Historical Trends of Fisheries and Stock Condition of Pacific Salmon in Russia

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At the present time, the main pink salmon and sockeye salmon stocks are in good condition on the Russian far east. However, pink stocks have tended to decrease in recent years. Wild stocks of chum salmon are currently in poor condition in many far-eastern regions, except for those of the north Okhotsk Sea coast and Okhotsk region. We do not expect a noticeable increase in the near future.

There are abundant Pacific salmon stocks that are under intensive exploitation on the whole coast of Russian far east. In the long-term, the dynamics of these stocks are mainly determined by variability of global environmental conditions. Climate and related oceanographical effects determine general trends in Pacific salmon catches, although the trend can be strengthened or slowed by management of harvest and the releases of hatchery fry. At present, only the dynamics of the catch of salmon can be used as a quantitative indicator of long-term salmon stock conditions. Sometimes the coincidence of catch and salmon stock condition may not be exact.

INTRODUCTION

Salmon together with walleye pollock and crab are the three most important fisheries in the Russian Far East. During the 1990s, the salmon catch varied in the range of 120-250 thousand tons. Salmon contribute 4-6% of the total fisheries harvest of the region by weight, and have a high market value as a food product. These factors determine the exceptional significance of Pacific salmon for Russian Fisheries Branch. Since 1992, the Pacific salmon catch became the highest of the pelagic fish species harvested in Russia, surpassing the Pacific herring and saury catch. Commercial fisheries for Pacific salmon fisheries are developed on the entire Russian far eastern coast: from the Anadyr River to the southern Primorie (Figure 1). Chum salmon are the primary species harvested in the far northern and far southern regions. Pacific salmon catches reported here include the catch from the Japanese concessional fishery in the Russian EEZ that occurred from 1915 - 1943 (Chigirinsky 1994) as well as the catches from the inshore Russian fishery

PINK SALMON

Pink salmon is the most abundant salmonid species of the Russian Far Eastern Coast, and contributes about 40% of total salmon catch in the North Pacific Ocean (Shuntov 1994). Among Pacific salmon species, pink salmon has the second highest biomass behind chum salmon and constitutes about 25% of the total (Konovalov 1986). In the 1990's the pink salmon constitutes 72-86% of the Russian salmon catch in odd years and 68-74% of the Russian catch in even years.

The condition of pink salmon stocks in the Russian Far East has significantly fluctuated during the long-term period of fisheries exploitation, similar to the stocks of other salmon species. Unfortunately, it is only at the present time that the dynamics of salmon harvest value can be used as a quantitative parameter of salmon stocks' condition, and in long-term series sometimes the coincidence of catch and stock condition may not be exact. Some figures relating to this question will be represented below.

In the beginning of the Russian Pacific salmon fishery a approximate 15-year period of gradual increasing catch occurred (Figure 2). This gradual increase in catch occurred as the fishery was developed with increasing effort and market formation. It is significant that inter-annual variability in catch between even and odd years was not observed at this time. Substantial inter-annual variability in catch is characteristic of the subsequent 80 years of the fishery, with comparatively larger catches occurring in one year followed by lower catches in the following year.

Fig. 1 Main regions of Pacific salmon coastal fisheries in the Russian far east.

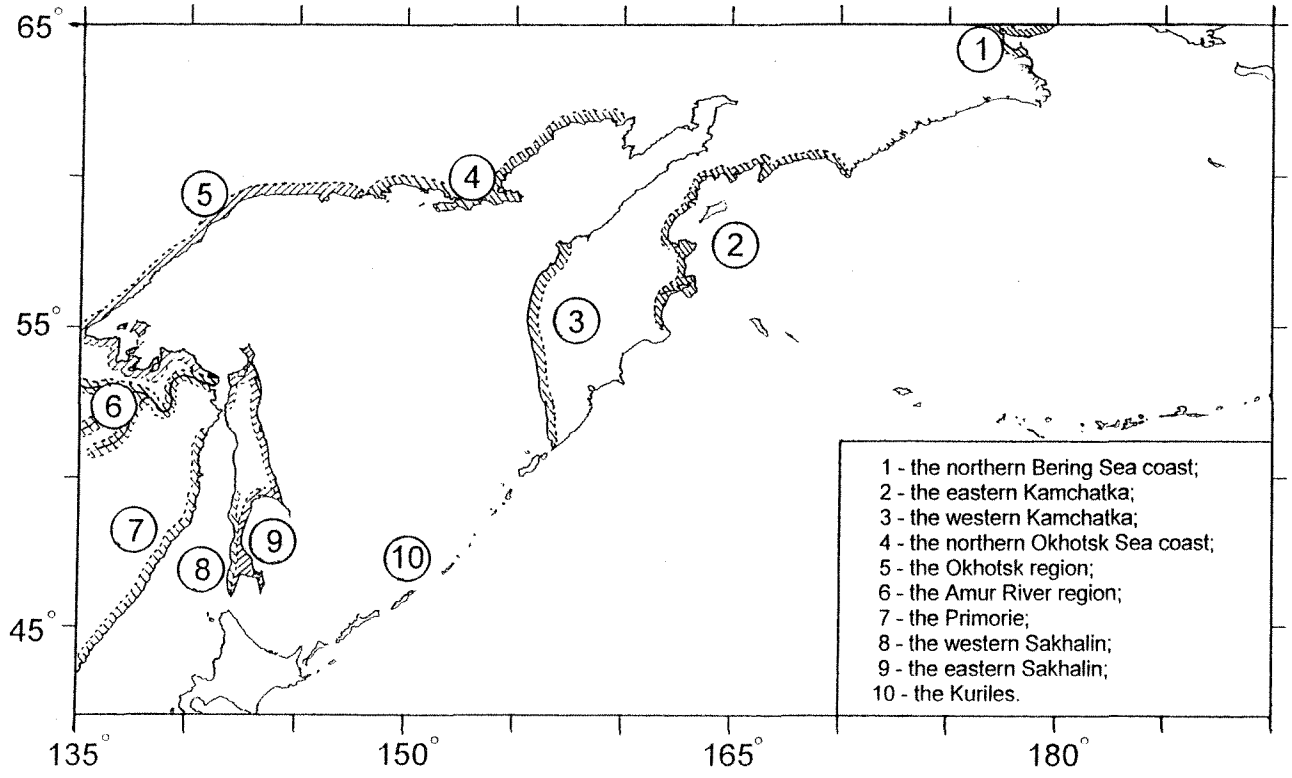
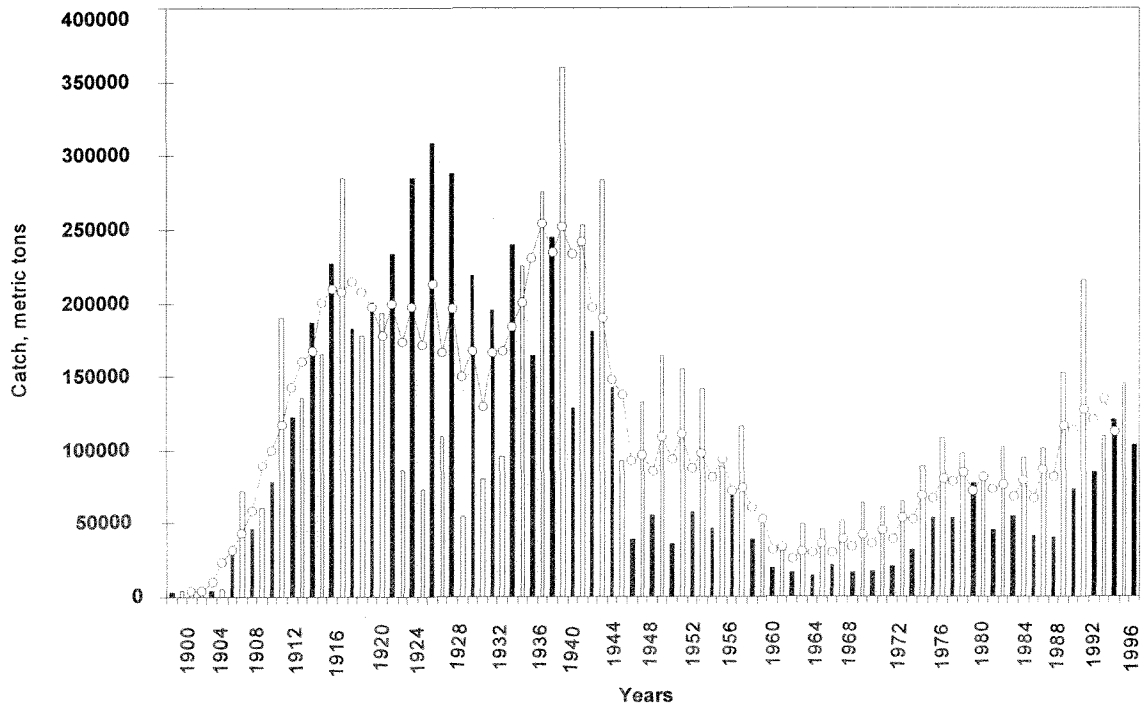
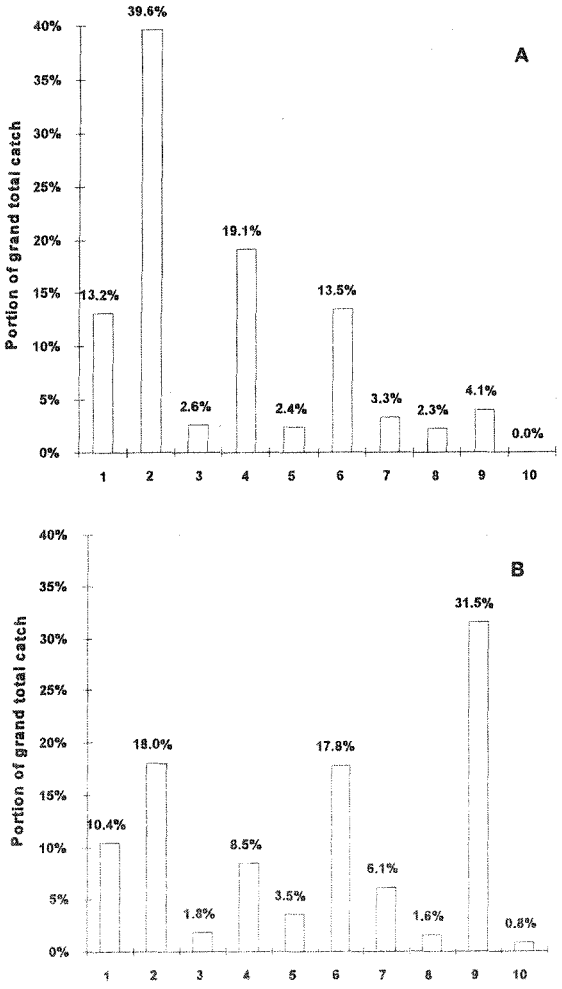


Fig. 2 Total Russian catch of pink salmon with 5-year moving average (solid line). Dark bars-even years, light bars-odd years.



By 1915 the annual pink salmon catch attained a level of 200 - 215 thousand tons. We consider this catch was sustainable and corresponded to a healthy stock condition. This level of harvest was maintained until 1922. In 1923 a sharp decline of harvest occurred during the odd years on the Kamchatka Peninsula. At that time, the Kamchatka Peninsula was the main region of salmon fisheries development in Russia. Later, a salmon fisheries infra-structure based on pink salmon was developed on Sakhalin Island too (Figure 3).

Fig. 3 Regional distribution of grand total catch of pink (A) and chum (B) salmon, 1900-1996. Regions: 1 - eastern Kamchatka; 2 - western Kamchatka; 3 - northern Okhotsk Sea coast; 4 - eastern Sakhalin; 5 - western Sakhalin; 6 - Kuriles; 7 - Okhotsk region; 8 - Primorie; 9 - Amur River; 10 - northern Bering Sea coast.



During odd-years of 1923 - 1933 the total Russian catch of pink salmon fell to 33 - 42 thousand tons. During this time the foreign catch also fell with a total odd year catch of 56 - 118 thousand tons. In contrast, the even-year catch of pink salmon increased and exceeded 300 thousand tons in 1926.

During the decade (1934-1944) odd-year catches increased and even-year catches decreased with catches remaining relatively stable in the range of 240-260 thousand tons. The development of the pink salmon fisheries on Sakhalin Island, where the odd-year populations dominate, contributed to the increase in odd-year catches. The odd-year dominance of inter-annual catch structure formed during the 1930's has been maintained to the present time. Note that low catches during the period 1945 - 1947 were due to political reasons (i.e., foreign fisheries were not conducted in Russian waters). In 1939 the historical high pink salmon catch was achieved - 360.3 thousand tons (Chigirinsky 1994). A total of 379.9 million fish, or 531.7 thousand tons of Asian pink salmon, were harvested including the Japanese driftnet fishery in the high-sea zone.

The Russian pink salmon catch has been decreasing from the early 1940's to the early 1960's. This decrease may have corresponded to a general decline in the health of pink stocks. It is believed that the main trends of pink salmon stock dynamics are the consequences of local or global environmental conditions and not related to harvest effort. We can relate many of the observed trends in catch with global climate variability over the North Pacific. Briefly, the intensity of water circulation in the Subarctic macro-gyre slackens during the periods of positive anomalies in reiteration of meridional form M-1 (Girs 1971) of atmospheric circulation. The Subarctic Front shifts northwards in these years, and subtropical waters spread northwards too. Therefore, the area suitable for pink salmon feeding in the Pacific ocean narrows and feeding conditions worsen.

The basis of the northward shift of main fronts and currents in North Pacific since 1957 has been described by Tully et al. (1960). During that period, the salmon production and catches declined on the both the Asian and American coasts of the Pacific Ocean (see Beamish and Bouillon 1993; Chigirinsky 1993). In contrast, in the south-western Pacific Ocean, the Japanese catch of subtropical fishes and squids (Japanese anchovy, Japanese common squid) increased to a level 4-5 times that of the period 1910-1950 (Davydov 1986). In the second half of 1970s another decrease of catch of subtropical species appeared, and conditions of salmon feeding may have improved. The return rate of chum to the Japanese hatcheries did not exceed 2% prior to 1976, and afterwards (1977-1986) it grew up to 3% even though no changes in chum hatchery technology occurred (Klyashtorin and Smirnov 1992). A gradual increase in Russian salmon catches, in particular those of pink salmon, was observed after the mid 1970's. The timing of these changes in salmon productivity coincides well with years of environmental regime shifts that were identified by many authors to have

occurred during the early 1950s and mid 1970s (Hare and Francis 1995).

Presently, the runs of pink salmon to the Russian far east coastal areas are in relatively good condition. The rate of increase in odd-year runs since the 1970's was similar to that for even-year runs although the catch in odd-year runs was greater. There appears to be some changes in stock structure, with the distribution of catches among western Kamchatka river systems variable over the period 1981 - 1986 (Figure 4). Catches were concentrated in the most southern group (from the Kihchik to the Opala Rivers) before 1985. A similar situation has occurred in eastern Kamchatka rivers (Figure 5).

In the 1990's, it appears that dynamics of climatic processes over the North Pacific appear to have become unfavorable for salmon production (Beamish and Bouillon 1993; Chigirinsky 1993). However, pink salmon is the most difficult of salmon species to forecast future runs. Currently, the even-year stocks are very productive in Western Kamchatka and in the Southern Kurile Islands. If this situation continues, a return comparable to the high harvest levels of 1920 - 1930 may occur. Furthermore, the environmental conditions in mid 1990s are rather different from those in early 1950s, where the salmon productivity declined. At that time the growth of biomass of Japanese common squid and Japanese anchovy took place simultaneously with the high level and actual increase of Asian pink salmon productivity.

CHUM SALMON

The Russian year-to year catch of chum salmon has been more stable than the catch of pink salmon (Figure 6). Initially, the chum salmon fishery developed very rapidly. The rapid development was due in part to the fact that the early fisheries occurred in rivers, primarily in the Amur River reservoir. Fishing in rivers is logistically simpler than in marine coastal areas. In the early years, 60-75% of total Russian chum salmon catch was from the early ("summer") race, harvested primarily in the Amur region. In 1910 the chum catch reached the historical high of 138 thousand tons. This initial period of high harvest was short-lived, and by 1916 the chum salmon catch declined to 21.7 thousand tons, of which only 5 thousand tons were caught in the Amur region. Researchers have cited over-harvest as a possible reason for the collapse of the summer-run stocks. However, other natural causes may also have contributed to the decline as a simultaneous decrease of chum salmon stocks also appeared on the whole Russian coast.

Fig. 4 Ratio of pink salmon catch between river groups (from north to south) in western Kamchatka, 1980-1986. Row 1 - from the Lesnaya to Utkholok River; 2 - from the Kovran to Sopochnaya River; 3 - from the Saychek to Kolpakova River; 4 - from the Brjumka to Pymta River; 5 - from the Kihchik to Opala River; 6 - from the Opala to Kambalnaya River.

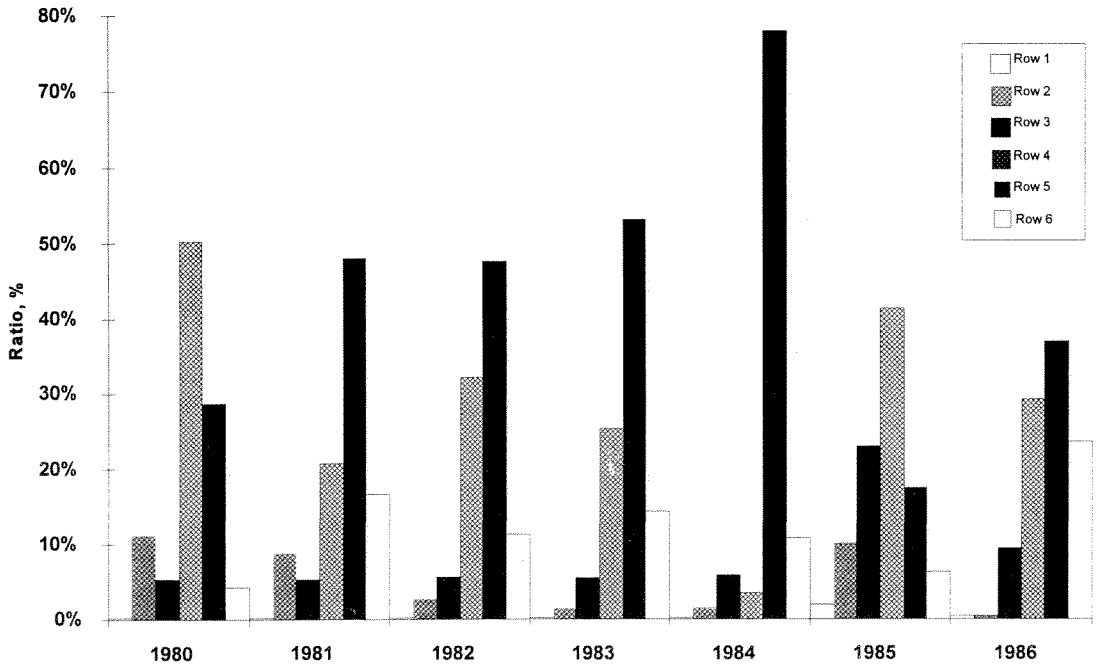


Fig. 5 Ratio of pink salmon catch between river groups (from south to north) in eastern Kamchatka, 1980-1986. Row 1 - from the Khodutka to Bearezovaya River; 2 - the Kamchatka River; 3 - from the Ucka to Drapka River; 4 - from the Kikmavayam to Tymlat River; 5 - from the Packlavayam to Anapka River; 6 - from the Lylangvayam to Kultushnaya River; 7 - from the Impucka to Apucka River.

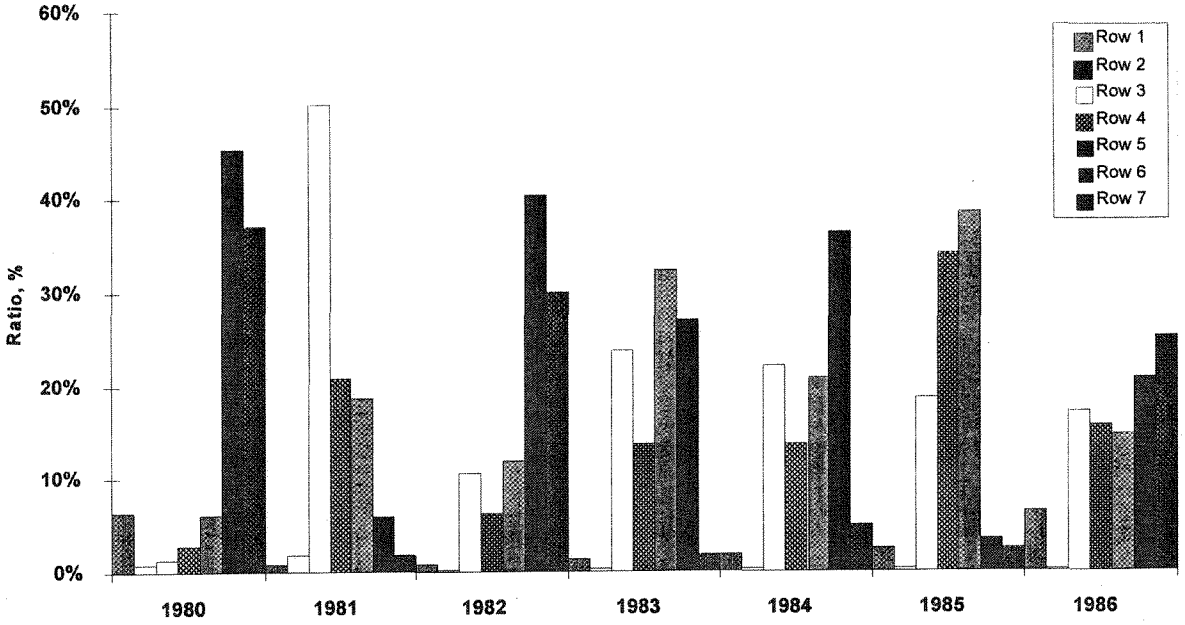
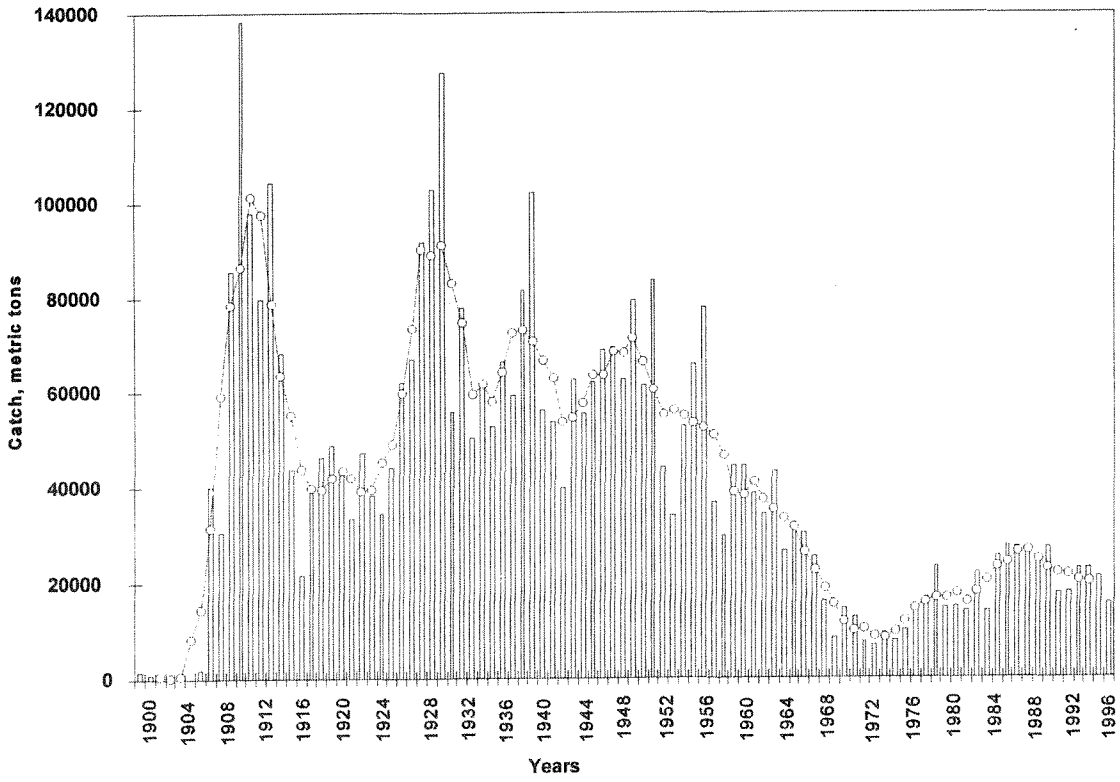


Fig. 6 Total Russian catch of chum salmon with 5-year moving average (solid line).



In 1929-1930 the harvest of chum salmon increased to comparatively high values. This increase was due to development of fisheries for chum salmon outside the Amur Region which contributed no more than 17-19% of the total catch. During that period, the western Kamchatka stocks were the largest component of the Russian chum fisheries, contributing 47.7 - 48.4% of the total. In the 1930s - 1940s, the harvest of chum salmon was relatively stable. Annual catch varied in three year cycles within the range of 52 - 79 thousand tons. According to classical theory, these stable cycles may have been related to over-seeding of the spawning grounds. It is well known that three-year-olds contribute a substantial component of spawners in these Russian stocks, especially in years of high population numbers.

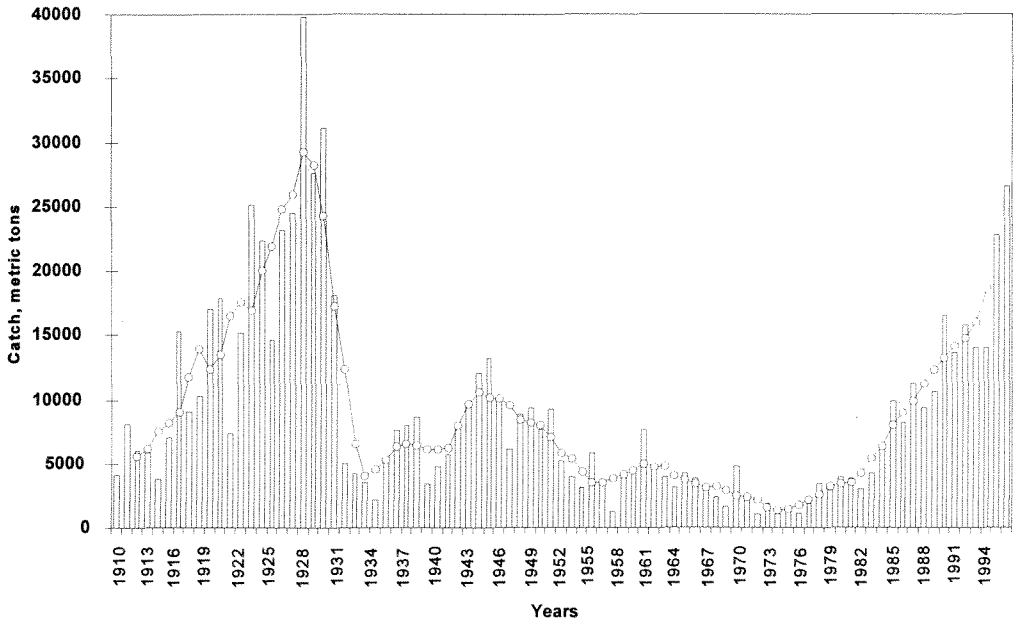
From the early 1950s to the mid 1970s the Russian harvest of chum salmon again decreased. This decrease was gradual but rather significant and was undoubtedly connected to the depleted condition of Russian chum salmon stocks. The decline occurred in all Russian regions (Figure 3). The eastern Kamchatka annual catch value fell from 10-11 tons down to 0.7 - 1.2 thousand tons; the western Kamchatka annual catch fell from 15-23 to 0.2 - 0.3 thousand tons; the Sakhalin and Kuriles annual catches fell from 7-10 thousand tons to 1.8 - 1.9 thousand tons; the Okhotsk Sea coast annual catches fell from 11-19 thousand tons to 0.2 - 0.3 thousand tons; the Amur region annual catch fell from 11-13 thousand tons to 2.6 - 3 thousand tons; the Primorje region annual catch fell from 2.5 - 4 thousand tons to 0. The southern stocks of chum salmon have not recovered to this time. In the Amur and Primorje regions, the anthropogenic influence on spawning habitat impacted chum stock restoration. On Sakhalin and Iturup Island, depleted chum stocks are too weak to be commercially fished. On the northern Okhotsk Sea coast and eastern Kamchatka, a slow recovery of chum stocks has occurred after 1975, but during the 1990s these stocks began to decrease again.

It is believed that competition with the chum juveniles of Japanese hatchery origin during the marine rearing phase has prevented recovery of the wild Russian chum stocks to some degree. More than 2 billion chum smolts are released annually from the Hokkaido and Honshu hatcheries. These hatchery releases resulted in a 12-fold increase in the Japanese catch of chum salmon since the mid 1970s. Chum salmon of all Asian and American stocks spend their feeding period in the Bering Sea and adjacent Pacific waters during the warm seasons. This is a relatively limited area, and the concentration of fish increases the competition for food. It is possible that the decreasing trend in catch of wild stocks of chum salmon will continue in the near future, given expected unfavorable climatic conditions mentioned above.

SOCKEYE SALMON

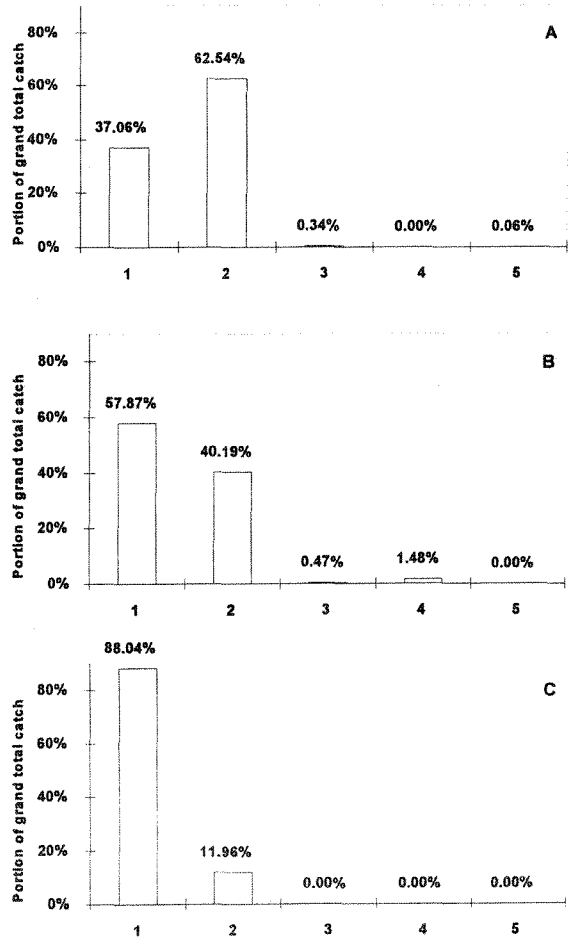
In contrast to chum salmon, the Asian stocks of sockeye salmon are currently in good condition (Figure 7). These stocks are almost completely

Fig. 7 Total Russian catch of sockeye salmon with 5-year moving average (solid line).



concentrated on the Kamchatka Peninsula in the lake systems of the Ozernaya and Kamchatka Rivers (see Figure 8 for distribution of regional catch). Since sockeye salmon always had the highest market value, stock condition has been well reflected by cyclic trends of its harvest. Furthermore, the increasing harvests of sockeye salmon in recent years suggests that stocks are rebuilding from the depressed levels of the early 1970's. At the beginning of sockeye fisheries, the annual catch increased with the development of the fishery. In 1928 the historical peak of sockeye salmon catch, 39.7 thousand tons, occurred (Figure 7).

Fig. 8 Regional distribution of grand total catch of sockeye (A), coho (B) and chinook (C) salmon, 1900-1996. Regions: 1 - eastern Kamchatka; 2 - western Kamchatka; 3 - northern Okhotsk Sea coast; 4 - Okhotsk region; 5 - northern Bering Sea coast.



In the 1930's, a sharp decline in catches occurred, followed by a long period of low stock levels. Interceptions by Japanese driftnet fishery near the Kamchatka coast (Harris 1989) which developed during this period, may have contributed to the low stock levels of Asian sockeye stocks during the 1950's to the late 1970's. However, the driftnet fishery may not be the only reason for the sharp decline in catch. Unfavorable climatic conditions may have contributed additionally to detrimental effects of the driftnet fishery in 1950s - 1970s. For example, after the very cold winters of 1968 - 1970, the sockeye salmon catch reached its lowest level of 1.0 thousand tons in 1972. Chum catch also declined to a minimal level of --0.7 thousand tons in this year.

Like other salmon species, the stock condition and catches of sockeye salmon increased after the mid 1970s. In 1995, the total harvest (including the catch of Russian and foreign driftnet fleet within the limits of the Russian Economic Exclusive Zone) of sockeye salmon exceeded 20 thousand tons for the first time since the 1930's. The cessation of high seas driftnet fishery has promoted the growth of sockeye catch in the Russian EEZ. It appeared in accordance with the international convention under the aegis of NPAFC.

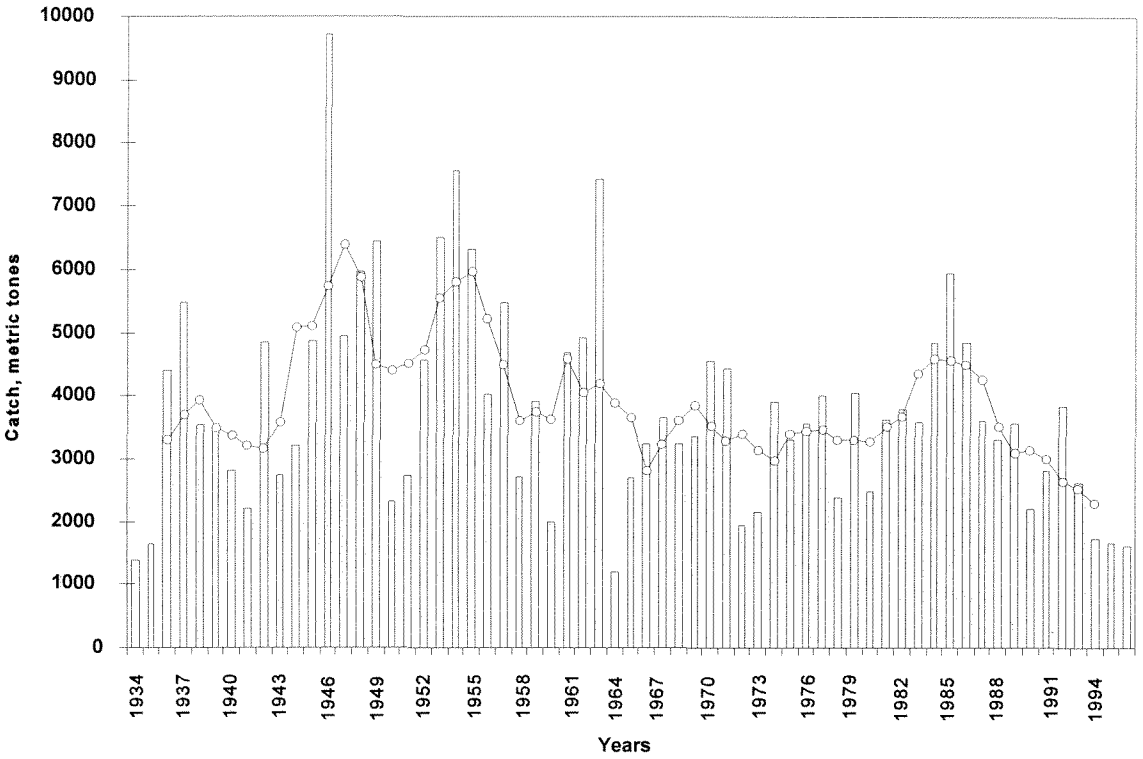
Prior to 1926, the proportion of western Kamchatka sockeye salmon stocks in the Russian catch was noticeably higher than that of eastern Kamchatka. During the period 1926 - 1929 the sockeye catches in eastern Kamchatka increased sharply, surpassing those of western Kamchatka by 1.2 - 1.5 times. During the period of low catches there were no consistent differences in the proportion of sockeye salmon catches among eastern and western Kamchatka. Since 1985, the catches from western Kamchatka region have been higher than eastern Kamchatka and this dominance has been gradually increasing. During the period 1910-1996, the proportion of sockeye catches from western Kamchatka has averaged 62.6%, while that of eastern Kamchatka was 37% (Figure 8).

CHINOOK AND COHO SALMON

Catches of chinook and coho salmon were lower than those of the other species of Pacific salmon. Relatively abundant populations of coho salmon spawn on the Kamchatka Peninsula and northern Okhotsk Sea coast (Figure 9). Coho salmon catch statistics exist since 1934. The five-year moving average was relatively stable in the range of 3.0 - 4.7 thousand tons (Figure 9). In recent years catches of coho salmon have been declining. It is believed that this decrease in stock condition has been related to increased poaching (illegal fishery) of coho salmon on the spawning grounds.

The Russian catch of chinook salmon consists mainly of one stock, the Kamchatka River, which has contributed more than 85% of the catch during 1934-1996. The remainder of the catch was from the Bolshaya River on the western Kamchatka peninsula. There exist several stocks of chinook salmon in western Kamchatka that are currently unexploited. It

Fig. 9 Total Russian catch of coho salmon with 5-year moving average (solid line).



is believed that these small stocks would allow an additional catch of about 100 tons of chinook salmon annually, if exploited. Dynamics of the Kamchatka River stock were characterized by increasing catches during the period 1969 - 1988 (Figure 10). Catches have been decreasing since 1977, when the peak catch of 3.1 thousand tons was achieved.

FUTURE OUTLOOK

It is believed that there is a significant potential for increasing the yield from salmon fisheries in some regions of the Russian far east by improving fishing methods and gears. More than 90% of the total salmon catch in the Russian EEZ is obtained by beach and river seines that are operated by small vessels. This fleet of small vessels sometimes finds it difficult to conduct fishing operations even during modest storms that are common during the fishing season. Thus, the large and modern motherships (where salmon are processed) must often stand idle because of stormy weather. This is especially true for western Kamchatka region where because of the exposed coast line it is difficult to conduct beach seining operations. In western Kamchatka a much lower proportion of the run is harvested relative to other areas (Figure 11). This is especially so during years of high pink abundance. In some areas logistical problems with the salmon processing industry has resulted in limited utilization of salmon runs.

Since 1991, the TINRO-Center had the opportunity to conduct large-scale complex sea expeditions during the Pacific salmon anadromous run. The number and biomass of maturing salmon were assessed by trawl surveys in the main regions of the Russian EEZ. In the near future, such expeditions may provide us with more correct information on the condition of Pacific salmon stocks, in particular pink salmon, in the Russian Far East.

Pacific salmon hatcheries are developing on the Russian far east in the main regions of salmon fisheries. The volume of enhanced Pacific salmon production is about 500-550 million fry released annually, with pink salmon comprising approximately 53% and chum salmon 48% of the fry released. The primary locations of salmon hatcheries are in the Sakhalin and Iturup Islands. The contribution of enhanced salmon production to the total Russian catch can not be clearly assessed. Some specialists consider that hatcheries had an important role in increasing pink salmon returning to the eastern Sakhalin coast during 1994 - 1995. This was due to the improving technology of the new hatcheries, built in the framework of a Russian - Japanese cooperative project. However, this view cannot be substantiated based on the estimated low proportion of hatchery fry (15%) of the total salmon fry produced.

Fig. 10 Total Russian catch of chinook salmon with 5-year moving average (solid line).

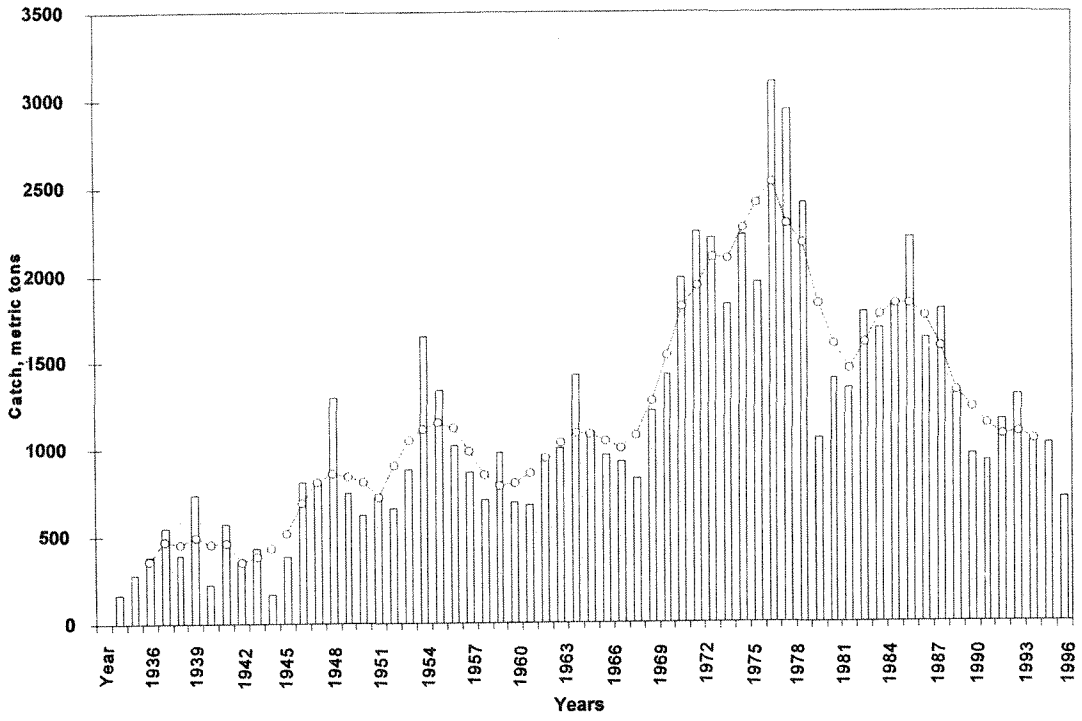
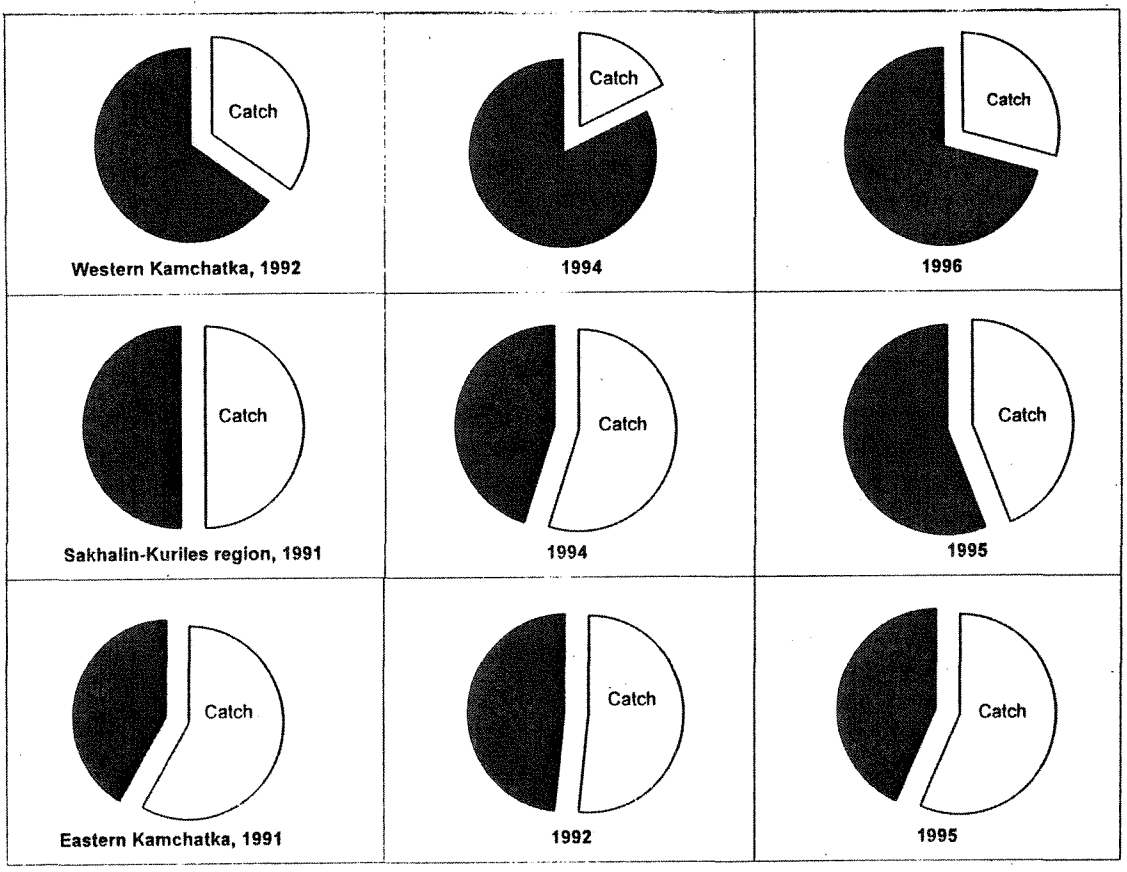


Fig. 11 Relative magnitude of pink salmon catch (open) and escapement (shade), by region, during 1990's.



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