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Stock Condition and Fishery of Masu and Japan Sea's Pink Salmon

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Stock condition and fishery of masu and Japan Sea's pink salmon

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The most abundant Pacific salmons in the basin of Sea of Japan are: pink, masu and chum. Despite salmon's abundance in this area is not high in compare to other areas of North Pacific, all these species are important fishery targets in countries of the Sea of Japan: Russia, Japan, South and North Korea. Unlike pink and masu, chum salmon almost does not occurred in southern part of Japan Sea in spring, spending winter probably in Pacific Ocean and Okhotsk Sea. Therefore, in spring only pink and masu salmon are fishery targets. Pink salmon abundance significantly exceed abundance of masu, therefore the former is the main fishery target this season. However, masu salmon is more valuable fish because it's commonly larger and more delicious.

There are a few salmon research conducted the Sea of Japan by Russian scientists (Darda, 1968; Birman, 1972; Gavrilov, Pushkareva, 1984; 1994), while Japanese scientists collected a lot of materials in this area. Sample's size of collected by Russian scientists were rather small until 1995 (hundreds of masu and pink), while there were a lot of materials collected by Japanese research vessels during about 40-years period (from middle 50-th) (some tens of thousands of masu and hundreds thousands of pinks were caught). Data on masu salmon for 1954-1961, were summarized and published by S. Tanaka (1965), data for 1962-1972 - by S. Machidori and F. Kato (1984) and F. Kato (1991). There is no similar report on the Japan Sea's pink salmon, with the exception of tagging and other information summarized by Takagi et al. (1981). Therefore we used results of salmon surveys which were published in prefectural station's Bulletins. Those data were used for summarising of information on fishing ground shifting and CPUE evaluations (Reports of Japanese prefectural Fisheries experimental stations of Ishikawa, Toyama, Niigata, Yamagata, Aomori and Akita Prefectures on gillnet salmon research, conducted in 1970-1991 in the Sea of Japan[1] (1972-1993)).

Marine pink and masu salmon fishery in the Sea of Japan

In Japan salmon fishery is separated on coastal and offshore fishery. Offshore fishery in the Sea of Japan starts in March. Fishing grounds locate this period near Sado Island and westward from it to Korean Bay locating mainly between 37° and 39°N. In winter and spring salmons distribute in wide temperatures, but main concentrations are formed in rather warm waters with surface temperature about 8-10°C (Tanaka, 1965; Birman, 1972; Machidori, Kato, 1984).

Pink salmon is the main target of fishery as the most abundant species. However in March body size of pink is small. Due to this, masu salmon is more valuable object and many vessels were fished mainly for masu, but not pink. Appropriate area for masu is smallest in the beginning of season. Due to that, fish density and CPUE were highest that period (Tanaka, 1965; Machidori, Kato, 1984; Reports ... , 1972-1993).

Following by surface waters warming, fishing grounds shift northward reaching 40°N in April. Just a few years only some vessels conducted operations more northward off 40°N this time. Large-scaled gillnet fishery is conducted in the Sea of Japan from 50-th years. During such long time fishermen have got experienced searching appropriate fishing ground. Therefore, data on fishing grounds shifting significantly reflect salmon stock shifting. Until 200-miles economic zones (EZ) establishment in 1977 nothing prohibited to enter for Japanese fishermen into adjacent to Primor'e waters, which are located now inside EZ of Russia. However before establishment of EZs Japanese have been never conducted operation in March and April in the area of present Russian EZ (Reports ..., 1972-1979).

This is explained by the fact that adjacent to Primor'e waters are influenced by the cold Primor'e Current and till May its were inappropriate for salmons. Due to this, in winter and spring masu and pink are habit in waters influenced by warm Tsushima Current. This is correct for present days also. In 1994 in southern path of Russian EZ in the Sea of Japan from April 11 to April 26 salmon survey have been conducted. Surface water temperature varied from 2 to 5°C. In total during the whole research 5920 tans of gillnets were set, but total salmon catch was only 114 fishes. So, catch per tan of gillnet (CPUE) was only 0,02. Survey conducted by three Japanese salmon fishery vessels in 1995 the same area also evidenced that in late April and early May masu and pink salmon did not formed fishery concentrations in adjacent to Primor'e waters due to low surface water temperature (less than 5°C).

Forty to eighty percent of the total masu salmon catch in Japan was taken in coastal waters (Machidori, Kato, 1984). And present time about 90% of marine catch is taken by coastal fishery accordingly official statistics (Fishery Agency of Japan, 1993-1995). In the case of pink salmon, the main catch is taken by offshore fishery. But

[1] Further cited as "Reports ...".

proportion of coastal and offshore catch in 1970-1994 significantly varied from year to year: from 0.2% to 73.7% (on average 10.2%) (calculated from Table 1). Main catch (about 90%) of masu and pink salmon take a place from March to June, however these species was caught by coastal fishery through whole year.

Before 1981 pink and masu salmon catch of Republic of Korea was tens-hundreds of tons. From 1981 due to increased effort salmon catch sharply increased and exceeded 2700 tons (INPFC, 1996). After that, until 1994, on average annual catch consisted 1674 tons (varied from 666 to 2767) (Table 1, Fig. 1). Before the 1981 more than 90% of pink salmon in the Sea of Japan were caught by Japanese fishermen. But from 1981 percentage of caught by Korean fishermen pink salmon significantly increased (Fig. 1). There are no data on the percentage of pink and masu salmon in the INPFC document. It's written only that the species taken are mainly pink salmon with some masu.

Salmon fishery in the sea also is conducted in the waters of North Korea (Gavrilov, Pushkareva, 1994). However there are no information available on the catch. Masu salmon is occurred in trapnets from February to June (Tanaka, 1965). Beside Korean, Japanese vessels also conducted salmon fishery in EZ of North Korea (Valencia, 1989). Russian fishermen does not conduct offshore fishery in the Sea of Japan taking salmons in rivers and coasts.

Species composition of spring salmon catch in the Sea of Japan

As it was mentioned earlier, pink salmon is dominant species in salmon catch in the Sea of Japan in spring. In the 60-th and in early 70-th it's percentage usually exceed 90% (Fukataki, Kato, 1974). From 1970 to 1991 pink salmon percentage in total catch (N=284291) of prefectural research vessels consisted 79.9% (masu - 20.1%). Occasionally chum salmon also was caught consisting 0.06% in total catch. Despite pink salmon is predominant species, percentage of masu significantly varies during the season. The masu percentage in catch from 1970 to 1991 on average was 67% (varied from 8 to 99%). In April percentage decreased to 32% (varied from 4 to 87 %), in May - to 9% (0-40%) and in June - 0.6% (0-2.5%) (Table 2) (Calculated on data from Reports ..., 1972-1993). So, in the Sea of Japan in spring masu salmon presented the main part in salmon catch in early season.

Last years, when Japan Sea's pink abundance decreased, percentage of masu had tendency to increasing in the beginning of the season (Fig. 2A). In April tendency of decreasing is observed (Fig. 2B), and in May - took a place cyclic fluctuations influenced by yielding of pink (Fig. 2C). In years of low pink abundance masu percentage significantly increased reaching 40% already in May.

Chum salmon were observed not every year and it's percentage is was very low. Usually this salmon (about 60% from all chum) were caught northward of 40°N, however few fish were caught near 38°N. Low percentage of chum in catch and unannual founding of this species evidence that chum salmon spawning in rivers facing to the Sea of Japan spend winter mainly outside Sea of Japan, migrating probably to Pacific Ocean and Sea of Okhotck.

Catch of masu and pink salmon per gillnet (CPUE)

Catch per unit gillnet (CPUE) of masu salmon accordingly to averaged data were highest in March and decreased during the season (Fig. 3A). In March CPUE of masu was 0.36 fish per tan[2], in April - 0.13, and in May - 0.05 (Table 2). CPUE values for pink salmon by averaged data, unlike in masu, were increased from March to June (Fig. 3B). Accordingly to many year's data, from beginning of 80-th tendency of masu salmon CPUE decreasing in March is observed. Weak CPUE declining also took a place in April and May, excluding some CPUE increasing in 1990-91 in April.

In March CPUE of pink salmon was 0.23 fish per tan, in April - 0.69, in May - 1.12 and in June - 2.89. During from 1982 to 1991 in March CPUE of pink did not exceed 0.1 (Table 2), and also was low in other months having two light peaks in the middle of 80-th and in the beginning of 90-th (Fig. 3B).

Origin of pink and masu salmon from catch in zones of Japan and countries of Korean Peninsula

For determination of origin of pink salmon, wintering in the Sea of Japan, Japanese scientists during many years conducted targeting in spring. From 1956 to 1971 in the Sea of Japan 6921 fish of .1 age were targeted. From this amount 78 fish were recovered in Primor'e, 13 fish - in Amur, 59 - in west coast of Sakhalin, in the east coast of Sakhalin - 15, in the northern coast of Okhotsk Sea - 1 pink (Fukataki, Kato, 1974; Takagi et al., 1981). Earlier experiments (before 1949) on targeting pink in the Sea of Japan and near west coast of

[2] Here 1 tan is 1 gillnet of 50 meters long.

(Hirano, 1953; cited by Takagi et al., 1981) revealed, that pink salmon, recovered in west Sakhalin, might be migrating to rivers of Primor'e, Amur, rivers of east coast of Sakhalin and north coast of Okhotsk Sea.

So, tagging experiments revealed that pink salmon wintering in the Sea of Japan spawn mainly in Primor'e, Amur and western Sakhalin. At the same time fish from eastern Sakhalin, Kuril Islands and northern coast of Sea of Okhotsk also present here. There were no recoverings of targeted in Sea of Japan pink salmons in rivers of Hokkaido, and there are no pink's spawning stocks on Honshu. On the continental side, North Korea is the southern limit of pink salmon's spawning area, but significant stocks occurred northward only from middle Primor'e of Russia. Therefore, pink salmon distributed in the Sea of Japan originate practically only from Russian rivers.

As well as pink, masu salmon originated from different regions inhabit the Sea of Japan. Information on tagging experiments of masu salmon is limited in compare to pink. Recoveries of tagged in central part of Japan Sea masu took a place in rivers of Primor'e, in coastal waters of Sakhalin, coastal waters and rivers of Japan (Fukataki, 1970; Machidori, Kato, 1984). The fact that some fish tagged in zone of Japan were recovered in rivers of Russia proved that some masu salmon from the catch of Japanese fishermen originated from Russia. This fact also confirmed by biological information (Tsiger, 1993, 1994; Kurmazov, Tsygir, 1993).

A significant part of fish from central part of Japan Sea moves to Primor'e when water temperature increases in spring (Tanaka, 1965; Machidori, Kato, 1984; Reports of Ishikawa and Yamagata ..., 1973-79). It allows to say that those fish are originated from Primor'e rivers. Many fish caught near Western Kamchatka had hooks in their mouths wich were used in longline fishery in the Sea of Japan evidencing on the wintering of masu salmon from Western Kamchatka in Japan Sea (Shimazaki, 1971). Freshwater age of masu salmon is shorter on average in southern rivers than in northern ones. About 90-95% of sea-run adults from rivers of Japanese Islands are fish who spent 1 year in rivers. At the same time in the samples of masu salmon collected in waters near Hokkaido there were many fish who spent 2 winters in rivers (Okazaki, 1989). Consequently, many fish migrating near the Japanese Islands aren't originated from rivers of Japan.

Percentage of male in sea-run stocks of masu salmon varies from 0% in the southern regions to more than 40% in the northern populations. Therefore, high percentage of male in waters near Honshu in area of 38-39°N in early March is evidenced on the presence of fish from northern areas of reproduction there (Machidori, Kato, 1984). In the co-operative Japanese-Russian research cruises conducted in 1993 and 1994 in 200-miles economic zone of Japan scale samples of masu salmon were collected and age determination were done in 33 fish. From this amount 33% were fish with freshwater age 2 years. This is higher than usual ratio for Japanese rivers, as well male percent (39%). Therefore it's reasonable to suggest that some fish were originated from rivers of Russia.

Masu salmon from Russian rivers are caught not only in offshore waters in the Sea of Japan, but also in coastal catch in Japan Sea side and Pacific Ocean side. As evidence of this, the paper of T. Okazaki (1989) may be cited, where data on age and sex composition as well as allele frequency from both sides of Japanese Islands. were presented. Because of revealing in coastal catch from Pacific side masu salmon with freshwater age 3. , it was suggested that some fish from Western Kamchatka also spent winter there[3].

Masu salmon are caught in Ishikawa Prefecture (Honshu) in March is presented mainly by fish of Russian origin (Kimoto et al., 1994), which were left those coastal waters in April. The size of catch depends from the influence of Tsushima warm current, because of in cold years masu spent more time in coastal waters suffering to coastal fishery, and catch become higher. In coastal waters of Niigata Prefecture main part of masu catch are fish from more northern regions, including rivers of Russia (Shinji, 1989).

Unlike pink salmon do not spawn in rivers of Korean Peninsula, masu do. Consequently masu salmon of Korean origin presented in marine salmon catch from the coastal waters of Korean Peninsula. However, abundance of masu in North Korea significantly lower than in Russia. In the case of South Korea abundance of masu was very low already 30 years ago when only 100-200 fish entered to few rivers (Machidori, Kato, 1984). Because of there was no mention on masu salmon in later list of anadromous fish (cited by Valencia, 1989) probably it can be concluded that reproduction of sea-run form of masu is about stopped here. On the base of above mentioned, it might be suggested that main part of masu salmon taken in Korean waters consists fish from Russian rivers.

Because of in zones of Japan and Korean countries masu salmon from whole area concentrated in winter and spring season and from the other side, and main spawning rivers located in Russia, part of masu salmon catch in these countries are fish originated from Russia. But stock differentiation research are necessary for estimation of exact share.

[3] Masu salmon with freshwater age 3. are known from Werstern Kamchatka only.

Stock condition of Japan Sea's salmons and necessity of international co-operation for it's rational usage

On the Figure 4 historical data on of Japan Sea's pink salmon catch in main reproduction areas: Primor'e and Amur are presented. Statistics on north-western Sakhalin (Rybnovskiy region) also included because of fish caught there originated mainly from Amur area. Statistics on another parts of Sakhalin was not included because of impossibility of differentiation of Japan Sea's stocks from Pacific ones.

As followed from this Figure abundance and catch of Japan Sea's pink salmon significantly varied as well as on odd and even years by the same area and also by different areas the same year. Despite this great variation total catches were highest in the first half of century both for odd and even years, reaching a maximum about 20 thousands metric tons in even years and about 13000 in odd ones. In odd years generally Amur pink was more abundant, while in even - Primor'e pink while exceptions took a place for both generations. However, present time stock abundance is low in Primor'e and Amur for both generations (Fig. 4A,B). It's said that the main reason of this is the deficiency of spawners in rivers (Pushkaryova, 1975, 1981), what is strongly influenced by marine fishery (Gavrilov, Pushkaryova, 1984, 1994).

Before the War abundance of masu salmon was much higher than now in Russia (Semenchenko, 1989) and in Japan (Machidori, Kato, 1984; Nagasawa, Torisawa, 1991). Masu salmon stocks of middle and northern Primor'e were the most abundant through whole area. Some years the catch of masu exceeded the catch of pink salmon on weight. In northern Primor'e in 1928-1943 years annual catch of masu varied from 600 to 1200 tons (on average 770 tons). Relatively high abundance of masu salmon was also in Amur River where annual catch was 830 tons (Semenchenko, 1989). In 50-years the abundance of masu salmon was strongly decreased in Russia (Semenchenko, 1989). At the same time stock reduction took a place in rivers of Hokkaido (Nagasawa, Torisawa, 1991). Undoubtedly, the development of Japanese fishery in the Sea of Japan was one of the reasons of that. In 1957 due to reduction of stock size, the fishery of masu salmon was prohibit in Primor'e until present time. However abundance of masu continue to stay at low level.

For the present time only Japanese fishery statistics on masu salmon is available. Until 1973 the catch of masu was not separated from catch of pink. And from 1973 the number of caught pink and masu is calculated separately if possibly and data on both species was represented to FAO (Machidori, Kato, 1984). Accordingly to these data the catch of masu salmon in 1973-1994 years was from 1.543 to 4.100 (on average 2.783) thousands tons (FAO, 1977-1992; Fisheries Agency of Japan, 1994, 1995). According to these data annual marine catch of Japan has tendency of decreasing (Fig. 5) despite a lot of efforts in the artificial reproduction of masu salmon in Japan.

Amount of fishing Japanese vessels also significantly reduced in the Sea of Japan. In the beginning of 70-th there were more than 700 fishery vessels, in the middle of 70-th their number was reduced to 500 (Pacific salmon catch ..., 1989). In 1995 in the Sea of Japan only 23 Japanese vessels conducted fishery in the Sea of Japan. Taking to account common tendency of decreasing marine catch of masu salmon, and decreasing of catch per one gillnet (but not for vessel), it's reasonable to conclude on common tendency of reduction of masu salmon abundance in whole area.

During last years from beginning of 70-th tendency of Japan Sea's pink marine catch decreasing also is observed (Fig. 1). However level of reproduction of Japan's pink is low present period. Russia and Japan achieved agreement according to which gillnet and longline fishery of pink salmon in the 200-mile economic zone of Japan every year is quoted by Russian side and fishery stops when permitted amount of salmons was caught. But salmon fishery in zones of Korean countries is not quoted, and size of catch was not controlled. In connection to continuous decreasing of salmon's abundance and existing uncontrolled marine fishery of salmons of Russian origin, it's reasonable to achieve international agreement between four countries of the Sea of Japan (Russia, Japan, Southern and Northern Korea). The aims of such agreement should be regulation of Japan Sea's salmon fishery and co-ordination of scientific research. Fishermen of all listed countries should be interested in conservation and restoring of Japan Sea's salmon's stocks. Because of reduction of Russian salmon's stocks will lead to decreasing their catches.

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Table 1

Japan Sea's pink catch by regions and countries, tons

Year	Amur[1]	N-W Sakhalin[2]	Primor'e[3]	South Korea[4]	Japan offshore[5]	Hokkaido coastal	Honshu coastal	Total
1970	340	100	470	89[6]	5558	2135	497	9189
1971	2000	1020	3850	89	5815	81	119	12974
1972	250	510	130	382	4998	13	13	6296
1973	2910	690	3000	400	5616	17	117	12750
1974	500	310	140	206	5198	53	22	6429
1975	2000	500	1800	131	5476	406	402	10715
1976	2000	440	950	53	5026	92	91	8652
1977	1530	180	1630	80	3684	123	494	7721
1978	3410	440	2760	59	3954	13	141	10777
1979	1000	260	1410	65	3830	6	60	6631
1980	3451	1150	650	128	3815	44	10	9248
1981	2400	960	1260	2727	3869	6	15	11237
1982	3200	120	870	1107	3771	6	16	9090
1983	3600	1380	970	2122	3754	31	4	11861
1984	4330	392	620	2605	3501	20	78	11546
1985	3900	1234	1750	2353	3975	36	95	13343
1986	3200	610	700	2767	2549	380	636	10842
1987	2150	2120	3190	1372	2206	384	688	12110
1988	1650	220	340	1533	2179	227	399	6548
1989	877	657	4700	1197	1853	507	617	10408
1990	1476	843	640	666	1420	395	652	6092
1991	140	141	5250	1074	1234	2	1	7842
1992	2363	710	1830	1505	1252	59	15	7734
1993	118	123	3970	1269	1207	2	0	6689
1994	525	769	850	1144	1352	8	0	4648
1995	189	883	460		1467	1	1	3001

[1] By data from "Pacific salmon catches (1989)" and Khabarovsk Branch of TINRO.

[2] Data on Rybnovskiy area in North-Western Sakhalin by "Pacific salmon catches (1989)" and Khabarovsk Branch of TINRO.

[3] Data of Khabarovsk Branch of TINRO.

[4] INPFC (1987-1996).

[5] By "Pacific salmon catches (1989)", INPFC (1987-1996) and Fishery Agency of Japan (1993-1995).

[6] Averaged data for 1961-1971.

Table 2

Species copmosition (%) in salmon catch and CPUE (fish per tan) in the Sea of Japan by months and years

Year	N	percents			N fish	N tan	CPUE		N	percents			N fish	N tan	CPUE	
		masu	pink	chum			masu	pink		masu	pink	chum			masu	pink
		M a r c h								A p r i l						
1970	1	30,0	70,0	0,00	337	540	0,19	0,44	1	5,6	94,4	0,00	1441	1195	0,07	1,14
									1	5,4	94,6	0,00	4069	1217	0,18	3,16
1972	1	38,8	61,2	0,00	508	659	0,30	0,47	2	29,4	70,6	0,00	2040	1948	0,31	0,74
1973	1	8,0	92,0	0,00	237	375	0,05	0,58	2	4,0	96,0	0,00	7438	2884	0,10	2,48
1974	2	74,2	25,8	0,00	330	1329	0,18	0,06	4	16,5	83,5	0,00	5653	4735	0,20	1,00
1975	3	74,1	25,9	0,00	2537	4453	0,42	0,15	6	5,9	94,1	0,00	18582	8244	0,13	2,12
1976	3	32,7	67,3	0,00	8605	5601	0,50	1,03	4	18,7	81,3	0,01	9272	7510	0,23	1,00
1977	3	48,8	51,2	0,00	907	3428	0,13	0,14	4	16,6	83,4	0,00	2776	4678	0,10	0,50
1978	2	66,6	32,9	0,49	2058	3943	0,35	0,17	5	53,7	45,1	1,24	1052	5271	0,11	0,09
1979	3	53,5	46,2	0,34	5654	4351	0,70	0,60	5	49,6	50,4	0,00	389	4722	0,04	0,04
1980	4	81,8	18,2	0,01	7517	5851	1,05	0,23	5	76,8	23,1	0,14	1461	7795	0,14	0,04
1981	4	53,5	46,3	0,18	7913	7681	0,55	0,48	4	83,3	16,7	0,00	1878	7090	0,22	0,04
1982	3	96,8	3,2	0,07	4351	5796	0,73	0,02	4	86,6	13,2	0,15	1375	9531	0,13	0,02
1983	4	83,8	16,2	0,03	3982	7572	0,44	0,09	5	30,8	69,2	0,00	1507	8134	0,06	0,13
1984	2	85,4	14,6	0,00	803	3642	0,19	0,03	4	42,5	57,5	0,03	2972	8674	0,15	0,20
1985	3	84,4	15,5	0,12	3369	5620	0,51	0,09	3	21,2	78,7	0,07	2740	6441	0,09	0,34
1986	3	77,3	22,7	0,00	1163	4303	0,21	0,06	3	20,2	79,7	0,11	3786	4709	0,16	0,64
1987	3	87,2	12,8	0,00	2537	6112	0,36	0,05	3	24,1	75,8	0,08	1247	4669	0,06	0,20
1988	3	96,3	3,7	0,00	1016	3419	0,29	0,01	3	52,3	47,5	0,21	480	5105	0,05	0,05
1989	2	32,4	67,3	0,31	324	2348	0,05	0,09	3	12,5	87,4	0,07	1505	4541	0,04	0,29
1990	2	97,7	2,3	0,00	478	2380	0,20	0,01	3	24,9	75,1	0,00	2966	5246	0,14	0,43
1991	1	99,5	0,5	0,00	212	1455	0,15	0,00	3	20,5	79,4	0,06	3556	5527	0,13	0,51
Total					54838	80858							76744	118670		
Average		66,8	33,1	0,07			0,36	0,23		31,9	68,0	0,10			0,13	0,69
Min		8,0	0,5	0,00			0,05	0,00		4,0	13,2	0,00			0,04	0,02
Max		99,5	92,0	0,49			1,05	1,03		86,6	96,0	1,24			0,31	3,16

		M a y							J u n e							
1970	1	6,7	93,3	0,00	2998	1212	0,17	2,31	1	2,2	97,8	0,00	847	1060	0,02	0,78
1971	1	0,4	99,6	0,00	10525	1877	0,02	5,59	1	0,0	100,0	0,00	4738	360	0,01	13,16
1972	2	6,5	93,5	0,00	817	2189	0,02	0,35								
1973	2	1,0	99,0	0,00	8109	3981	0,02	2,02	1	0,1	99,9	0,00	4098	741	0,01	5,53
1974	4	7,4	92,6	0,00	10161	9249	0,08	1,02	4	0,5	99,5	0,00	4020	3614	0,01	1,11
1975	6	1,2	98,8	0,01	33182	10163	0,04	3,23	4	0,0	100,0	0,02	9249	3391	0,00	2,73
1976	4	20,9	78,9	0,19	6675	7038	0,20	0,75	3	0,1	99,9	0,03	7068	4374	0,00	1,61
1977	2	40,1	60,0	0,00	412	892	0,19	0,28								
1978	3	5,3	94,6	0,13	9407	5979	0,08	1,49	1	0,1	99,9	0,00	2185	925	0,00	2,36
1979	3	2,9	97,0	0,18	16190	7427	0,06	2,11	1	0,2	99,7	0,16	1245	1870	0,00	0,66
1980	3	14,3	85,6	0,08	1292	5632	0,03	0,20	2	0,5	98,9	0,63	2077	2236	0,00	0,92
1981	3	5,1	94,8	0,03	3931	5920	0,03	0,63	1	2,5	92,4	5,06	79	848	0,00	0,09
1982	4	38,0	62,0	0,00	748	6139	0,05	0,08								
1983	3	2,8	97,2	0,05	2053	5656	0,01	0,35								
1984	2	17,7	82,2	0,07	1373	3527	0,07	0,32								
1985	2	2,3	97,5	0,18	3299	3700	0,02	0,87								
1986	1	22,0	78,0	0,00	214	2052	0,02	0,08								
1987	2	6,6	93,3	0,08	1282	2989	0,03	0,40								
1988	1	0,8	99,2	0,00	258	871	0,00	0,29								
1989	1	0,2	99,8	0,00	492	1182	0,00	0,42								
1990	1	0,0	100,0	0,00	874	1465	0,00	0,60								
1991	1	0,0	100,0	0,00	1370	1068	0,00	1,28								
Total					115662	90208							35606	19419		
Average		9,2	90,8	0,05			0,05	1,12		0,6	98,8	0,59			0,00	2,89
Min		0,0	60,0	0,00			0,00	0,08		0,0	92,4	0,00			0,00	0,09
Max		40,1	100,0	0,19			0,20	5,59		2,5	100,0	5,06			0,02	13,16

All calculations are done from "Reports ..." (1972-1993).

N - number of summarized reports, N fish - sample size, N tan - amount of used tans.

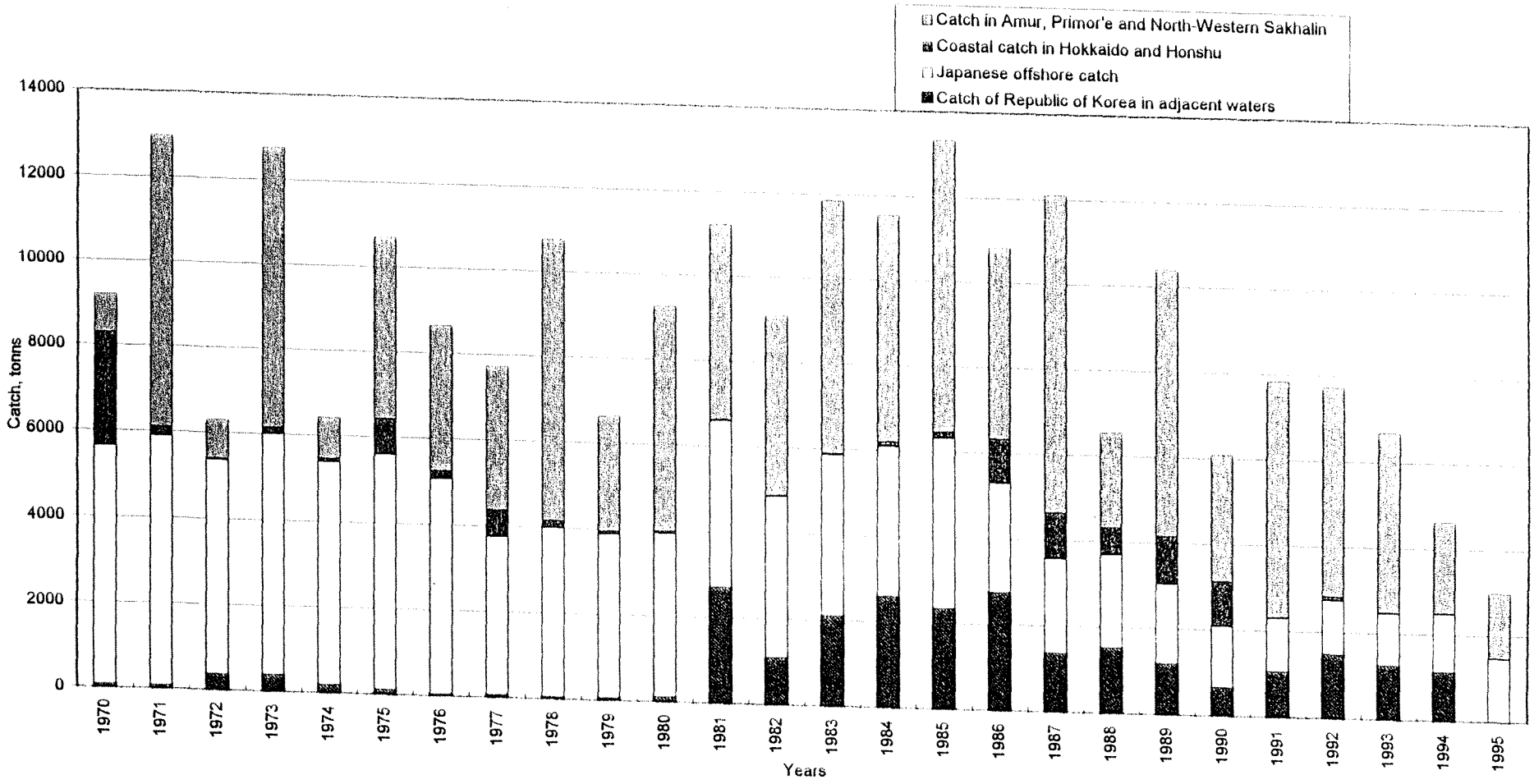

Fig. 1. Japan Sea's pink salmon catch in different regions by years, tons.
(Data on Korean catch for 1995 is not included)

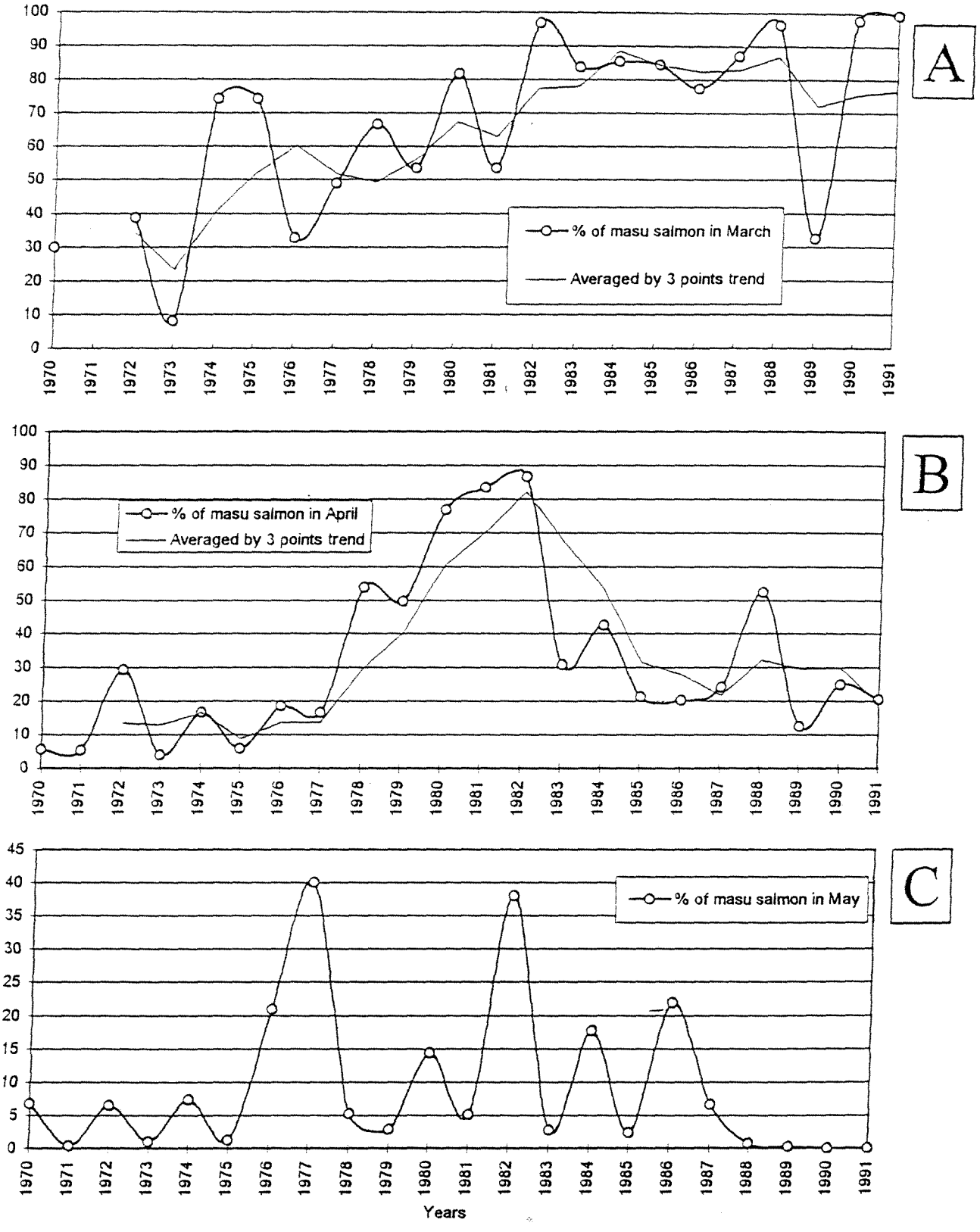

Fig. 2. Masu salmon proportion in Japanese gillnets catch in March (A), April (B) and May (C) by months, %

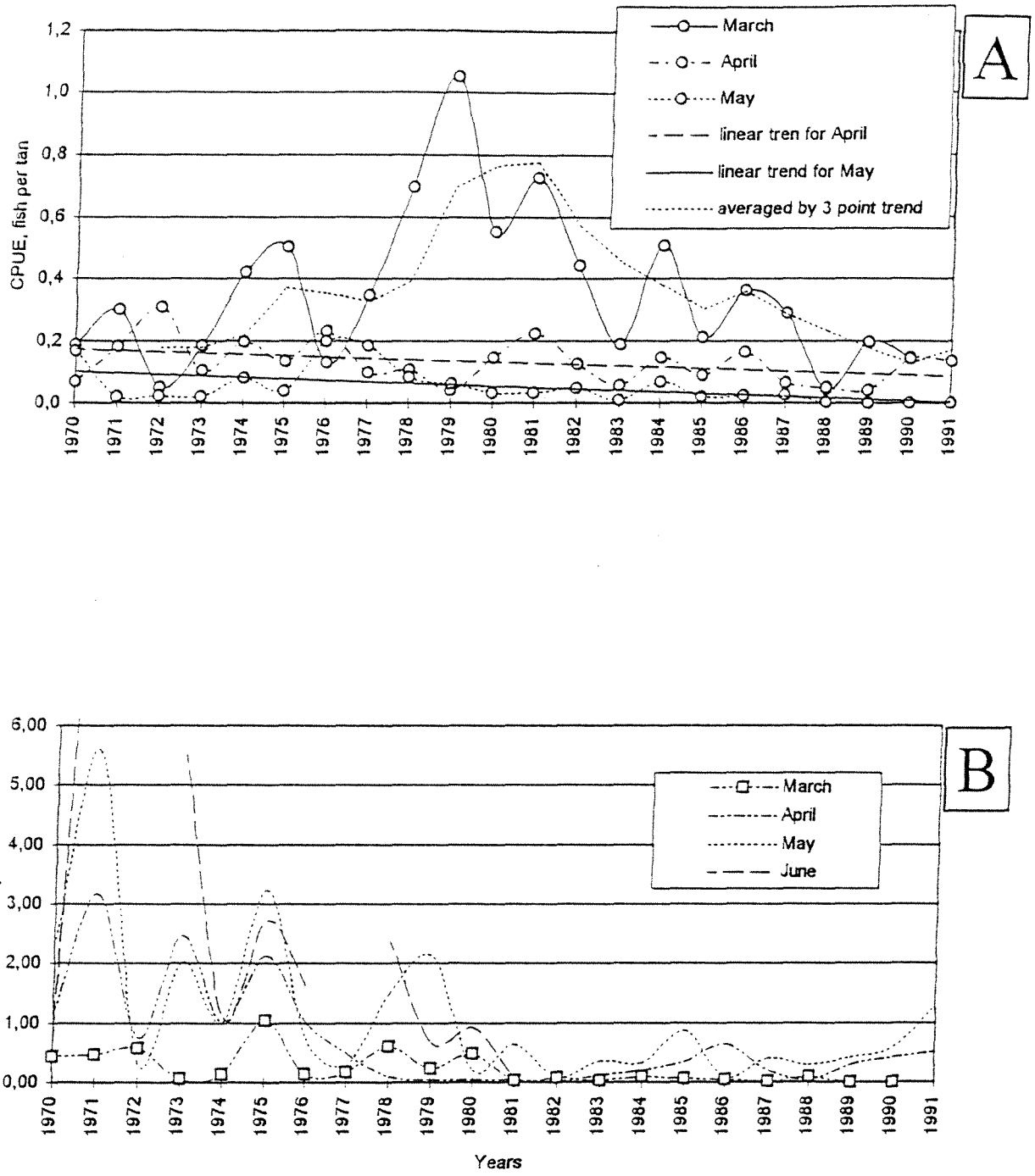

Fig. 3. Masu salmon (A) and pink salmon (B) catch per gillnet (CPUE) in the Sea of Japan in different months by years.

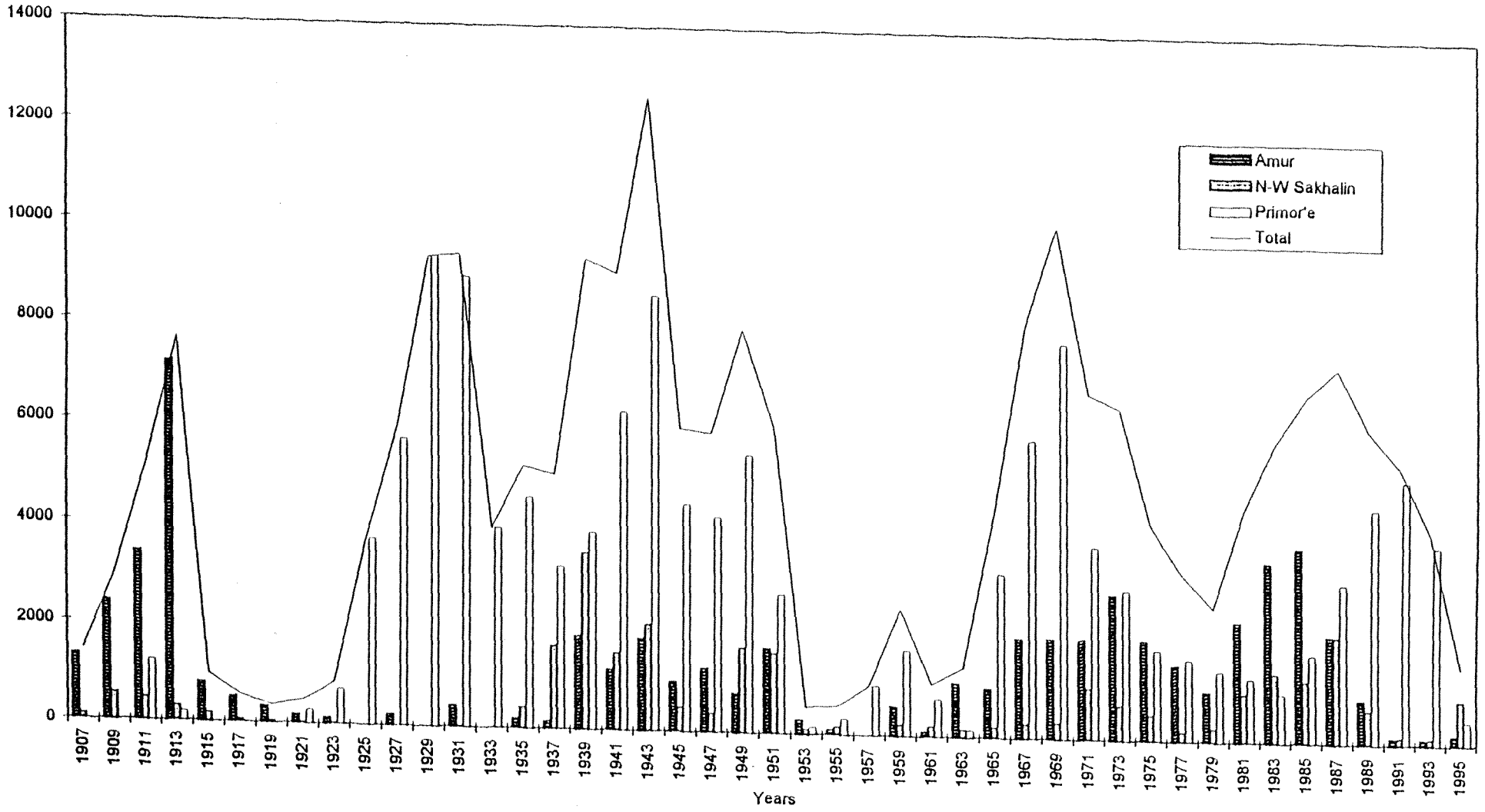

Fig. 4-A. Hystorical catch of pink salmon in Amur, Rybnovskiy (North-Werstern Sakhalin) and Primor'e areas of Russia in odd years of current century, tons

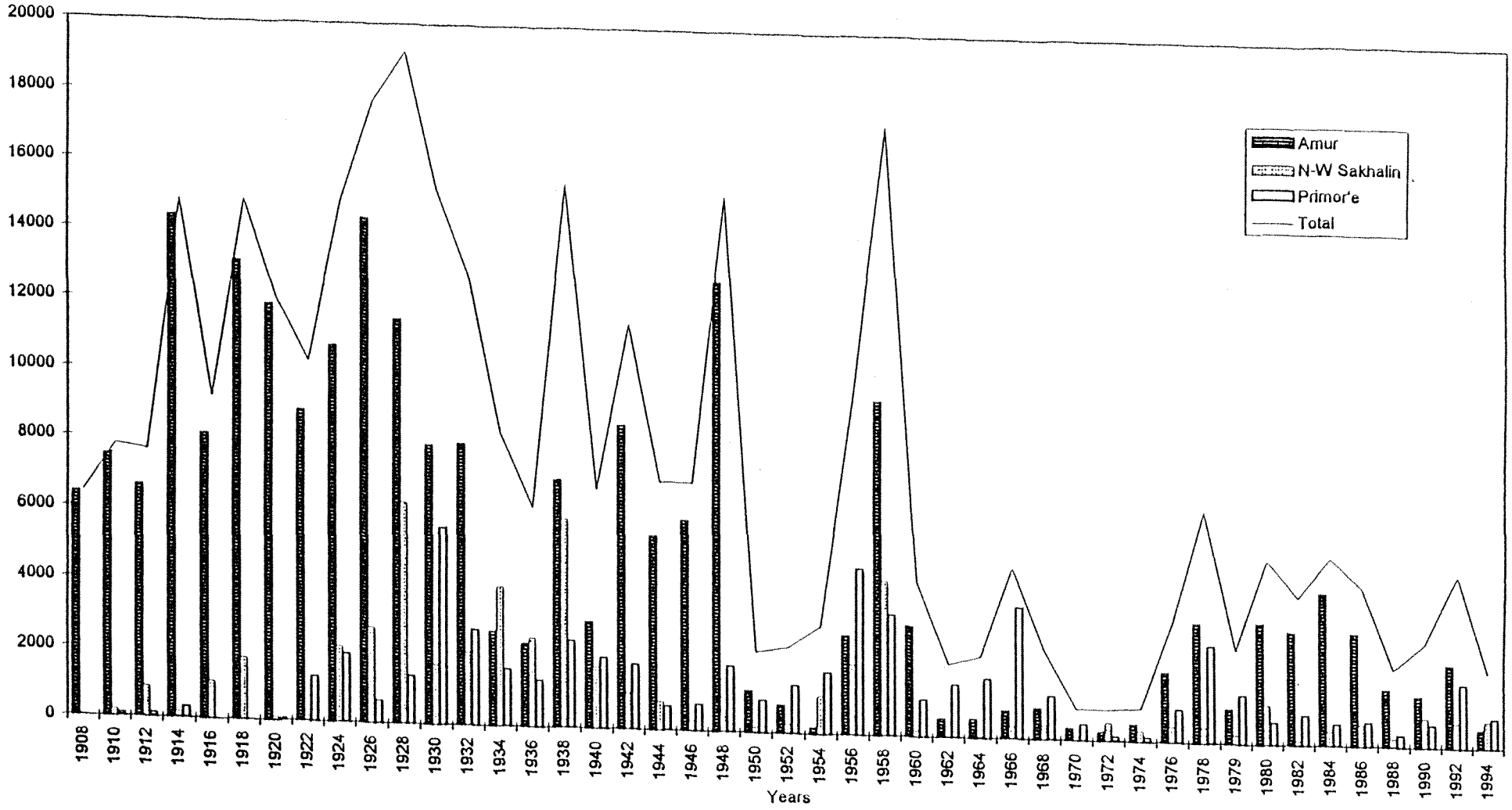

Fig. 4-B. Hystorical catch of pink salmon in Amur, Rybnovskiy (North-Werstern Sakhalin) and Primor'e areas of Russia in even years of current century, tons

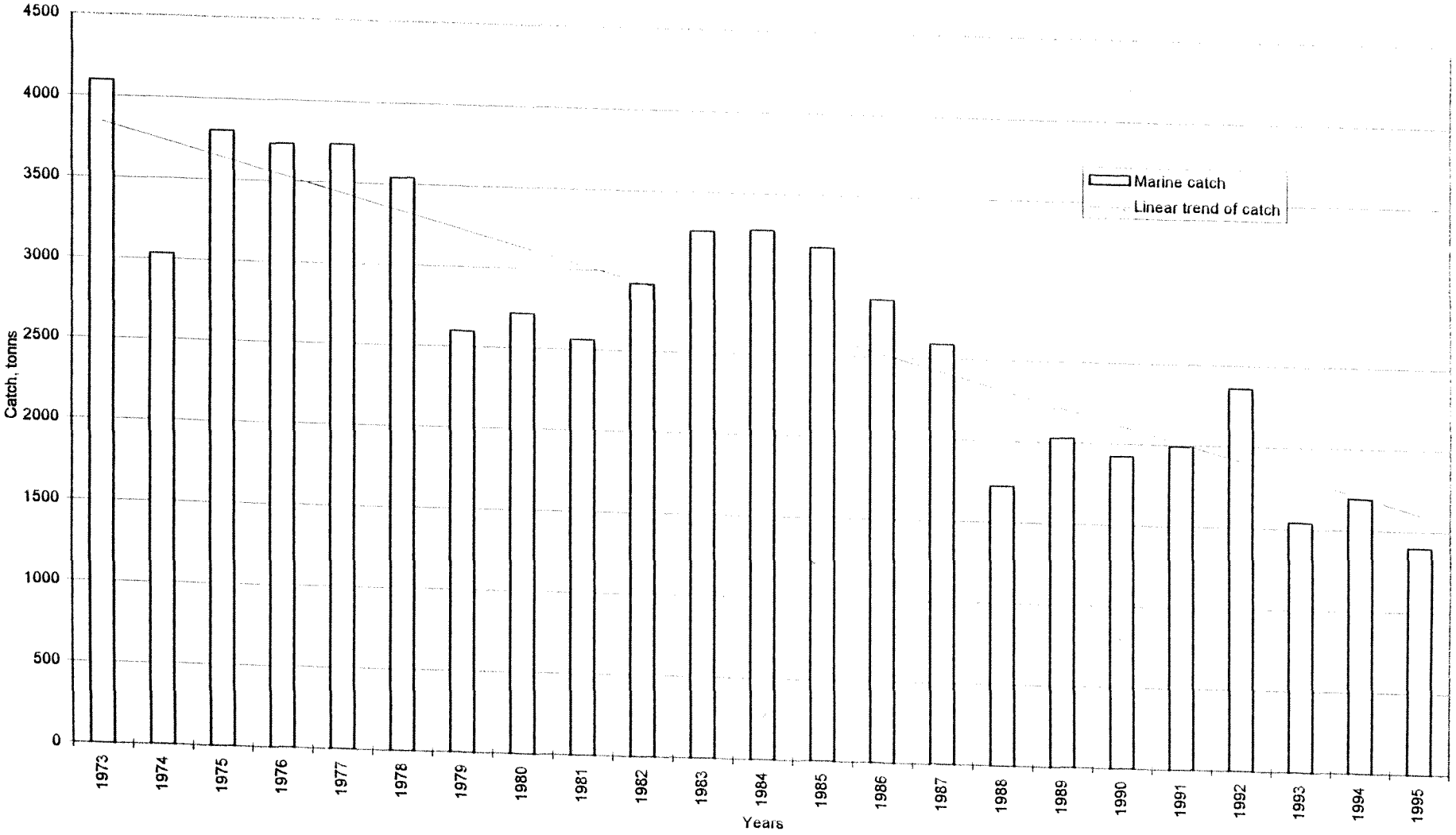

Fig. 5. Marine masu salmon catch of Japan
(by FAO, 1977-92 and Fishery Agency of Japan, 1993-96)