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Elena V. Kurenkova, Alexey A. Khoruzhiy, Alexander V. Zavolokin

Pacific Scientific Research Fisheries Center (TINRO-center)

4, Shevchenko Alley, Vladivostok, 690600, RUSSIA

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Abstract

The trawl surveys by R/V "TINRO" and R/V "Professor Kaganovskiy" were conducted during the summer of 2009 in the upper epipelagic layer of the western Bering Sea and northwestern Pacific Ocean. Its continued observations of north-west Pacific epipelagic community state during early summer period. One of main goal of these surveys was total registration of pink salmon on its early pre-spawning migration ways. Estimates of pink salmon abundance and biomass as well as it percentage of the nekton community are provided. The distributions and biological parameters of adult pink salmon described in detail.

Introduction

In autumn 2008, trawl surveys were conducted in the Okhotsk and Bering Seas. One of the main goal of these surveys was the estimation of juvenile salmon abundance. As a result, high numbers of juvenile salmon in the Okhotsk and record numbers in the Bering Sea was recorded. Winter and summer surveys allowed us to estimate this generation of salmon at the next stages of the marine period of life. The results of study of pink salmon during winter have been described earlier (Starovoytov, 2009). This paper shows features of pre-spawning migration of the pink salmon of this generation in the Bering Sea and North-West Pacific.

Material and methods

Comprehensive surveys were conducted by R/V "TINRO" in upper epipelagic layer of western Bering Sea and adjacent water of Commander Islands from June the 13th to July the 19th 2009 and by R/V "Professor Kaganovskiy" in upper epipelagic layer of the northwestern Pacific Ocean from June the 2th to July the 2th 2009. There were made 111 trawl tows on an area of 782 th. square km in the western Bering Sea and adjacent water, and 86 trawl tows on an area of 1043 th. square km in the northwestern Pacific. The plans of biostatistical regions in the northwestern Pacific Ocean and western Bering Sea are shown on figure 1. The plan of trawling stations made in these areas is shown on figure 2.

Standard methods used in this study for gathering and analysis of survey data have been described in detail in Doc. NPAFC № 1188 (2009) and published earlier (Volkov, Chuchukalo,1986; Volkov, 1996).

Results and Discussion

The record abundance of pink salmon were observed in the western Bering Sea and northwestern Pacific Ocean in 2009. The total abundance and biomass of pink salmon according to the surveys results amounted to 608.4 million inds. (or 720.4 th. t) in the Pacific waters off Kuril Islands (Radchenko et al., 2009) and 434.8 million inds. (or 463.9 th. t) in the western Bering Sea and adjacent Pacific water (Glebov et. al., 2009). As in previous years, the salmon dominated the fish biomass in Pacific waters off Kuril Islands (Table 1). The share of pink salmon was 47.5% of the total fish biomass in this area. In the Bering Sea, biomass of pink salmon exceeded the biomass of chum salmon for the first time in years of summer observations (Table 2). The share of pink salmon was 47.0% of the total fish biomass.

Distribution and biological characteristics of adult pink salmon in the upper epipelagic layer in the Bering Sea and adjacent water in summer 2009

Pink salmon were widely distributed in the western Bering Sea, but its distribution was uneven (fig. 3). The highest catches were registered near the Cape Olyutorsky and Koryak continental slope (165-2003 inds./hour). Apparently, it indicated that the pink salmon has started to enter in inner continental shelf. In whole, in the Commander Basin, western part of Aleutian Basin and adjacent area of continental shelf the catches of pink salmon were twice and three times higher compared to estimations of the same previous surveys.

Average size of the mature pink salmon in the pacific waters of Commander Islands varied widely due to mixing its regional stocks in this area (fig. 4). The major concentrations were formed by pink salmon stocks of the East Kamchatka, but along the southern border of the surveyed area was probably a high ratio of mature pink salmon of the Okhotsk Sea basin. Pink salmon in this area were characterized by the large size (average FL – 45.5-47.2 cm, average BW – 1.27-1.46 kg) and low gonad maturity (average GSI: female - 4.9-5.2%, male – 3.0 - 3.9%), and males predominated in this catches (frequency of occurrence 55-92%). The small-sized pink salmon (average FL – 41.5-42.8 cm, average BW – 0.90-0.96 kg) migrated northeast along the Commander Islands. These fishes were more mature (average GSI: female - 6.1-7.4%, male - 2.8-4.2%), and at the same time in this catches females was dominated (share of catches: 25-67%) (Glebov et. al., 2009).

In whole, size of pink salmon in all areas of the Bering Sea was uniform, regardless of timing and density of fish accumulation (fig. 4). The medium-sized fish (mode - 42-46 cm,

65.0%, average FL – 43.8 cm, average BW – 0.82-1.12 kg) migrated throughout south-western part of the Bering Sea (Commander and the southern part of the Aleutian Basin). The larger-sized adult pink salmon (mode - 44-48 cm, 66.8%, average FL – 45.4 cm, average BW – 1.13-1.22 kg) was dominant in the central and north parts of the Aleutian Basin and adjacent areas of the Koryak and Navarin shelf (fig. 4)

Type of the spatial variation of the sex ratio in the catches and the gonad maturity of pink salmon was no different from previous years and corresponded to the course of pre-spawning migrations. The share of females in catches gradually increased from inshore waters (7-31%) to the borders of Russian EEZ (62-83%). The average gonad maturity ranged from the southwest (average GSI – 6.7-7.4%) to the north-east direction (average GSI – 11.2-12.2%) (fig. 5), in connection with the earlier timing of spawning of the pink salmon in the rivers of the Koryak shore and the Anadyr Gulf.

Distribution and biological characteristics of adult pink salmon in the upper epipelagic layer of the northwestern Pacific Ocean in summer 2009

In the Pacific Ocean, pre-spawning pink salmon migrated to a broad front to the Kuril Islands coastal waters. During the survey period pink salmon occurred in all research area (frequency of occurrence 97.7%) (fig. 6). Catches varied from 1 to 265 inds./hour. Surface water temperature in most parts of the surveyed area ranged from 5 to 10°C (Radchenko et al., 2009). The more dense congestion of this species has been recorded in this temperature range. In general, three largest dense concentrations of pink salmon was observed in the surveyed area, which arranged in offshore waters of the southern, middle and northern Kuril Islands (1019-2045 inds./km^2). In inshore ocean waters of Kurils, where the surface temperature was 3-4°C, catches of pink salmon were significantly lower compared to the other surveyed area (1-24 inds./hour) (Radchenko et al., 2009).

Spawning time, length of migration ways, the location and direction of the main migration ways enable us to single out the adult pink salmon of different regions of the Okhotsk Sea by distribution patterns and biological parameters during pre-spawning migrations. It is used for rapid assessment of salmon runs to different regions. Pink salmon of the north Okhotsk Sea and the West Kamchatka coast has the longest migration ways and the earliest time of spawning. Fish in these two regions constitute the main part of pink salmon of early (summer) race, which takes place spawning run mainly in July. These fish are distinguished by larger size and greater degree of gonad maturity in mixed aggregations and are located in the northeastern part of the migration way. In addition, pink salmon of summer race are found on the eastern Sakhalin Island, especially in its northern part, where they are not numerous. Pink salmon of late (autumn) race is

absolutely dominant on the eastern Sakhalin, southern Kurils and Hokkaido. Spawning fish in these regions is carried out mainly in August and early September. Pink salmon are less mature and has a smaller size. These fish migrates into the Okhotsk Sea through the middle and southern Kuril straits.

In 2009, spatial distribution of average length and weight of salmon was not uniform (fig. 7). Large-size fish occurred in both north and south parts of studied area. As noted above, three largest concentrations of pink salmon was registered in offshore waters of the southern, middle and northern Kuril Islands. These features of distribution of size and abundance indicates that the dense concentrations of summer and autumn pink salmon races of different regional groups were mixed.

More distinct separation of pink salmon into two groups may be made using analysis of the spatial distribution of the average gonadosomatic indexes of fishes. Most mature fish (GSI of females > 5%, males > 2.5 %) were in the north-eastern part of the researched area (fig. 8). Presumably, the principal part of pink salmon in this region was represented by western Kamchatka groups and individuals from the mainland coast of the Okhotsk Sea. This group was approximately 11% of the total abundance of pink salmon registered in the period of this trawl survey. In the central part of the trawl survey and its western and southern borders, pink salmon were less mature. Perhaps, populations of summer and autumn races of pink salmon Khabarovsk Territory, eastern Sakhalin, southern Kuril Islands and Hokkaido were mixed in these areas.

Growth and survival of pink salmon in summer 2009

The climatic and hydrological conditions were favorable in Far Eastern Seas in 2000s. This promoted maintenance not only high abundance of pink salmon, but its high body length and weight. It was noted (Temnykh et al. 2010) that body size of pink salmon didn't decrease for most Russian stocks during period of their high abundance. Pink salmon maintained the rapid rate of growth in autumn, winter-spring and summer periods.

In summer 2009, in the Kuril Pacific waters the average size of super high abundant pink salmon was not appreciably different compared to previous years (table 3).

A decrease of pink salmon size, perhaps due to density-dependent factors, was observed only for the Bering Sea stocks in 2009 (table 3). In 2008, the juvenile pink salmon abundance was twice as high as the maximal estimations of abundance for all previous years of investigations. In spite of high plankton biomass in autumn in this area, juvenile pink salmon were on 1.0-1.5 cm less than last years. The density-dependent factors affected to size of adult pink salmon of this generation . At the average, the small adult pink salmon run the eastern Kamchatka coast in 2009 (Temnykh et al. 2010).

Comparison of pink salmon abundance at each stage of sea life (downstream migrations, anadromous and catadromous migrations, runs to the spawning areas) showed the decreasing of pink salmon mortality in 2000s (Radchenko 2007). In 2008-2009, despite of very high Asian pink salmon abundance, mortality in the ocean was somewhat below the average. It was about 63% for Bering Sea stocks and about 55-60% for Okhotsk Sea stocks (Shuntov and Temnykh 2009). It is obvious, that the density factor did not affect to pink salmon survival during last years. The final estimates of mortality (calculated by estimates of returns (catch + escapement)) were higher compared to estimates of mortality in the ocean. During passing through Kuril and Commander Islands coastal waters and Okhotsk and Bering Seas (July – September) salmon is preyed by many predators: mesopelagic predator fish, seals, killer whales, halibut, sharks and other.

References

Glebov I.I., Khoruzhiy A.A., Matveev V.I. 2009. Pacific salmon in nekton communities of the upper epipelagic layer of the western Bering Sea in June-July 2009. Bulletin №4 of realizations of «Concept of the Far Eastern basin research program of Pacific salmon study». Vladivostok. TINRO-CENTER Publ. 4: 54-64. (In Russian)

Radchenko V.I. 2007. Dynamic of pink salmon abundance in Okhotsk Sea region in first half of 2000th. Bulletin №2 of realizations of «Concept of the Far Eastern basin research program of Pacific salmon study». Vladivostok. TINRO-CENTER Publ. 2: 27-35. (In Russian).

Radchenko V.I., Loboda S.V., Ovsyannikov E.E., Kovtun M.V., Ovsyannikova S.L., Savin V.A. 2009. Approachs to the operative identification of pink salmon Oncjrhynchus gorbuscha by morpho-physiological features in mixed sea catchs. Bulletin №4 of realizations of «Concept of the Far Eastern basin research program of Pacific salmon study». Vladivostok. TINRO-CENTER Publ. 4: 39-53. (In Russian).

Shuntov V.P. and Temnykh O.S. 2009. Record salmon fishing – 2009. Bulletin №4 of realizations of «Concept of the Far Eastern basin research program of Pacific salmon study». Vladivostok. TINRO-CENTER Publ. 4: 3-11. (In Russian).

Starovoytov, A.N., S.V. Naydenko, E.V. Kurenkova, M.A. Ocheretyany and N.S. Vanin. 2009. Composition and structure of epipelagic nekton communities in the Central and Western parts of Subarctic frontal zone in Winter and Spring of 2009. N. Pac. Anadr. Fish Comm. Doc. 1188: 29 pp.

Temnykh O.S., Zavolokin A.V. and Koval M.V. 2010. Russian Research under the NPAFC Science Plan 2006-2010: A Review and Future Issues. Pacific Research Fisheries Center (TINRO-center), Vladivostok, Russia. NPAFC Doc. 1238. 23 pp.

Volkov, A.F. 1996.Method of zooplankton sampling. Izv. TINRO 119: 306–311. (In Russian with English abstract).

Volkov, A.F., and V.I. Chuchukalo. 1986. Manual for the study of fish food habits. TINRO, Vladivostok: 31 pp.

Table 1

Biomass (th. t) and ratio (%) of nekton within Russian EEZ in the northwestern part of the Pacific Ocean during summer in 2009

Families, species	**2004**		**2006**		**2007**		**2008**		**2009**	
	Th. t	**%**	**Th. t**	**%**	**Th. t**	**%**	**Th. t**	**%**	**Th. t**	**%**
O. gorbuscha	390.56	13.8	342.73	16.9	490.7	23.5	310.83	21.1	720.43	39,66
O. keta	142.08	5	95.43	4.7	103.91	5	97.52	6.6	143.46	7,8976
O. kisutch	8.17	0.3	3.79	0.2	4.77	0.2	2.76	0.2	2.92	0,1607
O. nerka	21.37	0.7	5.32	0.3	1.72	0.1	2.81	0.2	24.42	1,3443
O. tschawytscha	7.37	0.3	1.05	+	1.76	0.1	0.46	+	0.99	0,0545
All pacific salmon	**36.9**	**0,2**	**10.2**	**0,2**	**8.3**	**0,2**	**6**	**0,1**	**892.2**	49,116
All mesopelagic species	**919.73**	**32.5**	**1048.79**	**51.6**	**1062.59**	**51**	**635.25**	**43.1**	**963.1**	53,02
Brama japonica	23.79	0.8	62.26	3.1	20.14	1	27.22	1.9	77.44	4,2631
Engraulis japonicus	313.99	11.1	-	-	5.18	0.2	6.15	0.4	0.17	+
Cololabis saira	262.47	9.3	19.32	**0.9**	0.01	+	1.17	0.1	205.2	11,296
Other fish species	35.01	1.2	110.19	5.4	68.11	3.3	141.1	9.6	17.41	0,9584
All fish species	**2124.9**	**75**	**1689.5**	**83.1**	**1758.89**	**84.4**	**1225.27**	**83.2**	**1515.4**	83,426
Cephalopoda	707.02	25	344.35	16.9	325.23	15.6	248.37	16.8	301.09	16,575
Total	**2831.92**	**100**	**2033.9**	**100**	**2084.12**	**100**	**1473.64**	**100**	**1816.5**	**100**

Table 2

Biomass (th. t) and ratio (%) of nekton in the upper epipelagic layer of the Western Bering Sea and during summer 2009

Families, species	2003		2005		2007		2009	
	Th. t	%	Th. t	%	Th. t	%	Th. t	%
O. gorbuscha	18,74	1,5	94,85	11,6	113,17	12,9	404,91	35,6
O. keta	684,47	53,3	293,95	36,1	234,65	26,8	255,69	22,5
O. nerka	84,25	6,6	37,2	4,6	14,58	1,7	18,22	1,6
O. tschawytscha	51,27	4	37,67	4,6	7,26	0,8	4,19	0,4
O. kisutch	3,5	0,3	0,11	+	0,31	+	-	-
Salvelinus malma	1	0,1	9	1,1	3,72	0,4	3,76	0,3
All pacific salmon	**843,23**	**65,8**	**472,8**	**58**	**373,69**	**42,6**	**686,77**	**60,4**
Clupea pallasii	10,22	0,8	3,34	0,4	0,62	0,1	13,9	1,2
Th. chalcogramma	30,04	2,3	31,07	3,8	0,55	0,1	-	-
Pl. monopterygius	119,65	9,3	3,62	0,4	1,78	0,2	0,94	0,1
All Mesopelagic species	**36,18**	**2,8**	**9,45**	**1,2**	**169,27**	**19,4**	**46,55**	**4,1**
Other fish species	46,65	3,6	21,57	**2,7**	2,16	0,3	4,93	0,4
All fish species	**1086**	**84,6**	**541,8**	66,5	**548,07**	**62,7**	**753,09**	66,2
Cephalopoda	198,34	15,4	272,86	33,5	326,39	37,3	384,06	33,8
Total	**1284,3**	**100**	**814,7**	**100**	**874,46**	**100**	**1137,2**	**100**

Table 3

Average weight of pink salmon in the northwestern Pacific Ocean, western Bering Sea and adjacent waters in June – early July 2009

Region	Year	Abundance, mln. inds.	Average weight, kg
Bering sea	2005	81.4	1.318
	2007	17.3	1.439
	2009	**379.5**	**1.07**
adjacent Pacific waters of Commander Islands	2005	5.51	1.19
	2007	3.3	1.281
	2009	**55.5**	**1.06**
northwestern Pacific Ocean	2004	295	1,3
	2006	327	1,16
	2007	452	1,09
	2008	264	1,19
	2009	**608**	**1,18**

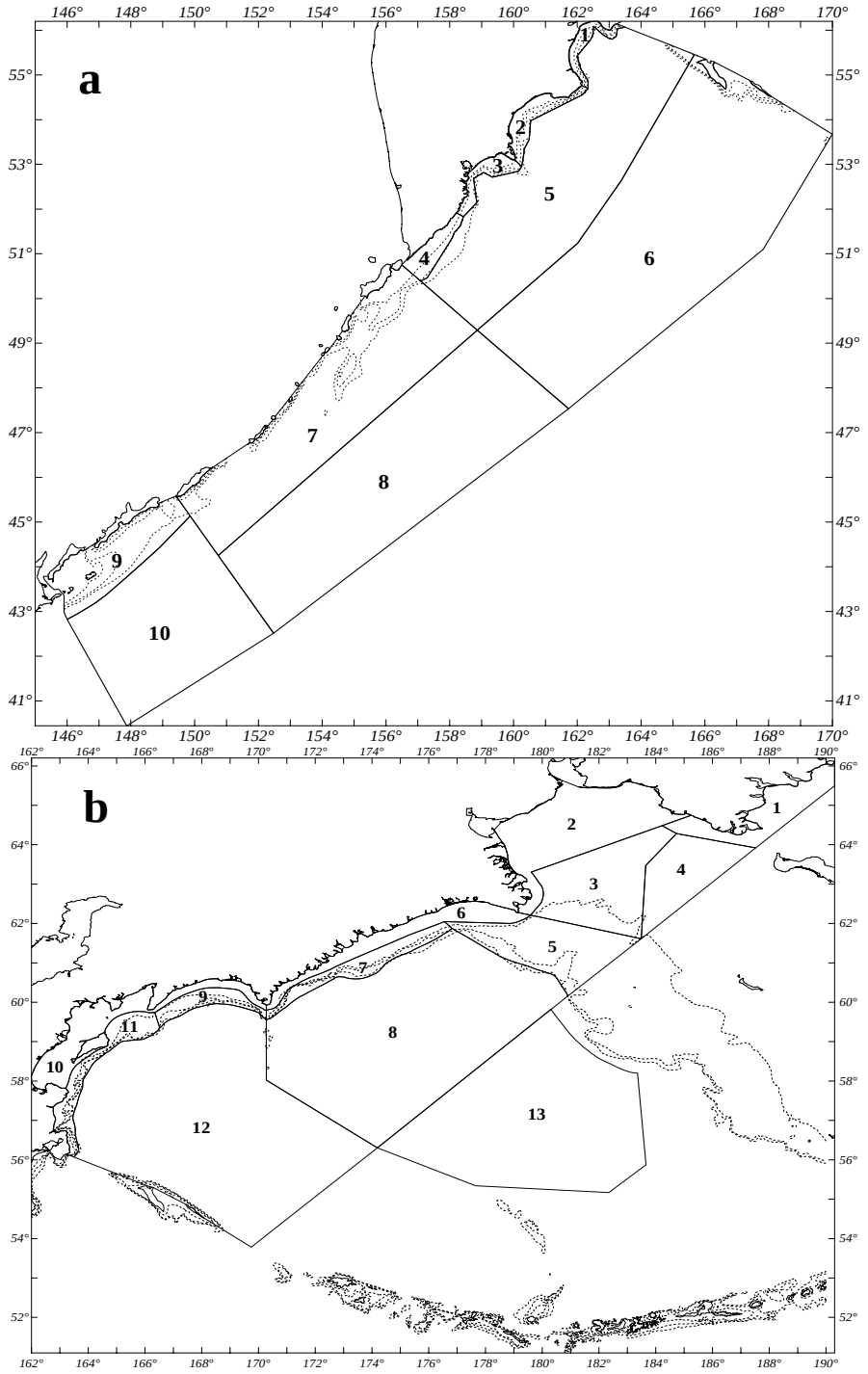

Fig. 1. **a -** The plan of biostatistical regions in the northwestern Pacific Ocean: 1 – Kamchatka Gulf, 2 – Kronotsky Bay, 3 – Avacha Gulf, 4 – southeastern Kamchatka, 5 – Kamchatka depression, 6 – offshore waters of Kamchatka and Commander Islands, 7 – inshore waters of central and northern Kurils, 8 – offshore waters of central and northern Kurils, 9 – inshore waters of southern Kurils, 10 – offshore waters of southern Kurils

b - The plans of biostatistical regions in the Bering Sea Russian EEZ and neutral waters: 1-Bering strait, 2 – north-west part of Anadyr Gulf, 3 – south-east part of Anadyr Gulf, 4 – eastern part of Anadyr Gulf, 5 – Navarin, 6 – Koryak shelf, 7 – Koryak slope, 8 – western part of Aleutian Basin, 9 – Olyutorsky slope, 10 – shelf of Olyutorsky and Karaginsky Bays, 11 – Karaginsky slope, 12 – Komandor Basin, 13 – central part of Aleutian Basin.

Bold line shows the regions borders, dotted line – isobaths 100, 200, 500 m, numbers show the regions

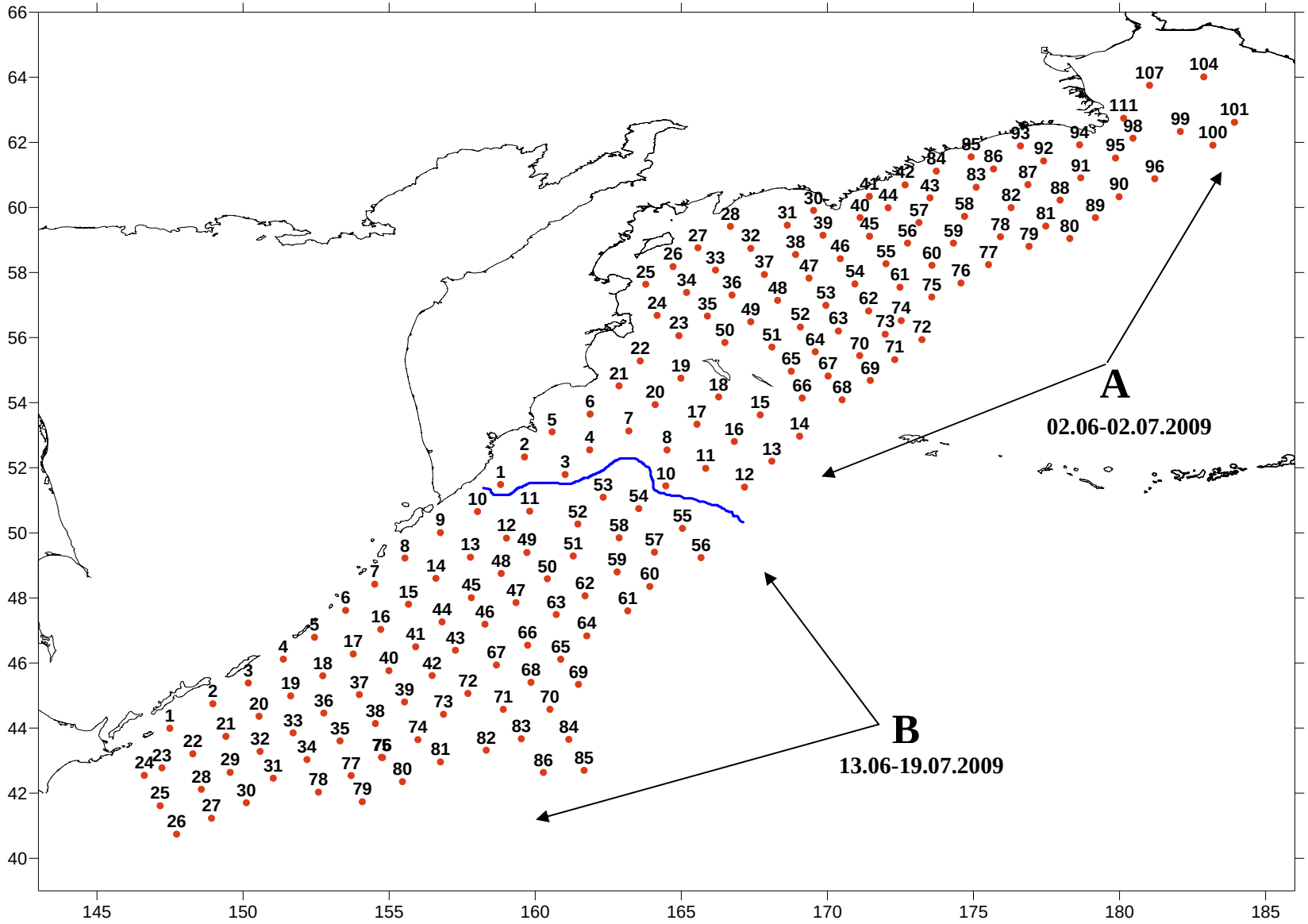

Fig. 2. The scheme of trawl surveys by R/V “TINRO” (A) and R/V “Professor Kaganovskiy” (B) in June-July 2009

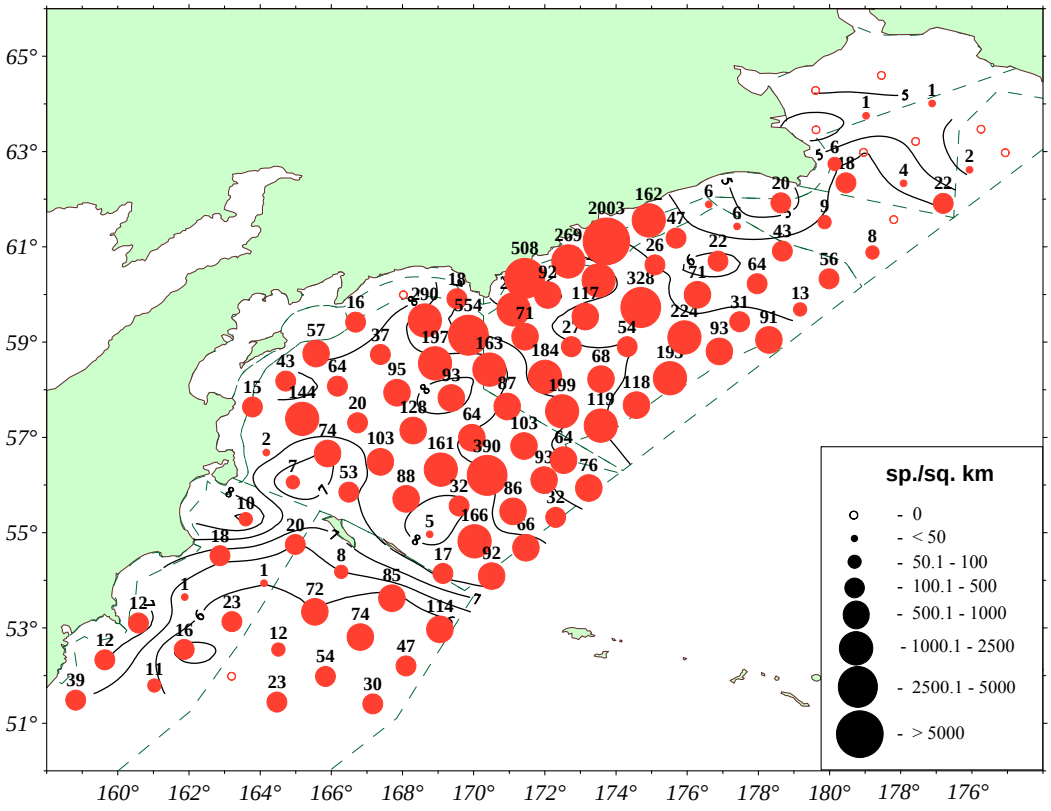

Fig. 3. Spatial distribution of mature pink salmon (inds./sq. km) in the upper epipelagic layer of the Bering Sea and adjacent water of Commander Islands in summer 2009. Numbers – catches, inds./hour

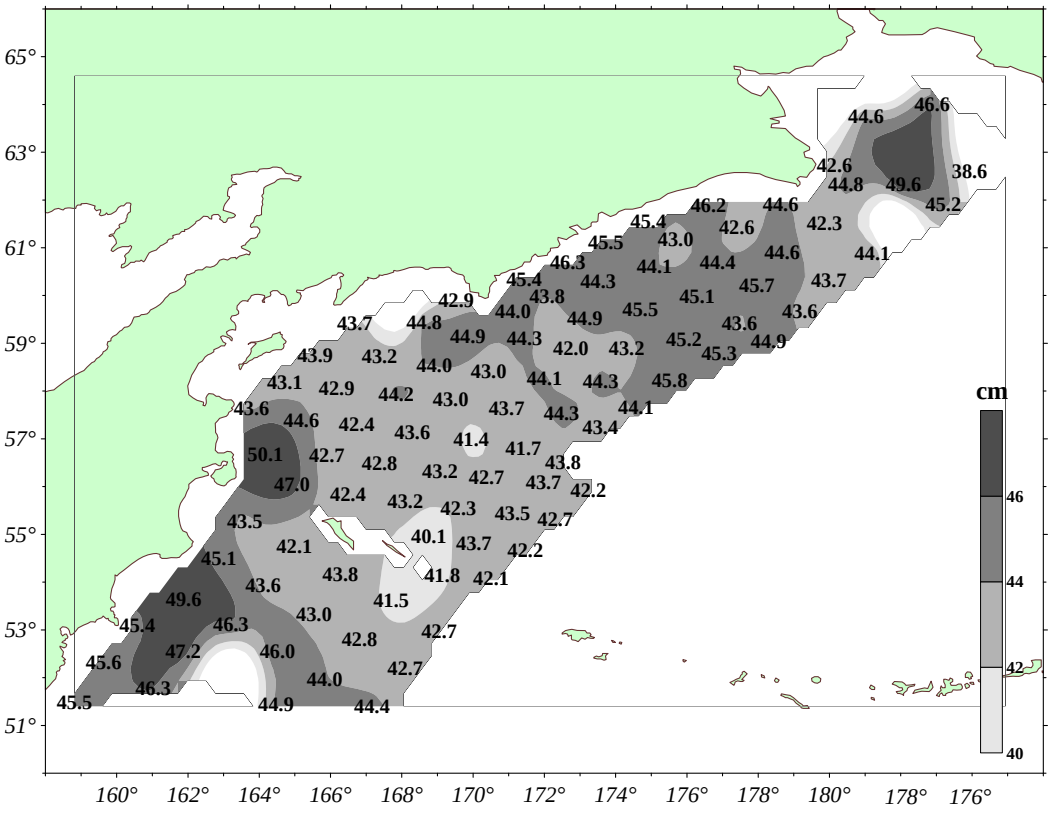

Fig. 4. Spatial distribution of average fork length (FL) of mature pink salmon in the upper epipelagic layer of the Bering Sea and adjacent water of Commander Islands in summer 2009. Numbers – average FL, cm

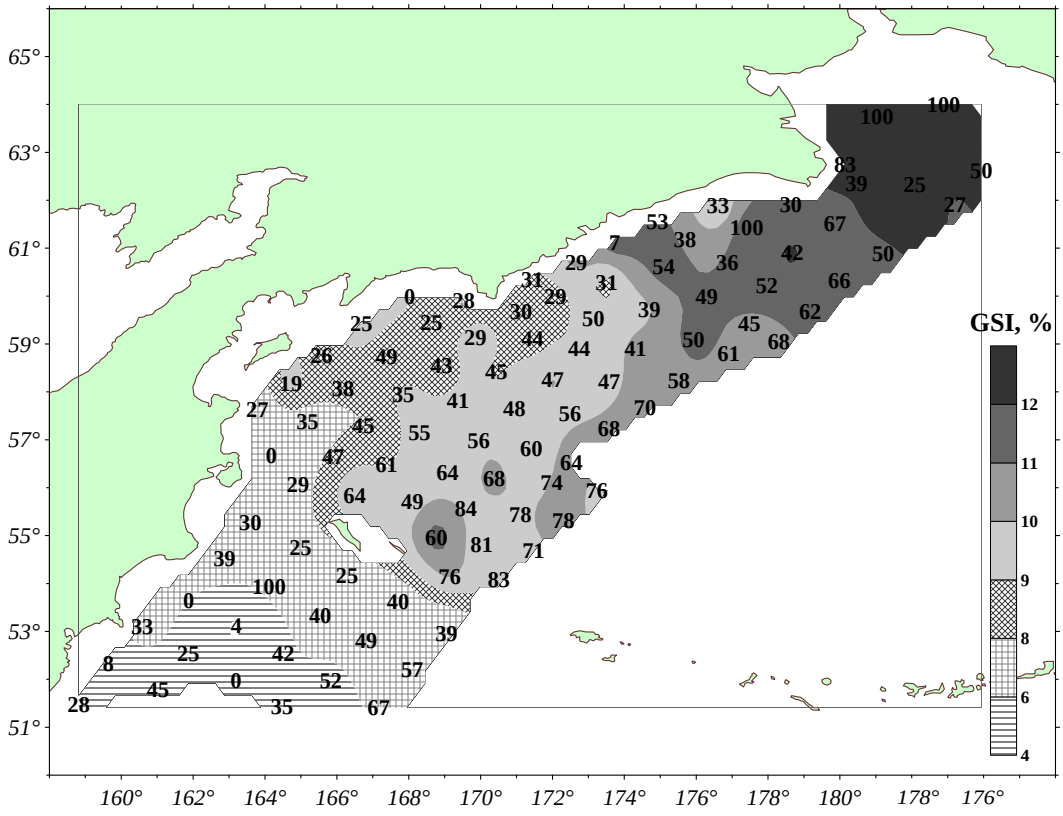

Fig. 5. Spatial distribution of pink salmon females maturity (GSI, %) in the upper epipelagic layer of the Bering Sea and adjacent water of Commander Islands in summer 2009. Numbers – share of female in the caches, %

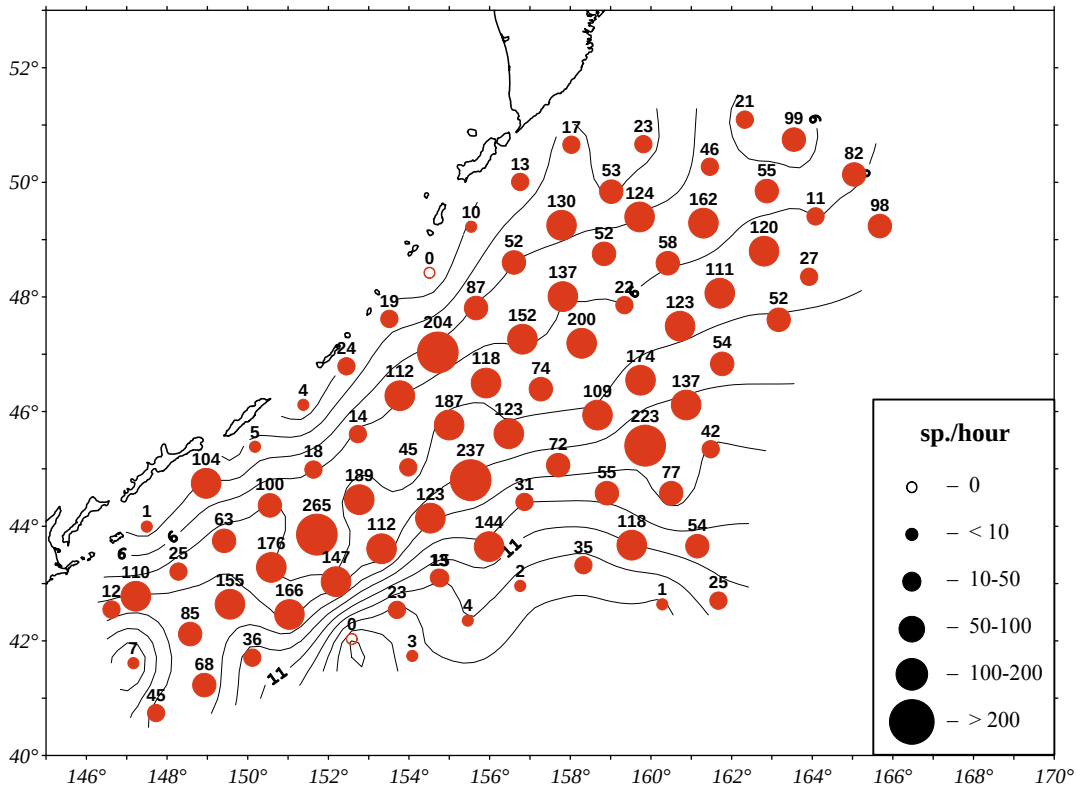

Fig. 6. Spatial distribution of mature pink salmon in the upper epipelagic layer of the northwestern Pacific Ocean in summer 2009. Numbers – catches, inds./hour

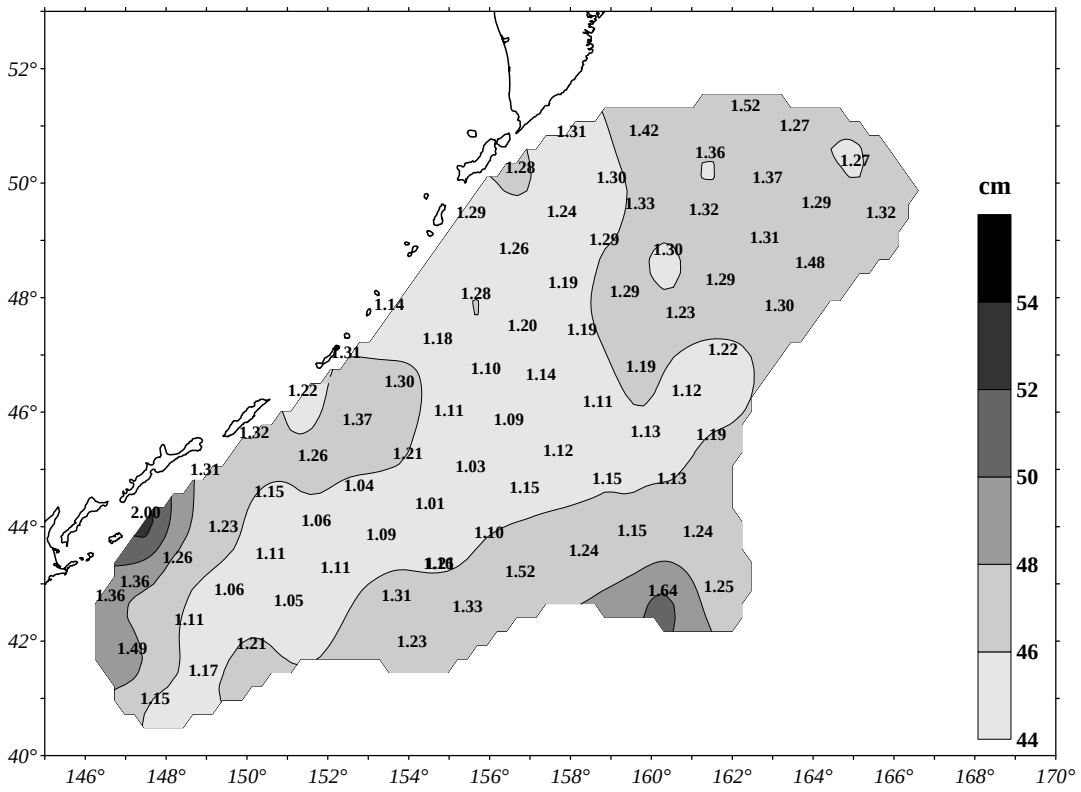

Fig. 7. Spatial distribution of average fork length mature pink salmon in the upper epipelagic layer of the northwestern Pacific Ocean in summer 2009. Numbers – average body weight, kg

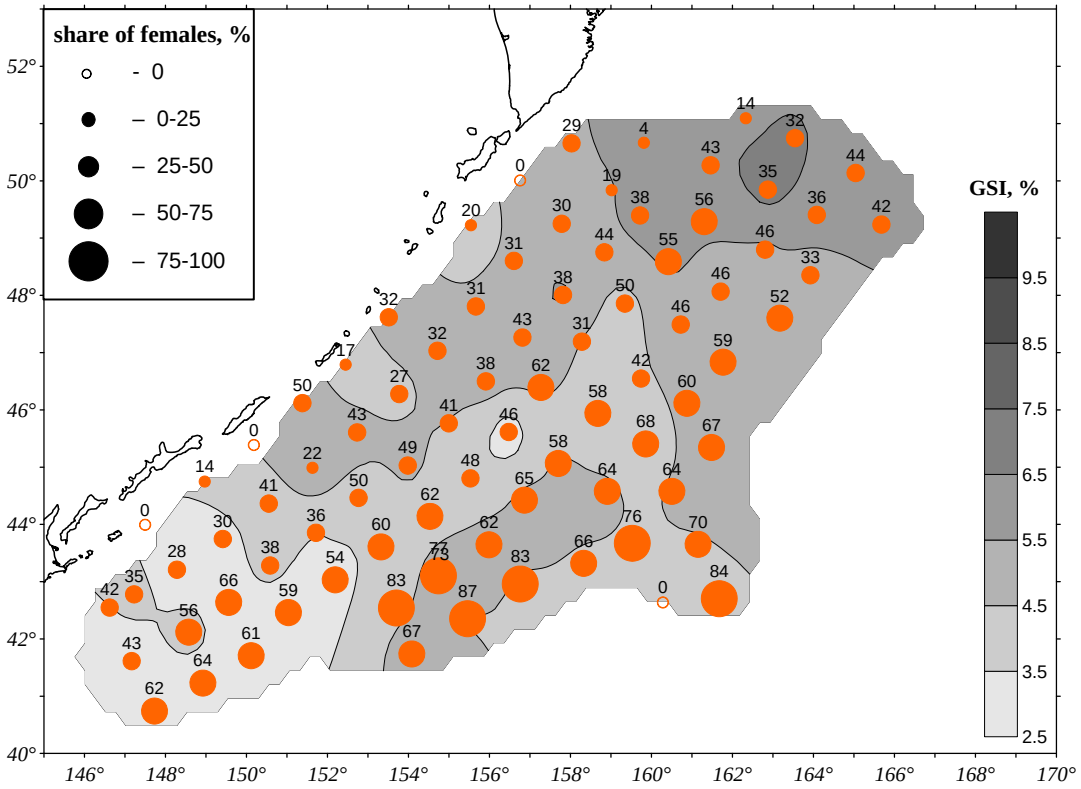

Fig. 8. Spatial distribution of pink salmon females maturity (GSI, %) in the upper epipelagic layer of the northwestern Pacific Ocean in summer 2009. Numbers – share of female in the catches, %