	17	15	12	22	16	21	15	132

Chum deserves a special comment (fig.1). Its biomass, basically matured species presented, was estimated at 57-62 thous.t. in the north. The occurrence of Japan chum was not excluded to be present there, but it is safe to say that the representatives of local stocks formed the base. By commercial statistics it was apparent the poor catch in the

north-eastern part of the sea in early September, though chum still occurred in offshore sea (fig.1). On the other hand, the fishery efficiency in the north-western part was higher of forecast and catch happened to be close to two plans. As figure 1 shows the main flow of migrating chum was directed towards just the north-western shore.

FEEDING

PINK SALMON. Pink salmon juveniles of 10-20 cm in length occurred being not abundant almost all over the studied area, the 4th and 10th areas excepted. Nekton, that is squids (mantle length - 20-30mm) and fishes - pollock juveniles (25-42mm), herring juveniles (25-35mm) formed the base of food in the majority of areas. In the 6th area juveniles fed only on plankton. Euphausiacea, the representatives of which were T.raschii, occurred in the 1st and 7th areas, but they were the most significant in the 7th area. Amphipoda T.japonica were found in the 5th and 6th areas where they were highly considerable in ration (table 3.4.10). Amount of food in the stomach of pink salmon juveniles was high, the general index of food fullness varied by areas from 100 to 239$^{0}/_{00}$. Pink salmon of 30-40 cm occurred as a seldom specimen only in the 4th and 10th areas.

Amphipoda constituted the major portion of food (100%) in Shantar region (4), pteropoda (L.helicina)-79% and euphausiacea (T.raschii)-20% in Sakhalin region. Amount of food in the stomach was rather high, the general index of stomach fullness made up 103-116$^{0}/_{00}$.

Nekton dominated in pink salmon (40-50 cm) food in the 1st, 7th and 10th areas, that was represented mainly by sand lance (140-145 mm), and herring juveniles (70-80 mm) also in the 10th area.

Amphipoda, represented by 3 species formed the food basis in the 4th and 5th areas. T.japonica predominated abundantly among amphipoda. Brachyura were found in food only in the 7th area where they comprised 50% of the total food. Euphausiacea were of significant importance in food only in the 4th area .

The total amount of food in stomachs of pink salmon (40-50 cm) was poor almost in all areas, excluding the 10th one where the general index of stomach fullness made up 163$^{0}/_{00}$.

Nekton predominated in pink salmon (50-60 cm) food in the first area - 70% and in the 10th - 99,5%. In the first area nekton was represented by squid juveniles and in the 10th - herring and sand lance juveniles. Euphausiacea occurred in stomachs almost persistently but were of great importance only in the 2nd, 4th and 5th areas. Amphipoda dominated in pink salmon food in the 1st, 4th and 5th areas, brachyura - in the 2nd.

The total amount of food in pink stomachs (50-60 cm) in the 1st area was low - 10-22 ,in the 4th and 5th- average (85-106‰), and in the 10th - high (222‰) due to fishes being the basis of food.

It is impossible to determine the ration of pink daily food by available data. It can be only noted that the highest indices of stomach fullness were observed in the mornings and evenings when fresh food predominated in stomachs (80-100%).

So it can be pointed out that nekton was the food basis of pink of all size groups in the majority of areas that are at variance with previous investigations when in summer plankton - euphausiacea, amphipoda, pteropoda dominated abundantly in ration, and fish portion didn't exceed 10-20% in mass.

CHUM. The chum feeding spectrum was rather various, but nekton, euphausiacea, amphipoda, in some areas - pteropoda and decapoda formed the food basis like of pink.

Chum juveniles (10-20 cm) occurred in 3 areas. In Shelikhov Bay (the 1st area) it fed only on amphipoda - T.libellula, in the 3d and 7th areas - fishes (pollock juveniles and sand lance). Everywhere the amount of food in stomachs was high - 118-256‰. Chum (20-30 cm) occurred as individuals only in the 1st area and consumed only herring juveniles. Index of stomach fullness was maximum - 353‰.

Nekton was the basis of chum (40-50 cm) food in the 2nd and 3d areas, and plankton, mainly euphausiacea and amphipoda - in the 5th and 6th ones. The 6th area excluded where index of stomach fullness was 256‰, amount of food in stomachs was poor. Chum of more than 50 cm in length occurred round the investigated region. Nekton - fishes and squids formed the basis of food in the majority of areas. Plankton predominated absolutely only in the 4th and 5th areas, amphipoda - in the 4th, pteropoda - in the 5th one. Euphausiacea occurred in food practically everywhere, but were of great importance in food of chum of 50-60 cm in length only in the 1st, 2nd, 5th and 7th areas, and chum of

more than 60 cm - only in the 5th and 6th areas. Copepoda were entirely absent. The large chum fed more intensively in the 1st, 4th, 5th and 10th areas - 82-160‰.

There happened to be impossible to determine the daily rhythm of chum feeding by areas because of materials deficiency. But joining the adjacent areas there have been determined 2 peaks of matured chum food activity in the daylight and 1 - at night.

Chum fed more actively in the morning (from 7 till 10 o'clock) and at night (from 22 till 24), just when it was marked the highest percent of fresh food in stomachs (60-100%). Minimum amount of food in stomachs was registered from 4 till 6 o'clock, this time a number of fishes with empty stomachs increased. Daily ration of matured chum in the north-eastern part of the sea (1,2,6,7 areas) was 2,4%, in the north-western (3,4,5,10) - 4,3%.

MALMA of 20-30 and 30-40 cm in length occurred as individuals only in the 3d area. It fed on pollock juveniles and being the nearshore - insecta. Amount of food in stomachs of malma fed on pollock juveniles was maximum - 407‰.

COHO SALMON of all groups fed on nekton mainly. Amount of food in stomachs was high, indices of stomach fullness varied from 91 to 304‰.

CHINOOK SALMON. As juveniles so adults consumed nekton mainly. Amount of food in juveniles stomachs was high everywhere, large chinook - only in the 2nd area.

MASU of 20-30 cm occurred as individuals only in the 6th and 7th areas, fed on pollock juveniles and sand lance. Amount of food was high - 284-288‰.

INVESTIGATIONS IN THE SAKHALIN-KURIL REGION

Investigations in the Sakhalin-Kuril region were of local type and were conducted only during the last decade of August. There have been done 27 trawlings, catches of which defined the ichthyocenosis composition of upper epipelagial (0-50 m) at the period of completion of sea anadromous migrations of pink salmon and commencement of mass approaches of the Japan spring chum.

Table 2

Biomass (thous.t.) and abundance (mln.sp.) of Pacific salmons in upper (0-50 m) epipelagial of the Okhotsk sea 24-31.08.1997

Species	Biomass		Abundance
	thous.t.	%	mln.sp.
Chum	33,2	8,25 %	9
Chum (fingerlings)	0,6	0,15 %	7,1
Pink salmon	20,6	5,11 %	12,9
Pink (fingerlings)	0,6	0,15 %	42,2
Chinook	3,5	0,87 %	0,7
Coho	0,3	0,07 %	0,1
Coho (fingerlings)	0,1	0,02 %	0,1

Note: Calculations are given according to data of 20 trawlings, have been conducted southward of line attached Ribbon Island and Bussol Gulf (area -154 thous.sq.km).

PINK SALMON. By the time of investigations in the south Okhotsk sea, pink salmon fishing season in Sakhalin region came to finish. In the Eastern Sakhalin up to August,25 it was taken about 63 thous.t. Near Sakhalin in late August pink salmon was found in catches of every trawling, but catches were scanty (1-18 specimen) and consisted of 2/3 females with high (12,5-13,1) average GSI (fig.2), that, of course, is evidence of closing stage of run. For further analyzing the pink salmon fishing season including poor catches in Sakhalin waters relative to forecast it should be pointed to the following 2 reasons. In August ,23 while vessel going to the south at the boundary of upper slope along Sakhalin between 52° and 50° N.L. it was met the dead smolts by 5-10 specimen for an hour. Evidently, somewhere at Sakhalin coast there have been taken place mortality and some part of dead fish somehow entered to Sakhalin countecurrent. It is not inconceivable that scales of pink salmon death were substantial. Last years it appeared some arguments that pink salmon mortality in ocean, in subarctic front became higher in winter. May be it is one of the reasons of decreasing the expected fish return from ocean relative to estimation of salmon juveniles abundance in autumn. In this sense the increase of fish abundance traumatized by daggertooth (and, possible, by lancetfishes) is worthy of notice. In 1997 9,4% of pink and 7,14% of chum salmon (even very large specimen) had

typical «knife» wounds on body. In previous cruises the portion of traumatized fishes was considerably less.

Up to August ,25 in the south Kuril area it was caught out 16,2 thous.t, of pink. As fig.2 illustrates the most part of fish being in the sea at that time concentrated at the range of 20 miles off Iturup. As about 20 thous.t. were calculated in the south Okhotsk sea and apparently, about 5 thous.t.stayed in Pacific waters it may be suggested that removal in the south Kuril region in September raised by 5-10 thous.t (it should be taken into account that calculated pink biomass consisted not only of fishes from Iturup and Kunashir but from Hokkaido and scanty number from Sakhalin as well.). Really, during the first decade of September fish removal reached 25 thous.t. in the South Kuril.

Size-weight composition of pink in Sakhalin-Kuril region is demonstrated in tabl.3 and 4. It's rather interesting picture. In adjacent Sakhalin waters curves of size and weight composition had two peaks. As Kuril and Hokkaido pink are always (or almost always) larger of Sakhalin ones so large specimen seem to refer to Kuril fishes. Indeed, the large fishes dominated in adjacent Kuril waters of the Okhotsk sea. However, in Pacific ocean, where during this period in previous years the largest fishes occurred, in late August of 1977 the catches consisted of small and large fishes. This phenomenon isn't explained yet.

CHUM SALMON. Chum was not so abundant as pink salmon (9-12,9 mln.sp. accordingly), but exceeded the last by its summary biomass (tabl.2). Chum concentrations being similar to the Okhotsk ones were observed in the Pacific waters of Kuril as well (fig.3). Curtainly, it was autumn Japan chum, mainly. Males predominated almost everywhere, that indicates to the leading part of high abundant Japan stocks be in the considered area. Chum came to the foraging end and a great number of females had a high GSI, that affected on average values of this index (fig.3).

Chum size composition in the considered area is presented in tabl.5. The increasing of portion of smaller fishes (including age 1+, 2+ and 3+) in adjacent waters of the Okhotsk sea and Pacific ocean is the most noticeable feature of spatial distribution of chum of different sizes. This finding isn't new. The Okhotsk sea is not an area for mass foraging of matured chum (within Far East). The part FEEDING shows that even being in

sea migration end chum salmon is feeding intensively. Biomass of Japan chum together with immatured specimen reach some first hundreds of thousands tons. Even while only a part of this mass run across the Russian waters they feed a great number of plankton and nekton. To compensate this loss it is necessary to organize a specialized catch, for example, drift-net fishing of chum in the south of the Okhotsk sea in August - September. Just Japan chum would be the basis of this catch. As last years net fishing (foreign and russian) is a common practice in the Russian waters in spring and summer, so the early spawning russian chum, in the first turn, is under fishing stress.

FEEDING

PINK SALMON. Pink salmon juveniles of 10-20 cm in the south Okhotsk sea catches occurred two times at night. Intensity of feeding was high, average total index of stomach fullness was $609^0/_{00}$ Food ration was represented only by plankton organisms, among which copepoda - N.plumchrus and amphipoda - T.Japonica dominated.

Spectrum of pink salmon (40-50 and 50-60 cm) feeding didn't differ essentially, but it should be noted that portion of nekton increased with fish size increased, mainly, at the expense of euphausiacea. Nekton predominated in food ration of matured pink salmon. Among the fishes that made up 45,8-65,5% of daily ration predominated Myctophidae of 80-120 mm and Atka mackerel of 120-170 cm in length. Squids in ration made up 7,2-8% and were represented, mainly, by juveniles of 20-30 mm mantle. Intensity of pink salmon feeding was average, index of stomach fullness was $70\text{-}98^0/_{00}$. Daily rhythm of pink feeding was weakly expressed, though, in total, feeding fall was observed between 02 and 08 o'clock and more intensive feeding lasted between 12 and 24 o'clock. Daily ration of pink of 40-50 cm, in total, round the investigated south Okhotsk sea was 2,4%, fish of 50-60 cm - 3,7% of body weight. As compared with the previous studies it can be noted the considerable increasing of nekton in ration. Amount of food in pink stomach was less then in 1993, but 1,5-2 times higher against 1995.

CHUM. In food composition of chum juveniles of 10-20 cm caught in the south Okhotsk sea there were dominated euphausiacea - 46,7% and appendicularia - 39,9%. Copepoda -11,7% and amphipoda - 1,7% were the secondary. Amphipoda -75% took the first place in chum food of 20-30 cm, euphausiacea - 15% and copepoda - 10% - the

second. Amount of juvenile chum stomach was high, average index of stomach fullness of fishes of 10-20 cm made up $247^0/_{00}$, of 20-30 cm - $279^0/_{00}$.

Chum of 40-50 cm occurred in catches incidentally, there were analysed 13 stomachs in total. All species were caught out at dark time when chum didn't feed. Average index of stomach fullness made up 29. Food consisted basically of euphausiacea - 46,6% and fishes - 33,3%. Chum of 50-60 and 60-70 cm occurred all over the investigated area. Amount of food was not high, average index of stomach fullness of chum of 50-60 cm amounted $40^0/_{00}$, 60-70 cm - $57^0/_{00}$. The base food consisted of fishes 77,1-83.1%, among which Myctophidae and Acta mackerel predominated. Euphausiacea and pteropoda were the secondary. Besides, there were found out amphipoda, ctenophora and squids in stomachs. Like pink salmon, daily rhythm of chum feeding was weakly expressed, more intensive feeding was noted from 18 to 24 hours. Daily ration of chum of 50-60 cm made up 1,2%, 60- 70 cm - 1,9%. The rest of salmons - sockeye, chinook, coho and masu occurred in catches occasionally and as individuals.

Table 3.

Size composition of pink salmon in Sakhalin-Kuril area 24-31.08.1997 r.

Lengh	Okhotsk Sea				Pacific Ocean	
	to the west from 146 E		to the east from 146 E			
AC (см)	N	%	N	%	N	%
<41	0	0.00%	2	0.93%	0	0.00%
41-42	0	0.00%	0	0.00%	1	2.33%
42-43	0	0.00%	0	0.00%	3	6.98%
43-44	1	1.89%	2	0.93%	3	6.98%
44-45	1	1.89%	3	1.39%	1	2.33%
45-46	8	15.09%	5	2.31%	5	11.63%
46-47	6	11.32%	11	5.09%	5	11.63%
47-48	2	3.77%	15	6.94%	5	11.63%
48-49	5	9.43%	19	8.80%	2	4.65%
49-50	11	20.75%	32	14.81%	4	9.30%
50-51	2	3.77%	43	19.91%	5	11.63%
51-52	4	7.55%	25	11.57%	1	2.33%
52-53	3	5.66%	20	9.26%	3	6.98%
53-54	2	3.77%	14	6.48%	1	2.33%
54-55	3	5.66%	11	5.09%	3	6.98%
55-56	2	3.77%	10	4.63%	1	2.33%
56-57	1	1.89%	2	0.93%	0	0.00%
57-58	0	0.00%	1	0.46%	0	0.00%
58-59	1	1.89%	0	0.00%	0	0.00%
59-60	0	0.00%	0	0.00%	0	0.00%
60-61	0	0.00%	0	0.00%	0	0.00%
61-62	0	0.00%	1	0.46%	0	0.00%
>62	1	1.89%	0	0.00%	0	0.00%
Total	53	100.00%	216	100.00%	43	100.00%
Average length, cm	49.7		50.5		48.2	

Table 4.

Weight composition of pink salmon in Sakhalin-Kuril area 24-31.08.1997

Weight, kg	Okhotsk Sea				Pacific ocean	
	to the west from 146 E		to the east from 146 E			
	N	%	N	%	N	%
<0.6	0	0.00%	0	0.00%	3	6.98%
0.6-0.7	0	0.00%	0	0.00%	1	2.33%
0.7-0.8	0	0.00%	2	0.93%	4	9.30%
0.8-0.9	2	3.77%	2	0.93%	3	6.98%
0.9-1.0	1	1.89%	6	2.78%	3	6.98%
1.0-1.1	4	7.55%	4	1.85%	5	11.63%
1.1-1.2	4	7.55%	11	5.09%	5	11.63%
1.2-1.3	6	11.32%	12	5.56%	4	9.30%
1.3-1.4	8	15.09%	21	9.72%	2	4.65%
1.4-1.5	5	9.43%	22	10.19%	0	0.00%
1.5-1.6	1	1.89%	29	13.43%	4	9.30%
1.6-1.7	7	13.21%	27	12.50%	1	2.33%
1.7-1.8	1	1.89%	26	12.04%	3	6.98%
1.8-1.9	2	3.77%	19	8.80%	0	0.00%
1.9-2.0	2	3.77%	7	3.24%	2	4.65%
2.0-2.1	3	5.66%	12	5.56%	1	2.33%
2.1-2.2	3	5.66%	8	3.70%	1	2.33%
2.2-2.3	2	3.77%	1	0.46%	1	2.33%
2.3-2.4	0	0.00%	5	2.31%	0	0.00%
2.4-2.5	1	1.89%	0	0.00%	0	0.00%
2.5-2.6	0	0.00%	1	0.46%	0	0.00%
2.6-...-3.4	0	0.00%	0	0.00%	0	0.00%
3.4-3.5	1	1.89%	1	0.46%	0	0.00%
Total	53	100.00%	216	100.00%	43	100.00%
Average weight, kg	1.6		1.6		1.2	

Table 5.

Size composition of king salmon in Sakhalin-Kuril area 24-31.08.1997 r.

Length, (AC), cm	Okhotsk Sea				Pacific Ocean	
	to the west from 146 E		to the east from 146 E			
	N	%	N	%	N	%
<44	0	0.00%	0	0.00%	1	1.79%
44-46	0	0.00%	0	0.00%	4	7.14%
46-48	0	0.00%	0	0.00%	0	0.00%
48-50	1	1.69%	0	0.00%	1	1.79%
50-52	1	1.69%	0	0.00%	1	1.79%
52-54	0	0.00%	1	0.75%	3	5.36%
54-56	1	1.69%	3	2.26%	7	12.50%
56-58	0	0.00%	4	3.01%	4	7.14%
58-60	4	6.78%	10	7.52%	3	5.36%
60-62	4	6.78%	32	24.06%	11	19.64%
62-64	12	20.34%	21	15.79%	7	12.50%
64-66	14	23.73%	25	18.80%	8	14.29%
66-68	9	15.25%	19	14.29%	3	5.36%
68-70	5	8.47%	10	7.52%	1	1.79%
70-72	4	6.78%	4	3.01%	1	1.79%
72-74	3	5.08%	2	1.50%	1	1.79%
74-76	1	1.69%	2	0.00%	0	0.00%
Total	59	100.00%	133	100.00%	56	100.00%
Average length, cm	64.9		63.8		59.2	

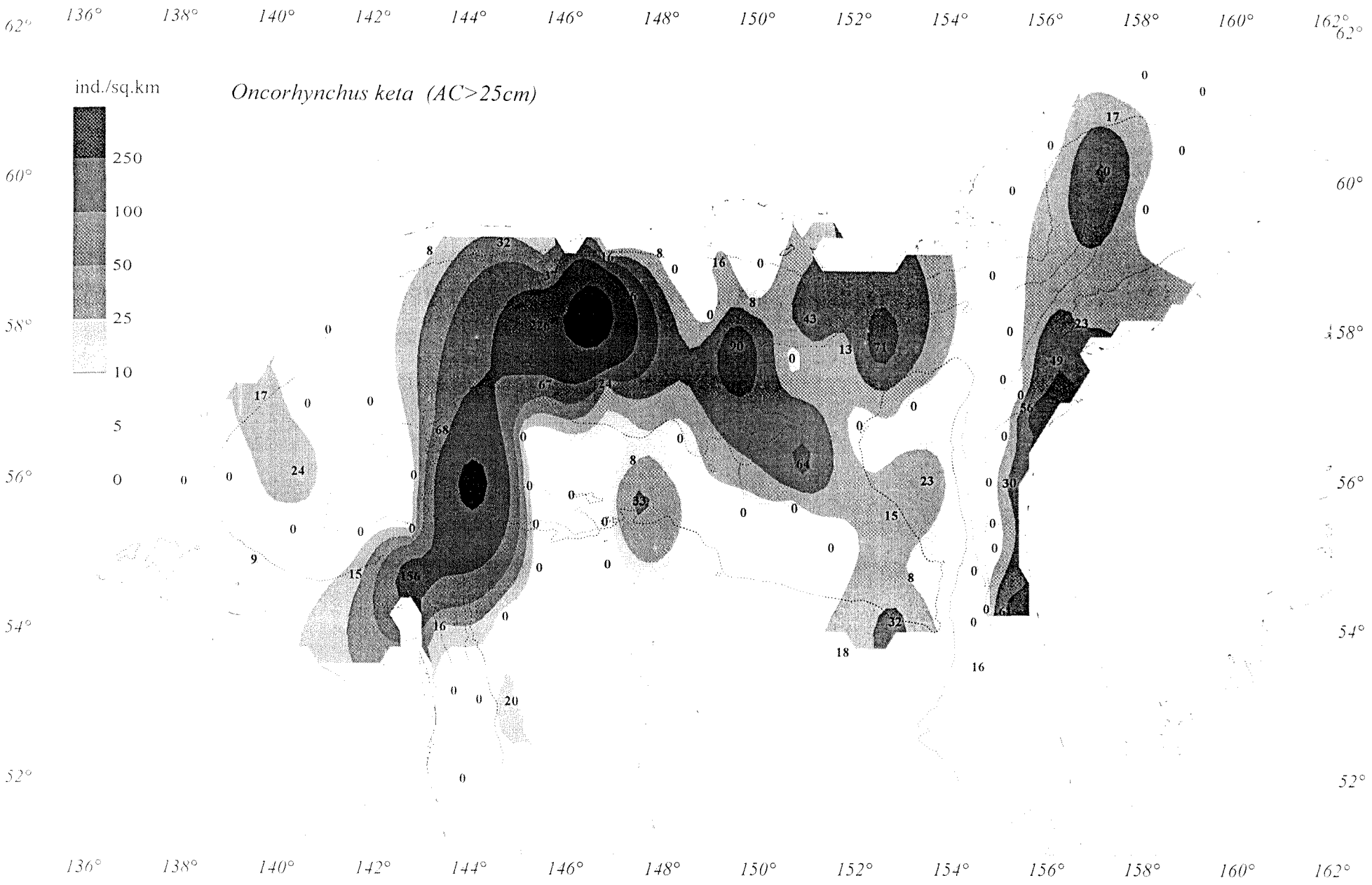
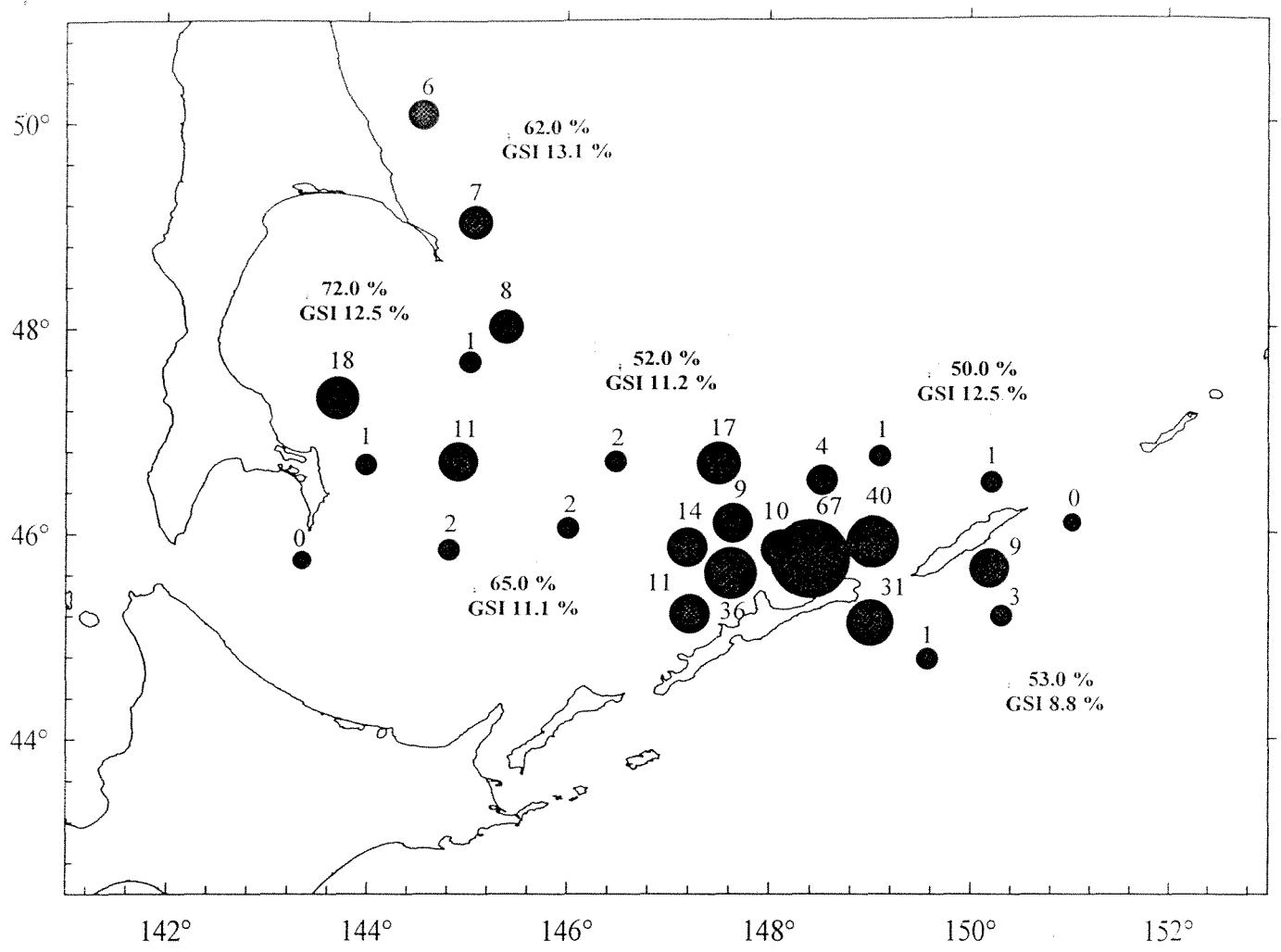
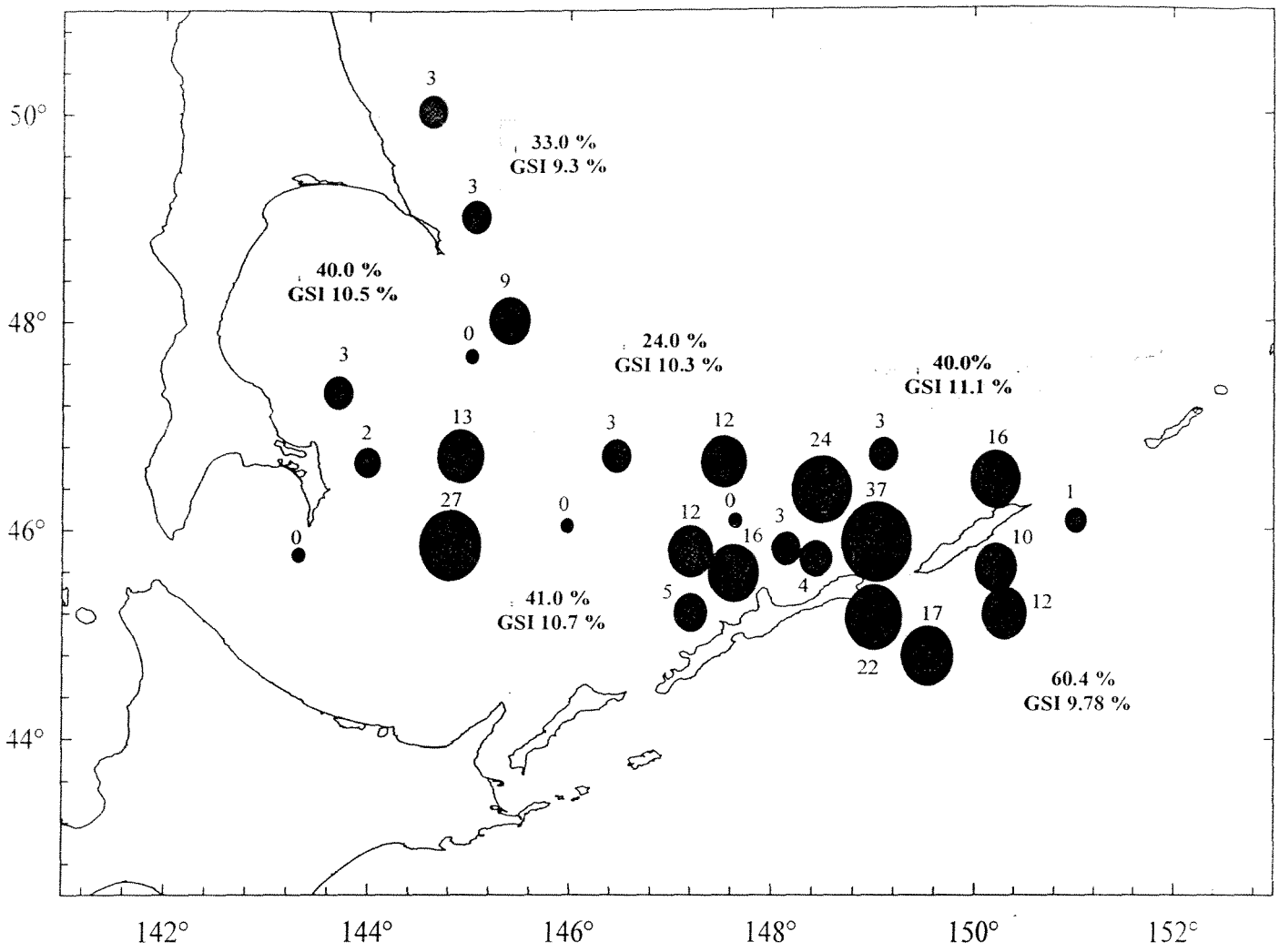


Рис. 1. Spatial distribution of chum abundance (July 10 - August 16, 1997).



Pag. 2. Matured pink salmon catch distribution in Sakhalin Kuril area during 24.08 - 31.08.97. Black circles with fioures - catch (pieces per one hour trawling). Squares - percentage of females and average maturity index of females.



Pag. 3. Distribution of chum catches at Sakhalin - Kuril area on 08.24 - 08.31.1997. Dark circles with digits - spcs catch per trawling hour. Squars - the rate of females and thier mean maturity coefficient.