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On Pink Salmon (Oncorhynchus gorbuscha) Abundance Influence on Asian Sockeye Salmon (Oncorhynchus nerka) Abundance

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ABSTRACT

Sockeye salmon reproduction in Asia is practically completely concentrated in Kamchatka peninsula. A total abundance of the mature part of the Asian sockeye salmon (the Ozernaya River, the Kamchatka River, minor Asian stocks) grew almost twice in 1985-2000 in comparison with the previous period of 1970–1984. In 1957–1983 a high abundance of pink salmon (dominating generations) by odd years was observed simultaneously at both coasts. In even years the abundance of pink salmon of the both coasts was considerably lower. Due to overflow of the spawning grounds almost the whole generation of pink salmon of the Western Kamchatka of 1983 died. As a result starting 1985 and till now in all odd years the abundance of pink salmon at the North-East Kamchatka became much higher than that at the Western Kamchatka. In its turn in even years starting 1986 and till now they observe a bigger abundance of pink salmon at the Western Kamchatka and a lower – at the Eastern Kamchatka. Changes of roll-down dynamics and pink salmon 0+ abandance of the both coasts as a whole changed food relations of pink salmon and sockeye salmon in the sea, especially at the primary stages of the marine period of life. These species are food rivals during the marine period of life. A historical fact of the Western Kamchatka pink salmon dominating generations' shift from odd to even years, and the coincident with this event increase of the Asian sockeye salmon stocks may be a basis for researches of this area sockeye salmon abundance by separate periods.

INTRODUCTION

Researches (Semko 1954; Birman 1985; Welch and Parsons 1993; Ricker 1995; Bugayev 1995; Bigler et al. 1996; Bugayev et al. 1996; Karpenko 1998; Yerokhin 1998; Karpenko et al. 1998; Bugayev et al. 2001 and others) agree in opinion that pink salmon, as the most numerous and short-cycle specie, may to some extent influence the growth and abundance of other salmon species at sea – first of all chum and sockeye salmon, and in some cases chinook salmon as well. The abundance and salmon growth at sea are closely interdependent. We have not found the data of the pink salmon influence on coho salmon number yet, though there is some information on coho salmon juveniles' eating out pink salmon 0+ (Birman 1985; Karpenko 1998).

The mechanism of pink salmon abundance influence on the growth rate and abundance of salmon generations is to be sought first of all in competitive food interrelations of those species during the fattening sea period, and also in the peculiarities of distribution of mature and immature individuals by the fattening areas in the years of high and low number of all salmon species at sea (Semko, 1954; Andriyevskaya, 1975; Birman, 1985; Welch, Parsons, 1993; Ricker, 1995; Bigler et al., 1996; Karpenko, 1998; Yerokhin, 1998; Karpenko et al., 1998; Bugayev, Dubynin, 2000 and others).

Sockeye salmon distribution in Asia is more than 90-95% concentrated in Kamchatka, where about 80% of all the Asian sockeye is at present fished in the basins of the Ozernaya and Kamchatka Rivers.

It was determined (Bugayev 1995; Bugayev et al. 1996; Bugayev and Dubynin 2000; Bugayev et al. 2001) that the growth of individuals at sea and the dynamics of the Ozernaya River sockeye salmon number is influenced by the pink salmon abundance at the Western and Eastern Kamchatka.

But only after the 1999 fishing season it became finally clear (Bugayev, 2000) that in the late 1980-s – mid 1990-s considerable fundamental changes took place in the dynamics of all the Asian sockeye salmon abundance and not only of the Ozernaya River stocks. In our opinion those changes are connected with the fluctuations of the pink salmon abundance. This paper is dedicated to the analysis of the present situation.

METHODS AND MATERIALS

The materials for this research were the catch statistics of the spawned sockeye producers of the Ozernaya, Kamchatka Rivers and other minor stocks within the Kamchatka Region and the Koryak Autonomous District as well as the data of the Asian sockeye salmon stocks catch at sea in 1970-2000 (Selifonov 1975; Bugayev and Dubynin 2000). All this allowed calculating the number of the mature part of the Asian sockeye stocks at sea.

The estimation of inshore run of the stock mature part (MP) of sockeye salmon abundance at sea was made by two variants. The first one – calculation of MP abundance of the Ozernaya River and other Asian stocks by the differentiation method (Selifonov 1975) with the expert estimation in 1973–2000. The second variant – calculation of MP abundance of the Ozernaya River and other Asian stocks in 1970–1976 by the first variant, and in 1977–2000 – by the standard methods (Bugayev and Dubynin 2000).

In 1957–2000 the Western and Eastern Kamchatka pink salmon abundance was estimated by the coastal catches and letting in to the spawning grounds without calculation of its catch by drift fishing (Bugayev 1995; Bugayev et al. 1996, 2001).

RESULTS AND DISCUSSION

At Fig. 1 fluctuations of the Western and Northeastern pink salmon in 1957-2000 are shown. As it is seen, 1957, 1983 and 1998 are distinguished for the extremely high abundance of the Western Kamchatka pink salmon abundance. Due to an organization malfunction of fishing in 1983 a high approach of fish caused a great spawning grounds overfilling with pink salmon producers in this area. Almost the entire generation of the Western Kamchatka pink salmon of 1983 died. As a result starting 1985 and up till now in all the odd years the pink salmon number at the Northeastern Kamchatka got considerably higher that that at the Western Kamchatka (Fig. 1).

In its turn in even years starting 1986 and up till now a higher number of the Western Kamchatka pink salmon and a lower number of that of the Eastern Kamchatka are observed (Fig. 1). The return of 1984 is not the one of 1983-generation, that is why in our opinion it's more correct to speak of the reconstruction in the system of pink salmon fluctuations of the even generations starting 1986 only.

And during the period - 1957–1983 – a high abundance of pink salmon (dominant generations) in odd years was observed simultaneously at the both coasts; in even years the number of pink salmon of the both coasts was much lower (Fig. 1).

Changes of the roll-down dynamics and pink salmon 0+ abundance of the both coasts undoubtedly changed food interrelations of pink, sockeye and chum salmon, especially at the initial stages of the marine period of life, those are also food competitors at this period (Andriyevskaya 1975; Birman 1985; Welch and Parsons 1993; Karpenko 1998; Yerokhin 1998; Karpenko et al. 1998 and others).

Up to 1981 inclusive at sea at the next year (even) pink salmon 0+ of abundant dominant generations rolled down from both coasts simultaneously. Probably due to death of the major part of the Western Kamchatka pink salmon generation in 1983 and 1984 the total roll-down of both coasts pink salmon 0+ turned out weaker than for the previous even years.

Up to 1982 inclusive as a result of the simultaneous roll-down to sea of numerous pink salmon 0+ of the dominant generations (odd years) from both coasts and their further fattening at sea the food base was hard eaten out regularly in a year. The latter negatively first of all told upon pink, sockeye and chum salmon juveniles. Not excepting that during some years the food base eating out was a catastrophe for salmon juveniles. The latter might have negatively influenced the number of the above salmon generations that were fattening during those years at sea.

Starting 1985 generation (return of 1983 generation) due to lack of coincidence by years at both coasts of pink salmon dominant generations' roll-down years the fattening conditions of Kamchatka sockeye salmon stocks might have improved as well as the survival of pink, sockeye and chum salmon at the marine period of life. This may have happened owing to a more proportional pink salmon 0+ coming to the ocean and a decrease of interannual food competition in comparison with the period prior to the shift of the spawn year of the pink salmon dominant generations of the Western Kamchatka (Bugayev 2000; Bugayev and Dubynin 2000).

This of course is an extremely simplified scheme. It's more of a working hypothesis for further researches of food interrelations of pink, sockeye and chum salmon at sea. We do not even aspire to its partial solution because this problem is so diverse and complicated that in our opinion it will hardly be solved in the nearest future.

According to R. S. Semko (1939, 1954) in the West Kamchatkan rivers over the period 1920-1934 the obvious cyclic dynamics in pink salmon catches has been demonstrated, i.e. the catches for even years are as several times as much being compared to those for odd years. In the other words, the situation is similar to that one observed recently (for 1985-2000) when the maximum stock abundance of pink salmon at the West Kamchatka has been observed for even years and the maximum stock abundance of pink salmon at the East Kamchatka - for odd years.

Exactly at the mid-end 1920-s high abundance catches of sockeye salmon West and East Kamchatka took place (Anonymous 1989) and maximum catches of sockeye salmon of Kamchatka River (Bugayev 1995).

For 1935-1937 the abundance of pink salmon at the West Kamchatka has been changed, the cyclic dynamics has been broken. Otherwise, the difference between maximum catches for even years and minimum catches for odd years varies. At the same time in the East Kamchatka the range of the pink salmon catches, either for even and for odd years, has been enlarged (Semko 1939, 1954). This is why it has been suggested a pretty extended transitional period to be (without obvious cyclic dynamics occurring) of mediate level in Kamchatkan pink salmon stock abundance.

At present (due to absence of air-calculating data at the spawning grounds) it's impossible to exactly define a year by the pink salmon catches before 1957 when in the past the abundance of pink salmon of the Western and Northestern Kamchatka began to fluctuate at one phase: during odd years they started to observe a high number in all Kamchatka, during even years – a lower number.

Basing on the analysis of the data of pink salmon catches in Kamchatka (Semko 1939 1954; Anonymous 1989) we suppose that a similar situation here was first observed in early-mid 1940-s and continued up to 1984 inclusive.

Before early-mid 1940-s, as we presume, the Western Kamchatka pink salmon number peaks were at even years during some period, and the Northestern Kamchatka – at odd years, i.e. they observed a situation similar to the present (1985–2000).

One of the reasons that caused a change of the pink salmon dominant generations in the past and now might have been spawning grounds overfilling. But we do not exclude that the last structural reorganization in the Western and Eastern coasts of Kamchatka pink salmon number in 1983–1986 is also a subsequence of global changes in the ecosystem of the North-West Pacific and the entire World Ocean, as well as it may be connected with the general climate warming on the Earth (Suplee 1998). The transition from the cold climate phase to a warmer one may cause a growth of temperature contrasts of the frontal sections in the ocean (characteristics of the ocean dynamics). When the main systems of streams notably liven up a synoptical and mesoscale changeability grows, therefore a large-scale horizontal and vertical exchange increase, what should positively tell upon the World Ocean bioproductivity (Byshev et al. 1997).

For the last ten years the changes of a global character in the ecosystems of the Far East seas have been observed (Shuntov et al. 1996; Shuntov et. al. 1997; Naumenko 2000), the changes being forecasted at first in early 1980-s (Shuntov, 1986). Whole the process of transformation has not been completed yet; the ecosystems important for the fishery undergo a transition period currently (Shuntov et al., 1996).

Exactly at the early–mid 1990-s pollock abundance reduction took place and herring abundance increased in the Western Bering Sea (Naumenko 2000).

As shown at Fig. 2, the abundance of the main stocks of the Asian sockeye has grown starting 1984–1985 in comparison with the previous period of 1970–1983. First of all this concerned the total abundance of approaches of sockeye salmon of the Kamchatka and Ozernaya Rivers, and also the total abundance of approaches to the rivers estuary of all big and minor Kamchatka Region (KR) and Koryak Autonomous District (KAD) sockeye salmon stocks. At last starting 1984–1985 the abundance of the mature part of the main Asian sockeye salmon populations increased at sea even prior to drift fishing (1).

A historical fact of the dominant generations of the Western Kamchatka pink salmon shift from even years to odd ones, and a growth of sockeye salmon abundance, which in general coincided with this event (Fig. 3), may be a basis for studying sockeye salmon stocks by separate periods. In connection with the fact that in 1984 the dynamics of different coasts pink salmon abundance is to some degree of an intermediate character (Fig. 1, 3), as there was no return from 1983 pink salmon generation, we referred 1984 to the first period (Bugayev 1995).

So, in this work, as in the previous cases (Bugayev 1995; Bugayev and Dubynin 2000), all the materials on the Asian sockeye salmo will be considered by us by the two periods: 1970–1984 and 1985–2000. The logic of such a division is that sockeye individuals that returned for spawning in 1985 and later already contacted at sea in 1984-1985 with the Western Kamchatka pink salmon generation of 1983, which for the first time for many years had no high number a the return of the mature individuals in odd 1985, and was lower in abundance than the Eastern Kamchatka individuals' number (Bugayev 1995; Bugayev et al. 1996, 2001).

As shown at Table 1, during the period of 1970–1984 the abundance of MP of the Asian sockeye in most cases was lower than that during the period of 1985–2000. The growth of the Ozernaya River sockeye salmon number is notable as well as the increase of the total abundance of the main Asian sockeye salmon stocks. The exception is only the Kamchatka River sockeye salmon, which practically increased the average abundance slightly in 1985–2000 in comparison with the previous period.

This situation is explained by a very considerable increase of the Kamchatka River sockeye salmon abundance starting only 1995 and going on up till now. Due to many years exceeding of the optimal abundance of the producers in the basin of the Azabachye Lake in 1977–1985 being the most important in the Kamchatka River sockeye salmon reproduction

(Bugayev 1995). During the period of 1986–1991 the Kamchatka River sockeye salmon abundance was very low (at the same time they observed almost optimal spawning grounds filling at the Azabachye Lake). The Kamchatka River sockeye salmon abundance began to grow only in 1992–1993, mainly owing to the Azabachye Lake sockeye salmon stock. Then the Azabachye Lake sockeye salmon abundance considerably and suddenly rose in 1995. A stable high abundance of the Azabachye Lake sockeye salmon and the entire Kamchatka River has been kept for several years already. During some years the Azabachye Lake sockeye salmon abundance may exceed 60% of the total sockeye salmon abundance of the Kamchatka River.

Table 1. Abundance of the mature part (MP) of the Asian sockeye salmon abundance in 1970–2000, in thousands of fish.

Area, stocks group	Estimation variant	1970 – 1984	1985 – 2000	1985 – 1994	1995 – 2000
The Kamchatka River	1 2	2494 2330	2896 2471	2039 1567	4326 3978
The Ozernaya River	1 2	2281 2494	5530 6061	5950 6539	4830 5266
Minor Asian stocks	1 2	753 704	1953 1847	2032 1915	1821 1733
Total number	1 2	5528 5528	10379 10379	10021 10021	10977 10977

For a more complete analysis of the situation we additionally subdivided the period of 1985–2000 into to sub-periods – 1985–1994 and 1995–2000. The data of this subdivision show that in 1995 the Kamchatka River sockeye salmon has considerably increased the abundance of MP in comparison with 1970–1984. This increase is connected in our opinion with juveniles' fattening conditions improvement at the marine period of life, what is, as we presume (Bugayev 2000; Bugayev and Dubynin, 2000), is a subsequence of changes of the Western and Eastern Kamchatka pink salmon abundance fluctuations. The Kamchatka River sockeye salmon has no had such a high abundance for about 55–60 years (Bugayev 2000).

Essential arguments in favor of the fact, that the dynamics of the Kamchatka River abundance is at present highly defined by a marine and not fresh water period of life, are the following facts. So, in 1992–1994 the abundance of producers in the Azabachye Lake exceeded the optimal one 7.0–9.4 times, and in 1998–2000 a catastrophical abundance reduction did not occur, what had usually been observed before at the exceeding the optimal the Azabachye Lake sockeye salmon abundance (Bugayev 1986, 1995). Although the abundance of the generations has considerably decreased, the abundance of the Azabachye Lake sockeye salmon in the general stock of the Kamchatka River sockeye salmon made about 30% in 1998 – 2000. A favorable situation with the Azabachye Lake sockeye salmon positively told upon the general abundance of the Kamchatka River sockeye salmon abundance.

If our hypothesis of pink salmon influence on the dynamics of the Asian sockeye salmon abundance is correct, a positive situation for sockeye salmon at the marine period of life will keep until the Western and Northeastern Kamchatka pink salmon dominant generations do not coincide by spawning years.

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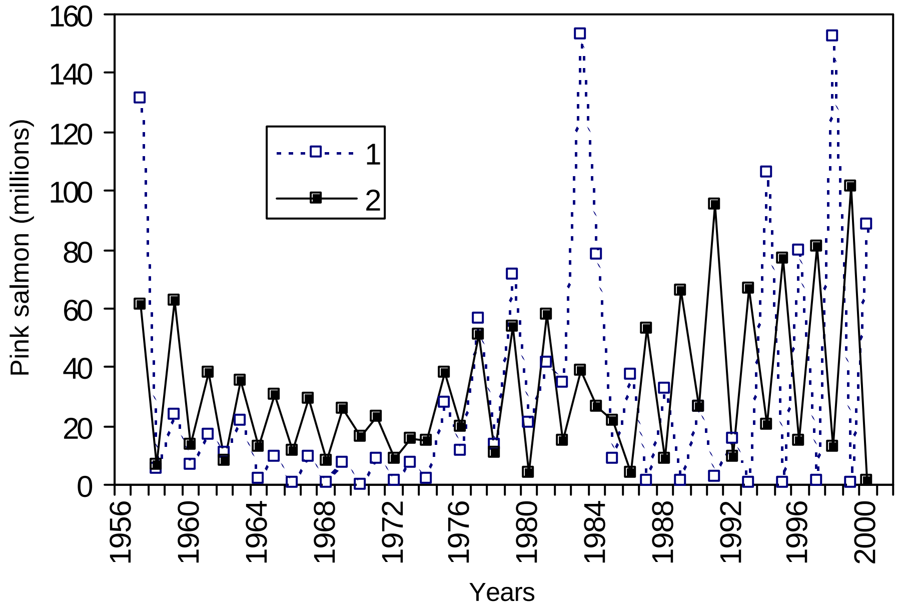

Fig. 1. Pink salmon approach to the rivers of the Western (1) and Eastern (2) Kamchatka in 1957–2000 after passing the drift fishing zone at sea, in millions of fish.

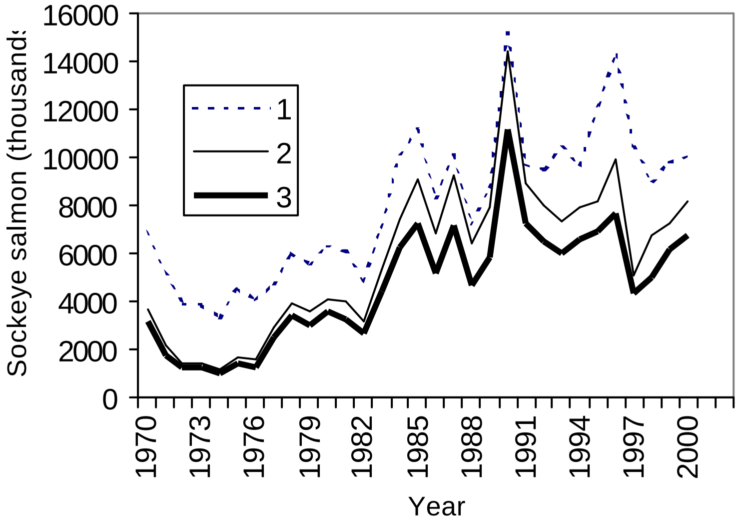

Fig. 2. Abundance of the main Asian sockeye salmon stocks at sea in 1970–2000: the number of mature part of the Asian sockeye salmon of all rivers of KR and KAD at sea prior to drift fishing (1), the total approach of the mature fish to the estuaries of all rivers of KR and KAD (2), the total approach of the mature fish to the Kamchatka and Ozernaya Rivers estuaries (3), in thousands of fish.

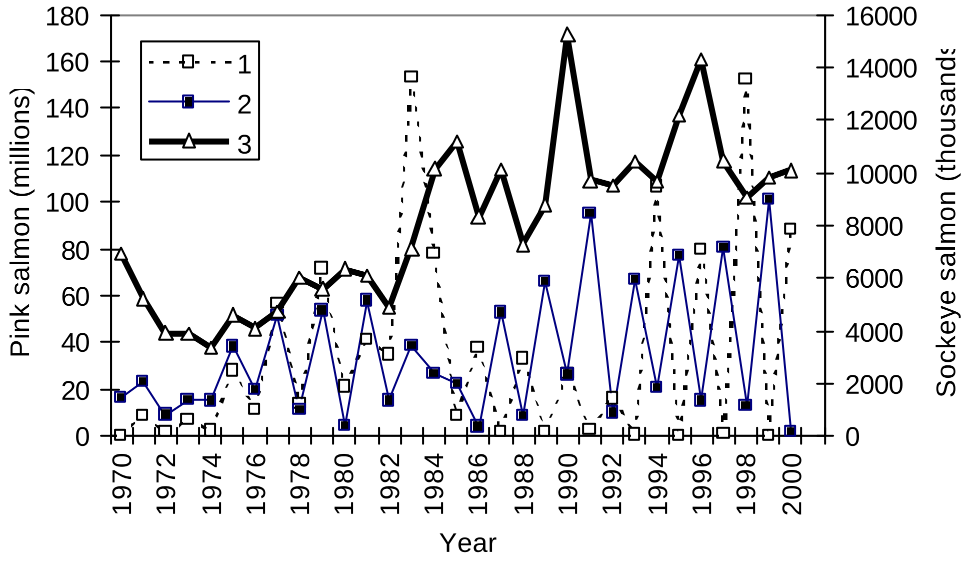

Fig. 3. Abundance of mature sockeye salmon and pink salmon at sea in 1970–2000: the approach of pink salmon to the rivers of the Western (1) and Eastern (2) Kamchatka after passing the drift fishing zone, million pieces; the number of the mature part of the stocks (by the first estimation variant) of sockeye salmon of all KR and KAD rivers at sea prior to drift fishing (3), in thousands of fish.