

NPAFC

Doc. 123

Rev. _____

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by

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submitted to the

North Pacific Anadromous Fish Commission

by

Russia

April 1995

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:

Lapko, V.V. and A.V. Startsev. 1995. New Data About Immature Masu Sealife in Okhotsk Sea. (NPAFC Doc. 123). 23 p. Laboratory of Applied Biocenology, Laboratory of Commercial Resources Prediction, Pacific Research Institute of Fisheries and Oceanography, Vladivostok, 690600, Russia

NEW DATA ABOUT IMMATURE MASU SEALIFE IN OKHOTSK SEA

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ABSTRACT Basing on results of annual epipelagic trawl surveys in Okhotsk Sea, new data about distribution dynamics, time and rate of young masu migration are presented. Masu come into high-sea areas of southern Okhotsk Sea in late July, numerously - in August. In this time considerable share of masu comes from southern parts of area. Young masu from rivers of eastern Sakhalin and western Kamchatka leave coastal waters in late September, mixing in high-sea areas with strange fish of Japan and Primore origin. In the late October masu begin to migrate to Pacific and Japanese Sea and finishes in December. Some fish can stay in southern Okhotsk Sea, uncovered by ice before January. Estimated masu abundance constituted about 1 mln. sp.

NEW DATA ABOUT IMMATURE MASU SEA LIFE IN OKHOTSK SEA

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The authors of the last reviews about masu salmon (*Oncorhynchus masou* Brevoort) affirm that the information about its sea life in Okhotsk Sea is very scanty (Machidori, Kato, 1984; Kato, 1991). Meanwhile, according to these scientists, young masu not only of Okhotsk Sea origin (streams of Sakhalin, Western Kamchatka, Southern Kuril Isles) occur there in summer - fall, but also the fish from the rivers of Japan Sea and pacific coast of Japan. In this season masu occur in adjacent pacific waters scarcely, i. e. Okhotsk Sea and partly Tatar Strait are the only area known to be occupied by young masu in late summer-fall (Kato, 1991). However Japanese researchers based on the data, collected mainly with help of driftnet hauls before 70-s, i. e. before the establishing of economic zones.

Since the mid 80-s the TINRO's laboratory of Applied Biocology began to carry out annual trawl surveys in pelagial of Okhotsk Sea. These investigations allowed to estimate pacific salmon number as well as other nekton hydrobionts. Obtained data and general conclusions concerning pacific salmon biology were published in some papers (Shuntov, 1989; Shuntov et al., 1993; Shuntov et al., 1994; 1994a). In current report the information about distribution and some features of immature masu biology during summer-fall period in Okhotsk Sea are presented.

MATERIALS AND METHODS

The primary data were collected in cruises of r/v "Professor Levanidov" and "Professor Kaganovskiy", those trawled in Okhotsk Sea and adjacent pacific waters 13.07 - 14.08.1991 (171 hauls), "Darvin" (21.10 - 28.12.1991; 155 hauls) and "TINRO", "Professor Kizivetter", "Professor Soldatov" (13.07 - 17.08.1993; 280 hauls). In addition, the data collected by Japanese r/v "Kavo-maru" (15.10-26.11.1993; 63 hauls), where one of the authors of current report worked, were joined. This vessel has conducted the trawl survey consisted of 31 hauls twice.

All Russian r/v caught salmon by the trawls of the same type and by means of the same method, repeatedly described before (Shuntov et al., 1993; Shuntov et al., 1994). The trawl of Japanese vessel had a similar dimensions: horizontal - 60 m (Russian - 70), vertical - 50 m (50 m), with 8-mm (10 mm) meshsize net in last 15 metres of trawl cone. During 1 hour haul with velocity 5.5 knots (5.0) the square of sampling was about 0.62 km² (0.65). So, the results obtained by Russian and Japanese r/v are considered as comparable.

The square method with catch coefficient 0.3 as standard (Shuntov et al., 1994) was used for stock estimation.

RESULTS

19 specimen of young masu were caught in summer 1991, 31 sp. - in the same season of 1993. In fall 1991 60 immature masu were caught and 49 - in fall of 1993. Catch distributions are

presented in figures 1-2. the length (FL), weight and sex ratio - in table 1.

Table 1
Length (FL), weight and sex ratio of immature masu

Season	Length.cm	Weight.g	Female share	n
Summer 1991	12.0 - 39.0	20 - 750	0.75	19
	26.13	230		
Fall 1991	25.0 - 45.0	130 - 1310	0.59	60
	32.2	448		
Summer 1993	14.7 - 32.8	26 - 345	0.80	31
	22.65	142		
Fall 1993	22.0 - 45.0	139 - 1340	no data	49
	32.7	494		

The quantity of young masu was estimated as 0.33 mln.sp. in summer 1991 and 0.74 mln.sp. in fall of the same year. In summer and fall 1993 these values were 0.48 and 0.22 mln.sp. respectively.

DISCUSSION

According to our data, immature masu are widely distributed both in nearshore and in outer waters of southern basin of Okhotsk Sea (fig.1). But catches were more frequent near coast of Sakhalin and southern Kuril Isles, as reported before (Shuntov, 1989). However, immature masu didn't make any considerable aggregations and were caught mainly single, maximum - 4 sp. per trawl. As we suppose, relative graduating of fish to nearshore waters is conditioned by masu migration into Okhotsk Sea from Japan Sea through Soya and Tatar Straits and from Pacific through southern Kuril straits along the coast where masu mix with the local young fish.

As known, masu seaward migration in the streams of Okhotsk Sea is the latest throughout the area (Machidori, Kato, 1984; Kato, 1991). Smolts migrate to sea from the rivers of Eastern Sakhalin in July - early August (Churikov, 1975; Gritsenko, 1973); from the rivers of Western Kamchatka - in July (Semko, 1956). As noted by Shuntov (1989), immature masu occur in offshore waters from July. In 1991 we have caught the first fish in July, 30, in 1993 - in August, 8. Through July, 11 - August, 8, 1992 r/v "Novouivanovsk" carried out the trawl survey (84 hauls at square 431 th. km²) from Sakhalin toward Kuril Isles along the longitude transects and didn't catch any masu. Near Western Kamchatka in July, 13-21, 1991 "Pr. Levanidov" and "Pr. Kaganovskv" worked from 51° N to 57°30' N (40 hauls) and also didn't discover masu salmon. Since July, 17 till August, 12.

1993 "Pr. Kaeranovskiy" worked in the same area (50°N - 55°N; 95 hauls) and obtained the same results. Finally, "Pr. Levanidov" since July, 9 till August, 10, 1994 conducted two surveys (49°N - 60°N; total - 95 hauls) and only in August, 4-6 have caught 3 specimen of young masu (18.8 - 30.8 cm, average weight 108 g) between 58° - 55°N and 153° - 156°E. So, the periods of masu abundance in the offshore waters of southern Okhotsk Sea and western Kamchatka are close. However, there are more numerous and heterogeneous young masu near Sakhalin, that is evidently conditioned by mixing of local and strange fish.

Average length of smolts from the Sakhalin rivers is 7.1 - 13.7 cm (range 6.7 - 16.0 cm), average weight is 13.4 - 30.1 g, sex ratio is close to equal (0.55 : 0.45) (Volovik, 1963; Kravchikina, 1963; Semko, 1956). Average length of smolts from western Kamchatka is 11.4 cm (Semko, 1956). Though smolts length is similar throughout the area, while the sex ratio of fish from Japan is shifted to predominance of females (average 70-80%, reach 90%). This is conditioned by the comparatively more share of males, remaining in the streams during the whole life or part of one in populations of southern area such as Korea, Japan, Primore (Semenchenko, 1983; 1989; Machidori, Kato, 1984). Masu smolts migrate seaward on 1-3 months earlier in southern areas in comparison with Okhotsk Sea. So, numerous strange fish came to Okhotsk Sea appreciably exceed in length and weight the local young masu, that cause the wide range of these values and females predominance in catches (tab.1).

In fall the situation changes in something. Our data about

distribution of immature masu in October-November (fig. 2; 3; tab.1) cover the period of the beginning of southward migration because the first catches of masu were in inshore waters of northern Hokkaido and Nemuro Strait in the late October, and in both sides of Hokkaido - in November (Machidori, Kato, 1984). Because of immature masu migrate to Pacific through southern Kuril Straits only, they gradually concentrate in the waters of southern Okhotsk Sea. The catches per haul increase noticeably in comparison with summer constituting 3-5 sp. in average and reaching 8 - 12 sp. Masu gravitate mainly toward western Okhotsk Sea and almost don't occur in the waters of northern and middle Kuril (fig.2). Till late November the most part of fish stock leaves Okhotsk waters, but in its extreme south masu can remain till December, when water temperature is about 3 - 5°C (Kato, 1991). This is confirmed by our data. For example, in November, 28, 1991 masu occurred in Okhotsk Sea at 52°N ($t = 3.6^{\circ}\text{C}$). In November, 25 near north-eastern Sakhalin one specimen was caught while waters temperature was 0.8°C. Besides, 3 sp. (31.0 - 39.5 cm; $t = 3.2^{\circ}\text{C}$) were caught in January, 19, 1991 in southern Okhotsk Sea. So, some fishes can be considerably delayed in the sea areas, uncovered by ice. Also immature masu occur periodically in pacific waters in vicinity of southern Kuril in December (Shuntov, 1989; our data); and near south-western Sakhalin in January (Semenchenko, 1989).

Both the length range and average length of masu, caught in October-November 1991 and 1993 are almost the same, and the minimum of range in fall corresponds to average length in summer.

We suppose, that this is related with increasing of Sakhalin masu share in catches in fall, because seaward migration from Sakhalin rivers proceeds to mid August (Krykhtin, 1962) and fish obviously goes into outer waters in September. Besides, sex ratio in catches equalizes in fall, that is typical for the smolts from Sakhalin rivers.

The stock assessment of young masu in Okhotsk Sea was made successfully in October-November 1991, because the survey was carried out at the optimum square in the optimum time. Investigated area was less significantly in fall 1993, but the dynamics of migration is exhibited evidently. During 35 days the number of fish decreased from 0.319 mln. sp. to 0.137 mln. sp. in the same square (fig.3). In general, taking into consideration that in fall 1991 the part of masu stock left area of survey and the assessment of masu number was 0.74 mln. sp. in that time, we suppose the total quantity was about 1 mln. sp.

Concluding, the period of sea life of young masu in Okhotsk Sea looks as follows. The first single fishes migrate to outer waters of southern Okhotsk Sea in late July, numerously - in early August. These masu are mainly from the streams of Japan and possible - Primore. In this time young masu from the rivers of Eastern Sakhalin and Western Kamchatka begin to leave inshore waters only and complete to September - early October. Fish widely distributes, reaching the northern Okhotsk Sea (Shuntov, 1989). Young masu from the whole area mix in Okhotsk Sea, but fish from Japanese and Primore rivers predominate. In late October immature masu begin to leave Okhotsk Sea, and, as we

suppose, the fish of non-Okhotsk origin are the first. To late November - early December the main stock of immature masu left Okhotsk Sea, but some fish can stay in southern waters uncovered by ice till January due to warm Soya Current. So, young masu habit in Okhotsk Sea in July - January in general, usually - in August - December. Estimated quantity is about 1 mln. specimen.

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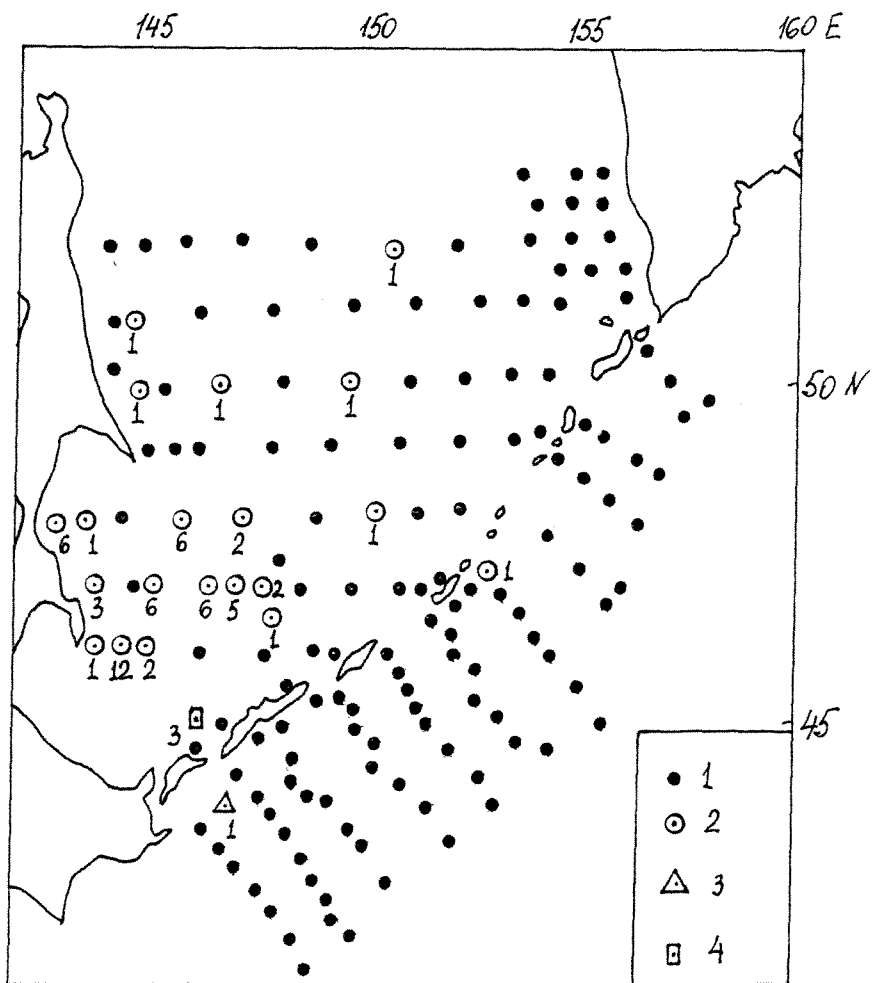
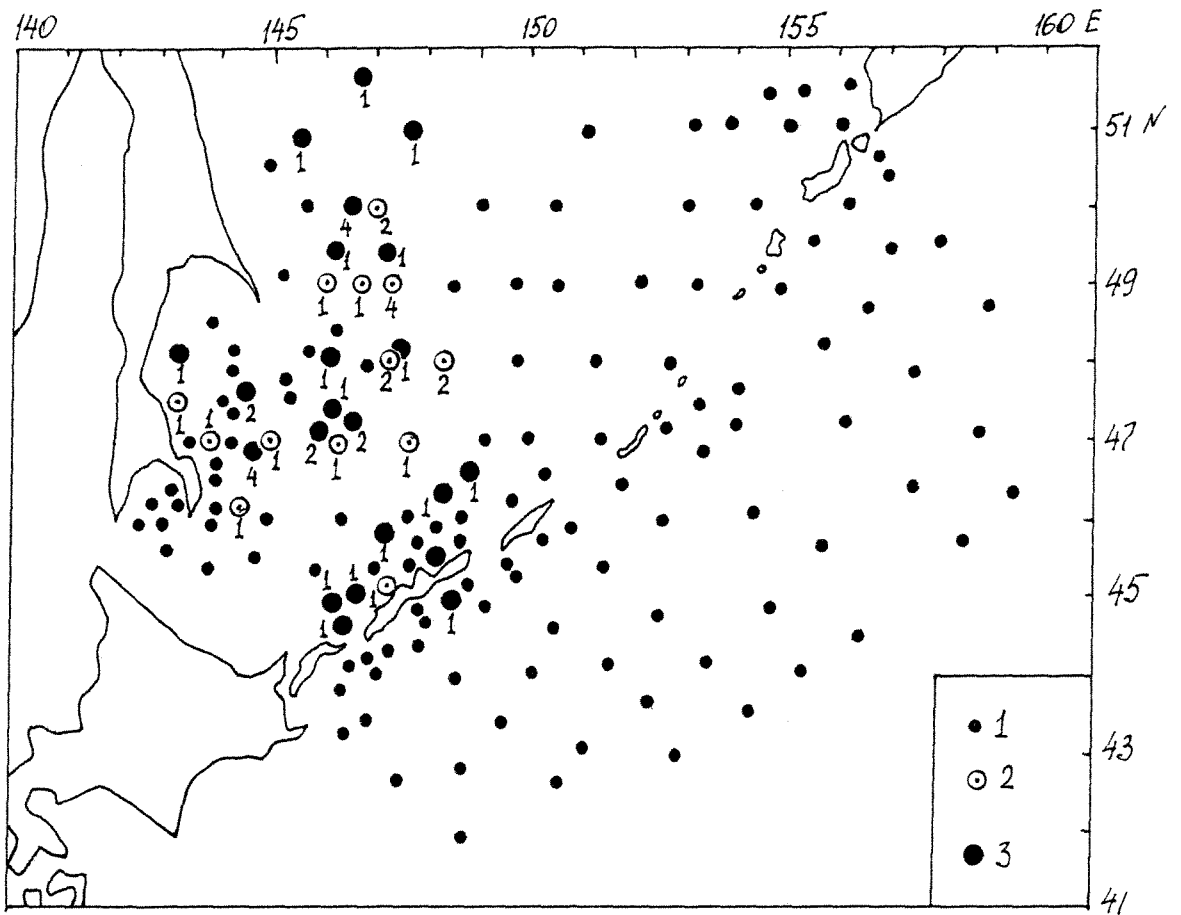
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FIGURES LEGENDS

Fig.1 Distribution of immature masu catches in southern Okhotsk Sea in summer 1991 and 1993. 1 - point of haul; 2 - point of haul with masu catch (sp.) in 1991; 3 - point of haul with masu catch in 1993.

Fif.2 Distribution of immature masu catches in southern Okhotsk Sea in fall 1991. 1 - point of haul; 2 - point of haul with masu catch (sp.); 3 - masu catch at 01.12.1987; 4 - masu catch at 19.01.1991.

Fig.3 Distribution of immature masu catches 15.10 - 02.11.1993 (A) and 08.11 - 26.11.1993 (B). 1 - point of haul; 2 - point of haul with masu catch (sp.).