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RESULTS OF 2000 SALMON RESEARCH CRUISE OF THE *STR SAJANOGORSK"*

by

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Abstract

The salmon research cruise of the *STR "Sajanogorsk"* of the KamchatNIRO was conducted in the western Bering Sea between 55 -59 N, and between coast of the Kamchatka and 172°E in September 1 — October 8, 2000 for stock assessment and carrying capacity estimation. The survey was made twice: first during September 1-15, and repeated from September 24 to October 8. The survey included oceanographic observation, sampling zooplankton, fishing of salmon and other fishes using trawl. Number of salmon caught by 85 sets of trawl was 17,812 salmon juveniles and 569 immature salmon. The catch of juveniles includes 12,834 pink, 261 sockeye, 4,302 chum, 208 coho and 207 chinook. CPUEs of pink and chum salmon in 2000 were quiet high for the last 20 years. Fish size of pink was equal for average, sockeye, chum, and coho salmon were less than average for the same period. Samples and data will be analyzed in the KamchatNIRO (Kamchatka Fishery & Oceanography Inst.)

Introduction

As is well known the estimation of number of juveniles that passed the maximum mortality period in coastal waters, gives a reliable basis for more accurate definition of pink salmon return forecast. Trawl survey results certainty and their prognostic value are considerably defined by the survey due date, parameters of gear, as well as a vessel's capacity that provides a necessary trawling speed.

The previous researches have stated that the optimal period for a survey is September -early October, when juveniles leave coastal waters but still adheres to the South-West Bering Sea. At that time they reside in the upper warmed up 20-30 m water layer and are well caught by a trawl. Researches are carried out on STR - 503 type vessels in September - early October by the standard net of stations. Was used a pelagic rope trawl 54.4/192 m with vertical opening of 25-30 meters.

The main tasks of the voyage in 2000 were:

- Sampling data characterizing abundance, species composition, biology, age structure and feeding of salmon juveniles in the fall within Kamchatka waters;
- Sampling data characterizing dynamics of plankton animals expenditure and salmon juveniles energy consumption at different stages of migration and fattening;
- Sampling data and materials for identification of salmon populations of different origin in mixed sea catches (samples of scales, muscular tissue; otoliths; parasite-fauna composition; morphometric characteristics);
- Sampling data for estimation of salmon juveniles' natural mortality as a result of diseases and eating out juveniles by predators;
- Sampling of hydro-meteorological and hydro-biological data characterizing background conditions;
- Estimation of juveniles' abundance of pink salmon and chum salmon by the results of a trawl survey for a more accurate definition forecast of run.

Methods

1. Period and Area

A trawl survey was carried out at the area limited within 55-59° N and Kamchatka coast and 172° E, during September 1 - October 8, 2000 (Fig. 1) (Table 1).

2. Oceanographic Observations

The temperature and salinity of 100 m water layer were measured with an STD-1000 thermohalinosonde at 84 stations.

3. Hydro-Biological Researches

Zooplankton samples were collected by a vertical towing of 100 m water layer with an IKS-80 net (mesh 0,55 mm) at 62 stations.

4. Catch of Salmon Juveniles and Other Species

In all 85 casts of trawl were done, 17,812 individuals of salmon juveniles and 569 immature individuals were caught. There were collected and fixed: 422 stomachs, 194 samples of muscular tissue of salmon juveniles for biochemical analysis, and 367 otoliths for studying age composition. A specimen of 2,146 pieces of juveniles was realized, as well as 3,633 juveniles pieces were measured and 12,645 pieces were weighed. The volume of the collected data is shown in Table 2.

Results and Discussion

1. Oceanographic Observations

During September 1-16 (the first survey) in the western and central part of the research area water surface temperature changed from 10° to 12.5° C (Fig. 2). The water salinity did not exceed 32 ‰ (Fig. 3). In the eastern and southwestern parts of the research area the water temperature was only 5.5° C, and salinity - more than 32 ‰. Comparison of hydrological conditions in the research area for the period from 1984 to 2000 has shown that in the first half of September 2000 these conditions can be evaluated as the warmest.

In late September - early October (the second survey) the surface water temperature in comparison with the first half of September decreased 2° C upon the area average (Fig. 4). In coastal areas the water cooling was even more considerable - 3.5 ° C than that in sea areas where the temperature decreased 1-1.5° C. At the entire waters the water salinity has significantly increased, though there remained a distinctive desalinated "corridor" spread from the Litke Strait to the Commander Islands, by which a part of salmon juveniles migrated (Fig. 5).

2. Ichthyologic Works

1) Salmon Juveniles Catches

In the specific composition of salmon juveniles catches (age .0+) during the first and the second surveys pink salmon dominated - 12,834 pieces (72%). Chum salmon was 3 times less -4,302 pieces (24.1%), and the part of other species was insignificant (sockeye salmon - 261 pieces (1.5%); coho - 208 pieces (1.2%); chinook salmon - 207 pieces (1.2%)).

2) Distribution

Pink salmon. A character of pink salmon distribution within the period of September 1-15, 2000 (the first survey) was the main accumulations (up to 1400 individuals per one hour of trawling) timing to the coastal zone (Fig. 6). They were situated between 56°30 and 60°00 N and 162°30 and 166° E. and the maximum catches were marked not farther than 50 miles from the shore. In late September - early October (the second survey) the greater part of pink salmon migrated to the high sea and reached 172°00 E dispersing at a spacious area in the southeastern part of the research area (Fig.7). Though high catches (up to 1300 individuals per hour) were noted also at the distance of just 8-10 miles from the shore.

Chum salmon. In the first half of September chum salmon juveniles were fattening together with pink. Distribution of main accumulations of chum salmon fully coincided with that of pink salmon (Fig. 8). Chum salmon catches in those accumulations were 3-4 times less than pink salmon. Distribution of chum salmon in the period of the second survey was of a coastal area. And if at that time pink salmon juveniles already started a southwest migration, Chum salmon did not move away from the shore farther than 30 miles (Fig. 9).

Sockeye salmon. Distribution of sockeye salmon juveniles in 2000 was similar to that of pink salmon (Fig. 10, 11). During the first survey sockeye salmon juveniles like pink salmon's adhered to waters with the temperature range from 10.5° to 12° C, and during the second survey

- to waters with temperature close to 8° C.

Coho salmon. Usually juveniles of coho salmon - the most thermophilic salmon species
- are rarely met in this area in September. In 2000 coho was also caught by individuals, but its encounter frequency was high enough: 62% (26 stations) at the first survey and 58% (25 stations) - at the second one. So often encounter frequency of this species also confirms a conclusion about the characteristics of the hydrologic regime of fall 2000 as "warm". During the first survey in the central part of the area one more accumulation of coho juveniles was noted (Fig. 12). In late September - early October coho salmon juveniles, as the surface waters started to cool, practically left the area; only in the southern part a low-density accumulation was noted (Fig.13).

Chinook salmon. Chinook salmon was met at 21 stations, but its catches did not exceed 15 individuals. During the first survey one accumulation of chinook juveniles was found (45 individuals) in the Ukinskaya Guba (Bay). Distribution of chinook salmon as well as other species was of a coastal nature in the first half of September of 2000 (Fig. 14). In this period chinook salmon at the distance of 30 miles from the shore was not met. In late September - early October it mainly left coastal waters and evenly distributed along the eastern border of the research area; any accumulations were not found (Fig. 15).

3) Migrations

A migration direction of pink salmon juveniles was influenced by hydrologic conditions prevalent in the autumn period. Heavy (3° C in the Litke Strait and 5° C in the Korf Gulf) fall of coastal waters temperature conditioned a start for pink salmon migration to the high sea, and the inflow of cold waters from the east limited pink salmon juveniles distribution in this direction. Migration of pink salmon juveniles occurred in two directions - south- and south-westbound.

Later pink salmon from the northern rivers of the Litke Strait and the southwest branch of the flow from the southern part of the Litke Strait practically joined having formed a joint stream that reached the Pacific Ocean between the Commander and Blizhniye Islands (Fig. 16). The southern branch of migrants from the southern part of the strait reached the Kamchatka Gulf and, having joined with pink salmon juveniles of the Kamchatka River that already started to leave the coastal waters, formed a joint southbound stream. Migration of pink salmon juveniles from the coastal waters to the high sea happened with an average speed of 13 km/day.

Migration of chum salmon occurred in a southbound direction within 50-mile coastal zone (Fig. 17). Migration speed was 7 km/day.

Sockeye salmon juveniles' migration occurred by the same ways as that of pink salmon.

4) Biological Data and Salmon Juveniles Growth

Average length and weight of a salmon juvenile body are shown in Table 3.

Pink salmon. Biological data of pink salmon juveniles in the first half of September (the first survey) are evaluated as the least for the period since 1981 up till present. During the second survey (24.09 - 08.10.2000) on the contrary they exceeded annual average level.

Bimodality has been noted in the dimensional composition of pink salmon (Fig. 18). Such different quality of juveniles is undoubtedly connected with different duration downstream migration, duration of its staying in coastal waters and migration to high seas not in the same period. Shown in Table 3 range of speed of linear and weight growth of pink salmon juveniles is given for different modal groups. It's necessary to note that pink salmon migrating southbound along the eastern coast of Kamchatka (Fig. 16) was mainly represented by smaller individuals (the first modal group), than the fish migrating south eastbound (the second modal group) (Fig. 18).

Chum salmon. Biological characteristics of chum salmon juveniles during the entire research period in 2000 were lower than the annual average level for the period since 1981. The dimensional composition of chum salmon juveniles is shown at Fig. 19. The curve characterizing the distribution of chum salmon body length at the first survey had two peaks. The fist peak presence is explained by the selection represented mainly by fish from the accumulations of the South Litke Strait; and the second peak - from the Korf Gulf accumulations and the adjoining waters. At the second survey the length distribution was close to normal.

Sockeye salmon. Biological characteristics of sockeye salmon juveniles during the entire research period in 2000 were lower than the annual average level for the period since 1981. During the first survey the average sockeye salmon body length was 15.2 cm, and the weight -50.0 g.; during the second survey - 18 cm and 73.4 g accordingly. Such low fish length and weight values were noted for the period since 1981 twice (1984 and 1991).

Coho salmon. Biological data of coho juveniles were close to the annual average level. During the first survey the average body length was 25.1 cm, and the weight - 204.3 g (Table 3). And during the second survey the average length was 25.7 cm, weight - 213.1 g (Table 3). Coho juveniles' body dimensions increased as the fish moving away from the shore.

Chinook salmon. The average chinook salmon juveniles' dimensions in the first half of September

were: length - 19.5 cm, weight - 97.1 g (Table 3), and were lower than that of the annual average level. In late September - early October (the second survey) the length and weight increased and were - 22.2 cm and 138.7 g, and exceeded the annual average level.

5) Feeding of Salmon Juveniles

Salmon juveniles was strongly feeding during the entire period of fall fattening. By the end of the research period improvement of fattening conditions was noted in comparison with early September, it expressed in the increase of the average rank of stomachs fullness with juveniles of pink salmon, chum salmon, sockeye salmon and coho. The average rank of stomachs fullness of chinook salmon in late September - early October descended in comparison with the previous period. The food composition of pink salmon, chum salmon and sockeye salmon included mainly hyperiids, copepods and euphausiids. In the food composition of coho and chinook juveniles fish fries dominated.

Feeding intensity (stomachs fullness) and the food composition of juveniles allow assuming that the fattening conditions during the entire period were favorable. Its confirmation may be a high rate of growth of pink salmon juveniles. It was some lower with chum salmon and sockeye salmon what is probably connected with a high number of pink salmon, and a possible food competition and food relationships between these species.

6. Other species

Other dish species were mainly represented by sand lance (Ammodytes hexapterus) and threespine stickleback (Gasterosterus aculeatus) that were widely spread from the Litke Strait to the eastern border of the researched area. In the Bering Sea near the Commander Islands in catches atka mackerel was noted in weight, both mature individuals and larvae. In the nighttime anchovies (fam. Myctophidae) and squids were present in high abundence. At some stations pacific saury (Cololabis saira) was met, as a rule a high water surface temperature was typical for those stations. Out of sharks two samples of spiny dogfish (Squalus acantias) were caught. Also one sample of daggertooth (Anatopterus pharao) was caught in whose stomach 5 individuals of pink salmon and chum salmon were found.

Table 1. List coordinates of stations

Survey 1

Date	Station	N	E
1.9.2000	1		
1.9.2000	2	53°57	160°59
2.9.2000	3	54°01	162°00
2.9.2000	10	54°28	161°59
2.9.2000	9	54°29	162°56
2.9.2000	11	55°00	162°24
3.9.2000	13	55°48	162°20
3.9.2000	12	55°30	163°00
3.9.2000	8	54°59	163°59
3.9.2000	15	55°27	164°55
4.9.2000	14	55°58	164°00
4.9.2000	ad.l	56°31	163 "44
4.9.2000	ad.2	56°54	163°24
4.9.2000	36	56°53	163°23
4.9.2000	37	57°26	163°28
5.9.2000	35	56°59	163°58
5.9.2000	34	56°29	165°00
6.9.2000	16	56°00	166°00
6.9.2000	33	56°30	167°00
7.9.2000	32	57°00	166°00
7.9.2000	ad.3	57°15	165°32
7.9.2000	38	57°28	165°01
7.9.2000	ad.4	57°44	164°32
7.9.2000	39	58°00	164°00
8.9.2000	40	58°12	163°12
8.9.2000	41	58°12	162°38
9.9.2000	42	58°49	163°15
10.9.2000	43	59°30	164°00
10.9.2000	44	59°28	165°06
10.9.2000	45	60°05	165°47
12.9.2000	46	58°30	165°00
12.9.2000	47	58°59	165°58
13.9.2000	69	59°32	167°10
13.9.2000	68	60°00	167°58
13.9.2000	67	60°00	169°35
13.9.2000	71	59°31	169°01
14.9.2000	72	59°00	168°00
14.9.2000	48	58°30	167°00
14.9.2000	49	58°00	166°00
15.9.2000	50	57°33	167°01
15.9.2000	51	57°59	168°00
15.9.2000	70	58°29	168°56

Survey 2

Date	Station .N"	N	E
24.9.2000	13	55°48	162°24
24.9.2000	13a	56°03	162°30
24.9.2000	12	55°30	163°00
24.9.2000	12a	55°30	162°07
25.9.2000	11	54°59	162°24
25.9.2000	10	54°30	161°59
25.9.2000	3	54°00	162°00
25.9.2000	2	54°00	161°00
26.9.2000	9	54°31	163°00
26.9.2000	5	54°01	164°01
27.9.2000	7	54°31	165°02
27.9.2000	8	55°00	164°00
28.9.2000	8a	55°31	164°06
28.9.2000	15	55°30	165°00
28.9.2000	14	55°59	164°00
29.9.2000	36	56°55	163°23
29.9.2000	37	57°28	163°35
29.9.2000	35	57°00	164°00
30.9.2000	34	56°31	164°58
30.9.2000	16	56°00	165°59
1.10.2000	30	56°29	167°03
1.10.2000	28	55°00	168°00
1.10.2000	27	54°29	169°00
2.10.2000	26	55°01	170°00
2.10.2000	26a	55°01	171°00
3.10.2000	24	55°04	171°58
3.10.2000	25	55°30	171°00
3.10.2000	56	55°59	169°59
4.10.2000	29	55°29	168°59
4.10.2000	31	55°59	168°00
4.10.2000	55	56°30	169°00
5.10.2000	57	56°32	170°56
5.10.2000	54	56°59	170°02
5.10.2000	53	57°30	169°00
6.10.2000	52	57°02	168°02
6.10.2000	33	56°32	167°04
6.10.2000	32	57°00	166°00
7.10.2000	50	57°31	166°55
7.10.2000	49	57°59	166°01
7.10.2000	38	57°30	165°00
8.10.2000	39	57°56	163°59
8.10.2000	46	58°59	164°57
8.10.2000	47	59°00	166°00

Table 2. Number and types of data collected during survey STR "Sajanogorsk" (September-October, 2000).

Species	Survey	Specimens	Measured fishes	Weighted fishes	Infected fishes	Biochemistry samples	Stomachs	Otholites	Total catch
Pink	1	554	1,134	4,615	167	40	93	30	6,485
	2	714	1,307	5,250	78	40	134	76	6,349
Chum	1	211	374	947	161	30	46	30	2,189
	2	201	656	1,665	142	20	24	22	2,113
Sockeye	1	48	53	54	3	10	16	10	105
	2	146	3	0	7	25	45	113	156
Chinook	1	75	58	63	0	9	28	9	155
	2	47	0	0	0	5	17	36	52
Coho	1	80	43	51	0	10	12	10	131
	2	70	5	0	0	5	7	31	77
Total:		2,146	3,633	12,645	558	194	422	367	17.812

Table 3. Fork length, body weight, daily linear and weight growth rate of salmon juveniles in western Bering sea in September-October 2000.

Species	Period	FL (cm)	BW(g)	Daily linear growth rate (mm)	Daily weight growth rate (g)
Pink	1-15.09.2000	14.7	31.2	1.23-1.54	1.06-1.78
	24.9-08.10.2000	19.2	72.4		
Chum	1-15.09.2000	15.0	35.3	1.0	0.61
	24.9-08.10.2000	17.4	57.9		
Sockeye	1-15.09.2000	15.2	50.0	Age composition not determine	Age composition not determine
	24.9-08.10.2000	18.0	73.4		
Coho	1-15.09.2000	25.1	204.3	Age composition not determine	Age composition not determine
	24.9-08.10.2000	25.7	213.1		
Chinook	1-15.09.2000	19.2	93.4	Age composition not determine	Age composition not determine
	24.9-08.10.2000	22.2	138.7		

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Figs. 1-19 are not available on electronic version