SALMON OF THE NORTH PACIFIC OCEAN—PART IV
SPAWNING POPULATIONS OF NORTH PACIFIC SALMON

2. PINK SALMON IN THE FAR EAST

by
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GEOGRAPHICAL RANGE OF SPAWNING GROUNDS

According to Mori (1935), the southernmost pink salmon (*Oncorhynchus gorbuscha* (Walbaum)) spawning streams in Asia are the Tumen River, situated at the boundary between Korea and the U.S.S.R., and the North Nandai River immediately south of the Tumen River. During autumn through spring, in commercial concentrations, pink salmon visit waters off the coast where the above rivers are situated (Yoshida, 1942), but these pinks do not migrate into the streams of this area. Only very small quantities of pink salmon migrate into Korean streams. In Primore, too, pink salmon runs of commercial importance occur only in the northern parts, their abundance increasing toward the north (Milovidova-Dubrovskaia, 1937).

The southernmost pink salmon stream on the Japan Sea coast of Japan is the Teshio River in northern Hokkaido. The hatcheries on this stream catch small quantities of pink salmon every year for artificial propagation (data of the Hokkaido Salmon Hatchery). It is possible that very small numbers of pink salmon migrate into streams farther southward, but there have been no records of pink salmon catches in streams south of the Teshio River. Pink salmon are found, during their spawning migration, in waters off the Noto Peninsula, or even southward, and considerable amounts of pink salmon are caught by coastal traps and other types of gear along the Japan Sea coast of Honshu. However, these pink salmon are not bound for streams in Japan. On the southern part of the Japan Sea coast of Sakhalin, too, large quantities of pink salmon are caught by coastal traps during their spawning migration, but there are no important spawning streams along this part of the Sakhalin coast (Dvinin, 1952). Pink salmon spawn regularly in the streams of Aniva Bay of Sakhalin and the Okhotsk Sea coast of Hokkaido.

The southernmost pink salmon stream on the Pacific coast of Japan is considered to be the Yurappu River, which flows into Uchiura Bay (Hokkaido). There have been no records of pink salmon catches in the streams of northeastern Honshu, although pink salmon have been caught in Pacific waters off the coast of northeastern Honshu. According to Sano and Kobayashi (1953), considerable numbers of pink salmon migrated into the streams of southern Hokkaido until approximately 20 years ago, and significant coastal catches were made. In recent years, however, the numbers of pink salmon visiting southern Hokkaido streams have been extremely small. The Yurappu River used to be the southernmost stream for pink salmon spawning, but it has been receiving very few, if any, pinks in recent years. At any rate, the Yurappu River may be considered the southern limit of the biological distribution of pinks. Adult pink salmon returns have been obtained from transplantation of pink eggs into this stream in some recent years. In general, however, streams along the Pacific coast of Hokkaido west of Cape Erimo did not have large pink salmon spawning populations even before the general decline mentioned above. The Tokachi River and streams farther eastward along the Pacific coast of Hokkaido are still visited by pink salmon, although their quantities have decreased greatly in recent years.

The streams of the various coasts of the Okhotsk Sea, namely, Hokkaido, the Kuril Islands, West Kamchatka, the Okhotsk district, the Amur area and Sakhalin, are visited by spawning pink salmon regularly, and many important spawning grounds are found in these districts. The streams of the Bering Sea and Pacific coasts of Kamchatka, too, have pink salmon spawning grounds.

Shmidt (1950), referring to Andriiashev (1937), placed the northern limit of pink salmon distribution on the Bering Sea coast at Dezhnev Village, which is

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along the northernmost part, and, referring to Drialina (1933), stated that in some years pink salmon migrate into the Kolyma and Indigirka Rivers flowing into the Arctic Ocean. According to Andriiashev (1954) and Kaganovskii (1949), the western limit of the distribution of pink salmon streams in the Arctic Ocean is found at the Iana and Lena Rivers.

Transplantation in 1959 of Far Eastern pink salmon fry into the streams of the Kola Peninsula (northern U.S.S.R.) resulted in the return of adult pink salmon to various coasts and streams of the Barents and White Seas in 1960, and many pinks were also caught along the coast of Norway (Kossov *et al.*, 1960). It is foreseeable that the distribution of pink salmon spawning grounds might be changed greatly by similar transplantations.

DISTRIBUTION OF IMPORTANT SPAWNING GROUNDS AND BRIEF DESCRIPTIONS OF THEIR CHARACTERISTICS

The distribution of pink salmon spawning grounds is well reflected in the coastal catches of pink salmon, with a few exceptions. In order to roughly indicate the coastal distribution of pink salmon over the entire U.S.S.R. Far East, a map (Fig. 1) showing the distribution of U.S.S.R. coastal catches, as prepared by Kaganovskii (1949), and a figure (Fig. 2) showing the

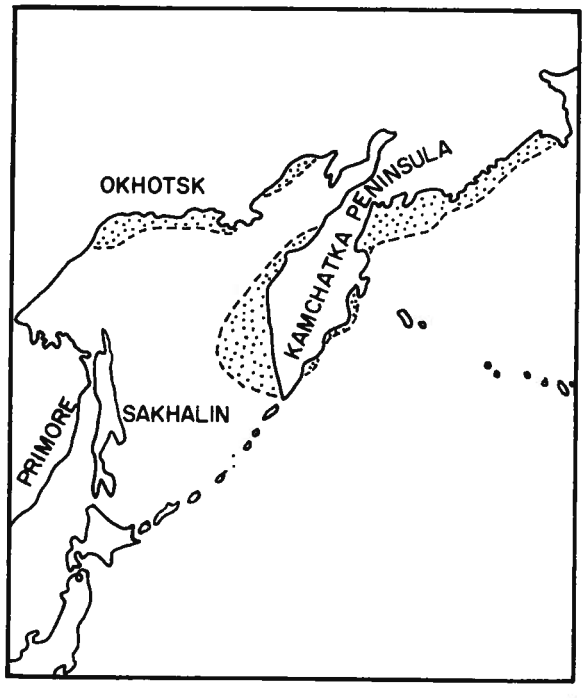

FIGURE 1. Distribution of pink salmon catch (shaded areas) in various areas of the U.S.S.R. Far East, averages for 1933–43 (Kaganovskii, 1949).

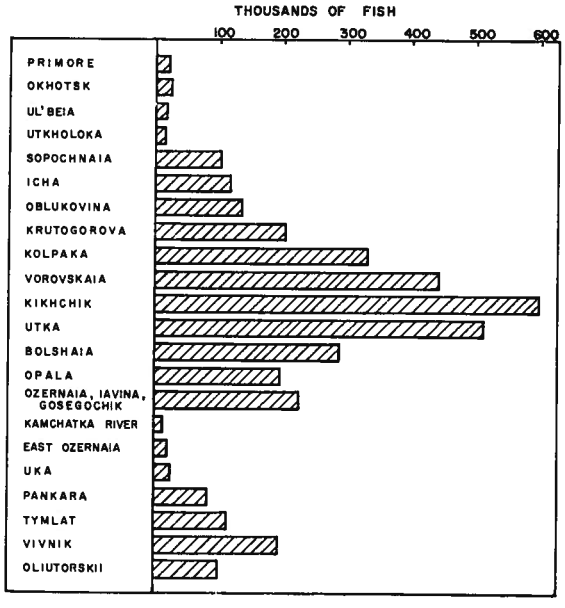

FIGURE 2. Average catch of pink salmon per unit of gear from various U.S.S.R. coastal fishing areas (mean of 1932–41) (Taguchi, 1957).

average pink salmon catches per unit of gear in different districts of the U.S.S.R. coast, as prepared by Taguchi (1957), are reproduced here. These charts indicate that the most important spawning grounds of pink salmon in the U.S.S.R. are on the west coast of Kamchatka, particularly its southern half, and that other major spawning grounds are found in East Kamchatka, the northern coast of the Okhotsk Sea, the Amur River and northern Primore, and southern Sakhalin. Distribution is by no means uniform along the coastlines of the Far East. One of the factors contributing to such uneven distribution of pink salmon spawning is the distribution of streams themselves, but this is not the sole cause. For example, large quantities of sockeye salmon migrate into the Kamchatka River, which is the largest stream system in East Kamchatka, while only small numbers of pinks migrate into the same river.

In the following paragraphs, the characteristics of spawning grounds are described for various districts. The following area division is used: Hokkaido-Kuril Islands, Primore, Amur, Sakhalin, the northern Okhotsk coast, West Kamchatka and East Kamchatka. Figure 3 gives approximate locations of some of the rivers and areas mentioned in this report.

HOKKAIDO-KURIL REGION

Practically all salmon streams in the Hokkaido-Kuril region have hatcheries which catch salmon for egg collection. Hence, the relative sizes of pink

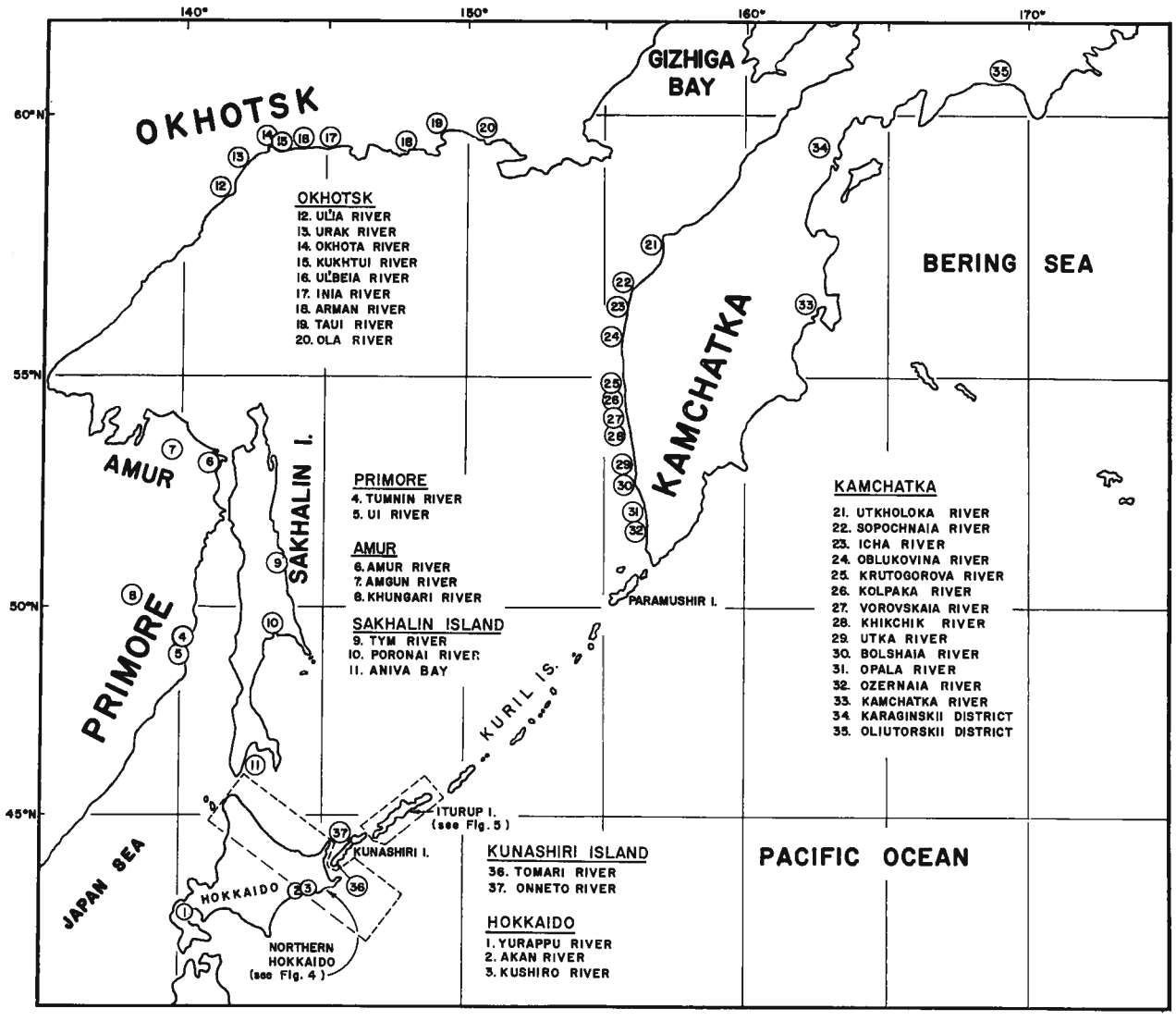

FIGURE 3. Map of the Far Eastern region discussed in the text, with approximate locations of some of the pink salmon spawning rivers and areas indicated.

salmon populations in these streams are reflected in the numbers of pinks caught by the hatcheries in the same streams. Table 1 shows the average numbers of adult pink salmon caught by catching stations in various streams during the period 1951–60. Figures 4 and 5 give the locations of pink salmon spawning streams of northern Hokkaido and Iturup Island, respectively.

The important pink salmon spawning streams in Hokkaido are limited to rivers flowing into Nemuro Strait and the Okhotsk Sea ; only small numbers of pinks migrate into the streams of the Pacific coast. It is said that large numbers of pinks used to migrate into some of these Pacific streams, however. On the Pacific coast, catches of pink salmon have been made in the Yurappu, Akan and Kushiro Rivers (see Figure 3), but pink salmon returns to the Yurappu River have been from eggs transplanted from other areas. At present, no pink salmon catches are made in this stream, because transplantation has been discontinued. In the Akan and Kushiro Rivers, pink salmon runs have been very small since the late 1950's, although large numbers of spawners used to migrate into these rivers, which are geographically close to the more important Nemuro Strait pink salmon streams.

Along the coast of Nemuro Strait, there are two relatively large rivers, the Nishibetsu and the Shibetsu, and many small streams (Fig. 4). The streams in the northern part of this coast are short mountain streams originating in the mountains of Shiretoko

TABLE 1. Average numbers of pink salmon caught by hatcheries in various rivers of Hokkaido, Kunashiri and Iturup Islands (from data of the Hokkaido Salmon Hatchery)[1] and estimated escapements to Urup Island (Mihara, 1952).

River	Number caught
HOKKAIDO—PACIFIC COAST (see Fig. 3)	
1. Yurappu	166
2. Akan	661
3. Kushiro	1,061
HOKKAIDO—NEMURO STRAIT (see Fig. 4)	
4. Furen	900
5. Bettoga	224
6. Nishibetsu	11,918
7. Tokotan	236
8. Shunbetsu	466
9. Tohoro	326
10. Shibetsu	3,011
11. Churui	759
12. Kunbetsu	41
13. Ubetsu	519
14. Shunkarikotan	462
15. Rausu	284
16. Sashirui	488
HOKKAIDO—OKHOTSK COAST (see Fig. 4)	
17. Iwaobetsu	7,176
18. Shari	2,081
19. Yambetsu	4,471
20. Mokoto	985
21. Abashiri	869
22. Tokoro	3,619
23. Yubetsu	8,016
24. Monbetsu	575
25. Shokotsu	2,149
26. Okoppe	2,441
27. Omu	2,591
28. Horonai	9,558
29. Otoshibe	660
30. Fureppu	1,410
31. Tokushibetsu	8,487
32. Horobetsu	899
33. Tonbetsu	3,163
HOKKAIDO—JAPAN SEA COAST (see Fig. 4)	
34. Teshio	77
.....	
KUNASHIRI (see Fig. 3)	
36. Tomari	183
37. Onneto	1,114
.....	
ITURUP (see Fig. 5)	
1. Toro	4,731
2. Bettobu	23,833
3. Arimoi	1,947
4. Shana	24,408
5. Biraito	2,005
6. Toshimoi	4,059
7. Oito	5,262
8. Rubetsu	17,131
9. Shibetoro	15,146
10. Rausu	830
.....	
URUP—OKHOTSK SEA COAST	
Iema	6,000
Tokotan	48,000
Kane	36,000
Nishiokawa	36,000
Mishima	48,000
Others	60,000
.....	
URUP—PACIFIC COAST	
Futami	12,000
Higashiokawa	24,000
Garan	12,000
Sosei	24,000
Others	60,000

[1]For Hokkaido areas, figures are average values for 1951–60; for southern Kuril areas, figures are average values of 1936–44.

Peninsula, but those in the southern part run through flat peatbog areas. Both the Nishibetsu and the Shibetsu Rivers belong to the latter group. From all of these streams, an annual average of a little less than 20,000 pinks has been caught for artificial propagation.

The easternmost part of the Okhotsk Sea coast of Hokkaido has only short mountain streams originating in the Shiretoko mountains, but the rest of the coast has streams (originating in the Kitami mountains which run parallel to the coastline) accompanied by relatively large lakes and plains. Also, the coastline has well-developed dunes and some brackish lakes formed by sand bars. The Iwaobetsu River (Fig. 4) is only a short mountain stream on the Shiretoko Peninsula, but it is known as an important pink salmon stream in Hokkaido; the average annual hatchery take is slightly more than 7,000 fish. Among other important pink salmon streams are the Tokoro, Yubetsu, Horonai and Tokushibetsu Rivers (Fig. 4). These streams on the Okhotsk Sea coast produce an average hatchery take of a little less than 60,000 pinks

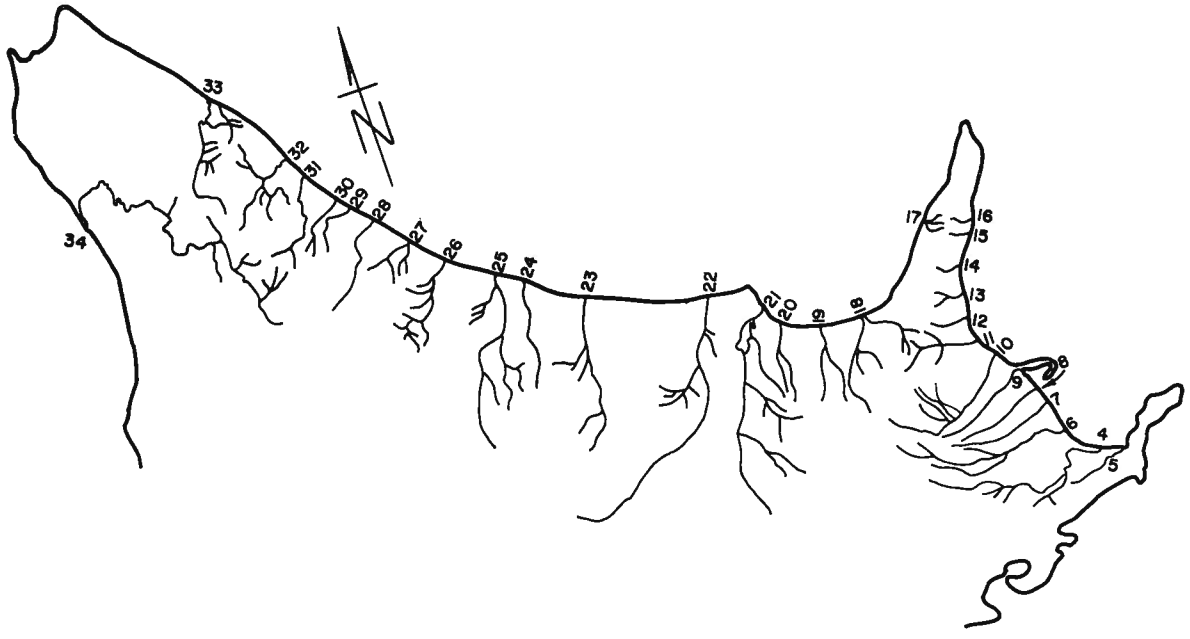

FIGURE 4. Pink salmon spawning rivers in Hokkaido. Reference numbers are those of Table 1.

a year.

The Teshio River (Fig. 4) is the only pink salmon spawning stream on the Japan Sea side of Hokkaido. The Teshio River is the second largest stream on that coast (next to the Ishikari River) and its lower part flows through a wide plain covered by peatbog layers. The middle part runs through a long narrow plain between two mountain chains. Catching pink salmon for artificial propagation takes place only at one station, situated in the middle part of the river system, where the annual average catch is only 77 fish. However, much larger numbers of pink salmon migrate to the spawning grounds of this river system without being caught by the hatchery.

Owing to their geographical locations, the winter conditions of Hokkaido streams are relatively mild, and stream beds are seldom frozen. Moderate snowfalls help to keep streams from too severe conditions. The monthly average air temperature at Abashiri (Ohkotsk Sea coast) ranges from −7.3°C in February to 19.9°C in August, the average annual rainfall is 867 mm, and the maximum snow depth is 85 cm. Snow usually begins to fall in late October and continues until the beginning of May. Generally speaking, the spawning grounds of Hokkaido streams have been deteriorating from such causes as variations in water level as a result of logging, removal of gravel, and expansion of cultivated areas. Also, pollution from starch manufacturing factories and city waste has been considerable in the lower reaches. These circumstances as well as poaching in streams are justifications for the extensive hatchery operations in Hokkaido. Commercial catches of salmon in streams are prohibited in Hokkaido.

Hatchery operations were carried out on Iturup and Kunashiri Islands of the southern Kurils before the end of World War II ; some information on the spawning streams of these islands is available. Although considerable numbers of pink salmon migrate into the streams of Urup Island of the central Kurils, little information is available. For various reasons, central Kuril waters were not intensively exploited during the pre-war years. They were investigated several times for commercial and scientific purposes, and part of the data obtained was published after the war. Table 1 shows the average numbers (for the years 1936–44) of pink salmon caught by the hatcheries of Iturup and Kunashiri Islands before the end of World War II.

Many small streams with small lakes are found on Kunashiri Island. These streams are visited by large numbers of chum salmon and considerable numbers of masu salmon, but they do not receive many pink salmon (Takayasu *et al.*, 1955). During the pre-war years, spawning pinks were caught in the Tomari and Onneto Rivers for artificial propagation : the numbers caught, however, were only several hundreds to several thousands a year.

Fairly large numbers of pink salmon spawn in the streams of Iturup Island (Fig. 5), which is also known for the presence of spawning sockeye. The available data are not directly comparable to those for Hokkaido pink catches, because the periods under study are different. However, hatchery catches averaged about

FIGURE 5. Pink salmon spawning rivers on Iturup Island. Reference numbers are those of Table 1.

100,000 pinks annually on this island, compared with an annual total of approximately 80,000 in Hokkaido hatchery operations. Hatchery operations in the southern Kuril area were most active on Iturup Island and this partially accounts for the large number of fish caught, but there is little question that spawning populations of pink salmon on this island are substantial. Nine of the ten pink salmon spawning streams shown in Table 1 flow into the Okhotsk Sea. The number of streams flowing into the Pacific Ocean is small, and also these streams were difficult to exploit because of poor access. Takayasu *et al.* (1954) conducted limnological investigations on this island, and some information is available on the pink salmon spawning streams. Most of the spawning streams have small lakes of various types, such as closed bays, blocked rivers and volcanic lakes, etc.

For Urup Island in the central Kurils, there is a limnological study by Mihara (1952). According to his rough estimation, the total number of pink salmon migrating into various streams on the Pacific and Okhotsk sides of this island is about 370,000. It is indicated that the pink salmon spawning grounds on this island are as important as or even more important than those on Iturup Island. Mountains are close to the coastline of the island, forming cliffs in many places. However, there are many rivers formed by mountain streams running through numerous swamps. The main spawning streams are given in Table 1 together with rough estimates of the numbers of spawning pink salmon. The largest of these is the Tokotan River, which flows into the Okhotsk Sea ; this river receives large numbers of pinks. There are no large streams on Shimushir and Onekotan Islands, which are situated north of Urup Island, but there are some pink salmon runs to these islands. Paramushir Island, the largest of the northern Kurils, has many pink salmon streams. However, the large commercial catches made by the fisheries based on this island before the end of World War II were from salmon populations migrating through waters around the island, and not from the local populations. There are no records concerning the local pink populations of Paramushir Island, which are undoubtedly very small compared with those passing through waters off the island.

STREAMS OF THE U.S.S.R.

Information on the pink salmon streams along the U.S.S.R. coast is very limited. Detailed descriptions of spawning streams of only two or three rivers are available. Figure 3 shows most of the U.S.S.R. areas mentioned in this section.

In Primore, pink salmon spawn in almost all streams, but their numbers differ greatly between streams. The streams in southern Primore are very insignificant as pink salmon spawning grounds. The number of spawners increases to the northward, and large runs occur in northern Primore. The major spawning streams in northern Primore are the Ui River (flowing into Vanino Bay), the Bolshaia and Maly-Zhuanku Rivers (flowing into Silanchev Bay), the Tumnin River (flowing into Datta Bay, with the main spawning grounds in a tributary—the Ulikae River), and the Chuma-Dua River (flowing into Chuma-Dua Bay). (Milovidova-Dubrovskaia, 1937.) The Tumnin River, which flows into Datta Bay, contributes the greatest portion of the pink salmon catch in Primore. The bay is 9–10 m deep in the middle part and becomes shallower towards the head. The depth becomes less than 2 m on two alluvial banks facing the river mouth. The Tumnin River mouth is 7–9 m deep. The Ulikae River flows, from the left side, into the Tumnin River mouth, and the main spawning grounds are found in this tributary. Spawning fish are protected in this area under regulations. (Milovidova-Dubrovskaia, 1937.)

A detailed study by Kuznetsov (1928) is available for pink salmon spawning in the Amur River. Pink salmon go upstream as far as the Khungari River, which is approximately 700 km from the sea, but their main spawning grounds are in the Amgun River, the junction of which is approximately 200 km from the sea. Some spawning fish migrate in the Amgun River as far upstream as 700 km from the sea. In the Amur River, the spawning of pinks overlaps that of summer chums and sometimes the same areas are used by both species. Pink salmon spawn not only in the main Amur and its tributaries but also in all streams flowing directly into the Amur Firth.

The main spawning grounds of pink salmon in Sakhalin are found on the east coast. Among the major streams are, from the north, the Tym, Poronai, Magunkotan and Naibuchi Rivers, the Poronai River being the largest stream. Pink salmon also spawn in various streams flowing into Aniva Bay. Large quantities of pink salmon are caught by coastal traps during June along the southern part of the Japan Sea coast of Sakhalin—the Chekhov area and southward—but most of these pinks do not spawn in local streams.

There are few pink spawning streams in southwestern Sakhalin. Although there are pink salmon spawning streams of considerable importance in the central and northern parts of the west coast of Sakhalin, pink salmon runs to these streams have been very small in recent years (Dvinin, 1952). Dvinin (1958) also mentioned the spawning rivers Ainskaia, Lesogorka and Agnevo on the northwestern coast of Sakhalin. In addition to the above-cited papers by Dvinin, there is a report by Taranets (1937) on pink salmon spawning in Sakhalin.

The Okhotsk district has many important salmon streams, which form a large salmon spawning region, with the Okhota River in the center. Westward from the Okhota River, there are the Urak and Ulia Rivers; eastward, there are the Kukhtui, Ul'beia and Inia Rivers. Farther eastward, such pink salmon streams as the Taui, Iana, Arman and Ola Rivers flow into Tauisk Bay. In the northwestern part of the Okhotsk Sea, pink salmon spawn in streams tributary to Gizhiga Bay.

There are a great number of pink salmon spawning streams on the west coast of Kamchatka (Fig. 3). Almost all of the important streams are located in areas south of Cape Yuzhnii, with only a small number of pink streams in areas northward. The Bolshaia River has large pink salmon populations and has been best studied for salmon spawning. It is one of the largest rivers in the Kamchatka Peninsula and is formed by such streams as the Bystraia, Plotnikova and Goltsovka Rivers. A long sand bar runs from the north to the south in the river mouth, and pink salmon migrate upstream through a long channel formed by this sand bar. There is a detailed study by Krokhin and Krogius (1937) regarding the physical and chemical conditions associated with salmon spawning in this stream. Also, Semko (1939, 1954) published detailed reports on pink salmon spawning, mostly for Bolshaia River pinks. Some pink salmon go upstream to the headwaters of this West Kamchatkan river system—as far as 350 km from the sea.

The largest quantities of East Kamchatkan pinks spawn in the streams of the Karaginskii and Oliutorskii districts. It is assumed that considerable numbers of pinks also spawn in the Anadyr district, but no accurate information is available. Only small numbers of pink salmon migrate into the Kamchatka River, which is the largest stream system in Kamchatka and which has large populations of sockeye. During the years when sockeye salmon were abundant in this system, the catch of pink salmon was as low as 1.6% of the total salmon catch in the area (Semko, 1939).

INFORMATION ON NUMBERS OF SPAWNERS, SPAWNING SEASONS AND ESCAPEMENTS

Hokkaido-Kuril Region

Table 2 gives the pink salmon catches along the

Table 2. Coastal catches (in metric tons) of pink salmon in Hokkaido, 1953–60 (not including high seas catches) (data of the Hokkaido Prefecture).

Year	Pacific coast	Nemuro Strait	Ohkotsk coast, eastern half	Okhotsk coast, western half	Total
1953	216	71	930	117	1,334
1954	152	19	121	51	343
1955	192	138	1,017	261	1,608
1956	259	68	978	212	1,517
1957	75	23	319	74	491
1958	118	63	422	155	758
1959	45	16	408	17	486
1960	48	9	235	38	330

Table 3. Catch of pink salmon by hatchery district, 1951–60, in numbers of fish (data of the Hokkaido Salmon Hatchery).

Year	Oshima	Tokachi	Nemuro	Kitami	Teshio[1]	Total
1951	—	25,990	41,289	95,407	18,678	181,364
1952	—	575	15,731	50,707	10,822	77,835
1953	467	3,236	13,381	62,566	8,509	88,159
1954	81	119	4,318	8,725	3,376	16,619
1955	37	1,055	17,612	110,848	31,273	160,825
1956	—	10	33,493	45,374	31,725	110,602
1957	—	423	10,308	11,672	4,461	26,864
1958	—	—	17,425	35,799	19,245	72,469
1959	—	—	16,510	27,422	7,542	51,474
1960	—	—	8,590	4,552	1,867	15,009
Mean	59	3,141	17,866	45,307	13,750	80,012

[1] Includes rivers flowing to the Okhotsk Sea side of Soya Peninsula, i.e., Fureppu, Tokushibetsu, Horobetsu, Tonbetsu.

Hokkaido coast during the period 1953–60 (mostly catches by traps ; drift net catches are not included) ; Table 3 shows the numbers of pink salmon caught in the various districts of the Hokkaido Salmon Hatchery during the period 1951–60. Year-to-year changes in the coastal and stream catches of pink salmon during the above period are illustrated in Figure 6. High correlations are indicated between the stream catches of pink salmon along the coasts of Nemuro Strait and the Okhotsk Sea and the coastal catches of the same districts. Similar correlations are not found for the Pacific coast of Hokkaido. This may indicate that the pink salmon found in the coastal and stream areas of Nemuro Strait and the Okhotsk Sea are closely related to each other.

On the Pacific coast of Hokkaido, the stream catch by hatcheries was higher in odd-numbered years than in even-numbered years during 1951–57, but a sharp overall decline took place during this period and there have been no catches after 1957. Coastal catches, on the other hand, continued after 1957. In this district, catches were low in 1954, 1957 and 1960. In general, catches after 1956 were at low levels.

The average numbers of spawning fish in individual streams are given in Table 1.

Figure 7 gives the proportions of coastal catches in different months. For the Pacific coast of Hokkaido, pink salmon caught along the coast are not necessarily bound for local streams. Part of the fish passing through waters off the coast are caught by coastal traps during May and June. Some catches are made even in July. In Nemuro Strait, small pink salmon catches begin to be made in May (although these may be masu salmon) ; the catch increases as the season progresses until it reaches its peak in August. The catch decreases in September and practically no pink salmon are caught in October. Practically the entire catch of pink salmon from the Okhotsk Sea coast is made during August and September. Thus, the coastal fishing season on the Nemuro coast is somewhat later than that on the Pacific coast, and that on the Okhotsk Sea coast is later still. Comparing the western and eastern parts of the Okhotsk Sea coast, fishing begins earlier in the former area than in the latter. There are no apparent differences between odd-numbered years and even-numbered years in

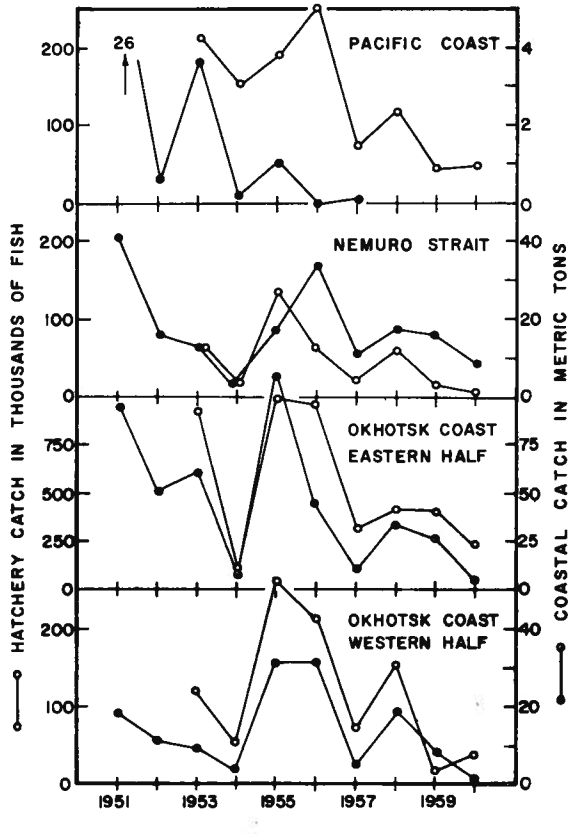

FIGURE 6. Comparison of coastal and river catches of pink salmon in Hokkaido, averages for 1951–59.

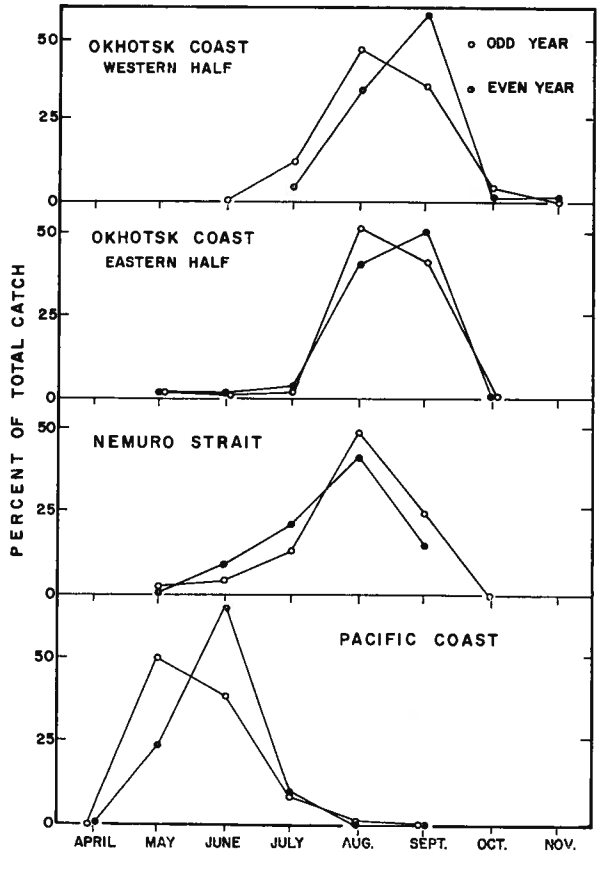

FIGURE 7. Seasonal changes in coastal pink salmon catches in Hokkaido, averages for 1953–60.

respect to fishing season.

The number of pink salmon caught (average for 1951–60) by the hatcheries is given separately for even-numbered and odd-numbered years in Figure 8, by region, ten-day period and sex.

In the early part of the season males outnumber females in streams, and females outnumber males in the latter part of the season. The sex ratio is approximately 50 : 50 during the peak of the season.

The chronological changes in the numbers of pink salmon caught in the streams of each district resemble those in the coastal catch as shown in Figure 7. For example, in the streams of the western half of the Okhotsk Sea coast, more pinks have been caught in August than in September in even-numbered years, while more fish have been caught in September than in August during odd-numbered years, which is also the case with the coastal catch. In the streams of the eastern half of the Okhotsk Sea coast, pink runs have been somewhat earlier in odd-numbered years than in even-numbered years, and the same tendency has also been observed in the coastal catch. Fishing begins earlier in the western half of the coast, and stream migration also occurs earlier in the western streams (beginning with July). In the Nemuro Strait district, stream migration occurs as early as June, and small coastal catches are also made in June.

There are two peaks in the upstream migration of pink salmon in the streams of the Nemuro Strait district. One occurs in late July and the other in September, the earlier peak being much smaller than the later peak. On the Pacific coast, pink salmon begin to enter streams in late July, and upstream migration is almost completed by late August. However, small numbers of pink salmon go upstream again in late September and early October, forming the second peak. The biological significance of the above fact is an interesting subject.

The average date by which half of the total seasonal catch of pinks in Hokkaido is attained was computed both for the coast and for streams. Catches from the Pacific coast were excluded. Roughly speaking, the date is August 9 for the coast and August 18 for streams. On the average, therefore, pink salmon are caught in

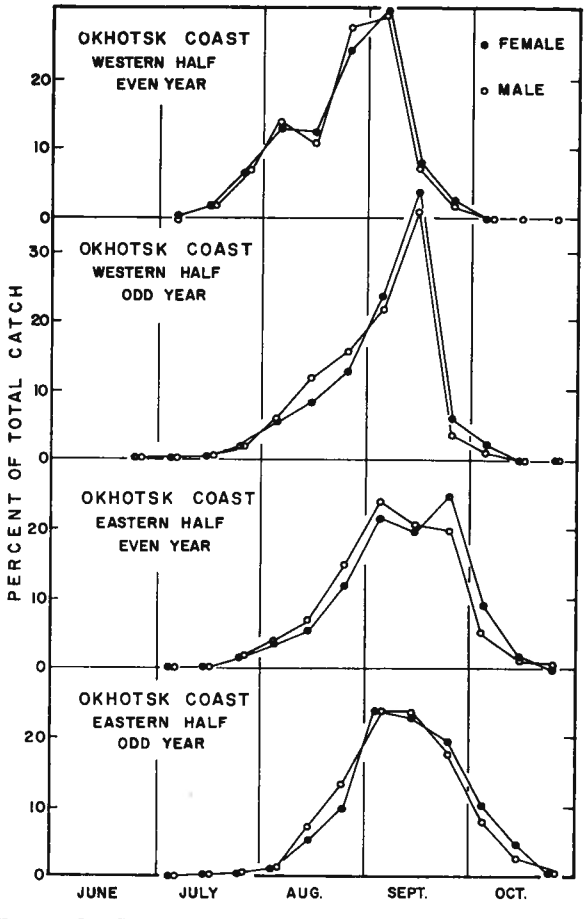

FIGURE 8. Seasonal changes in hatchery pink salmon catches in Hokkaido, averages for 1951–60.

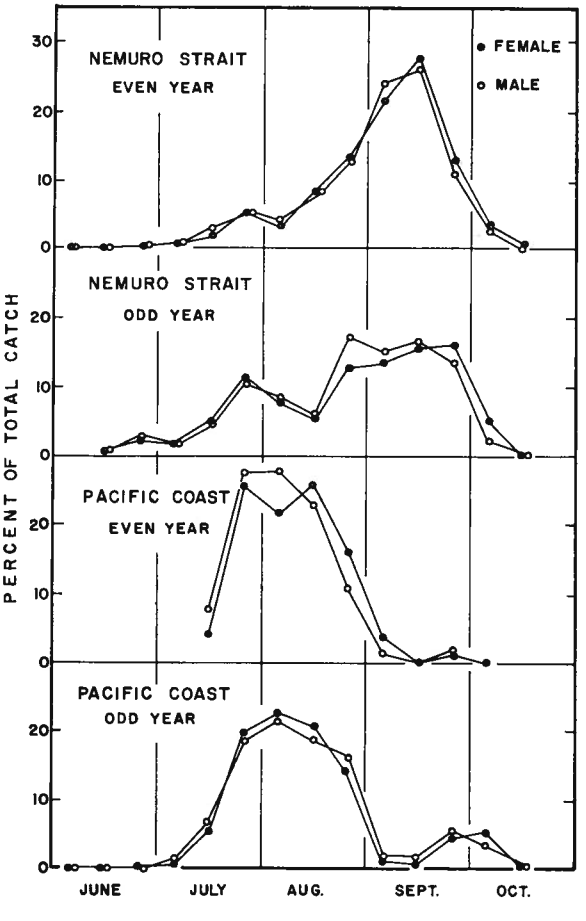

FIGURE 8. Continued.

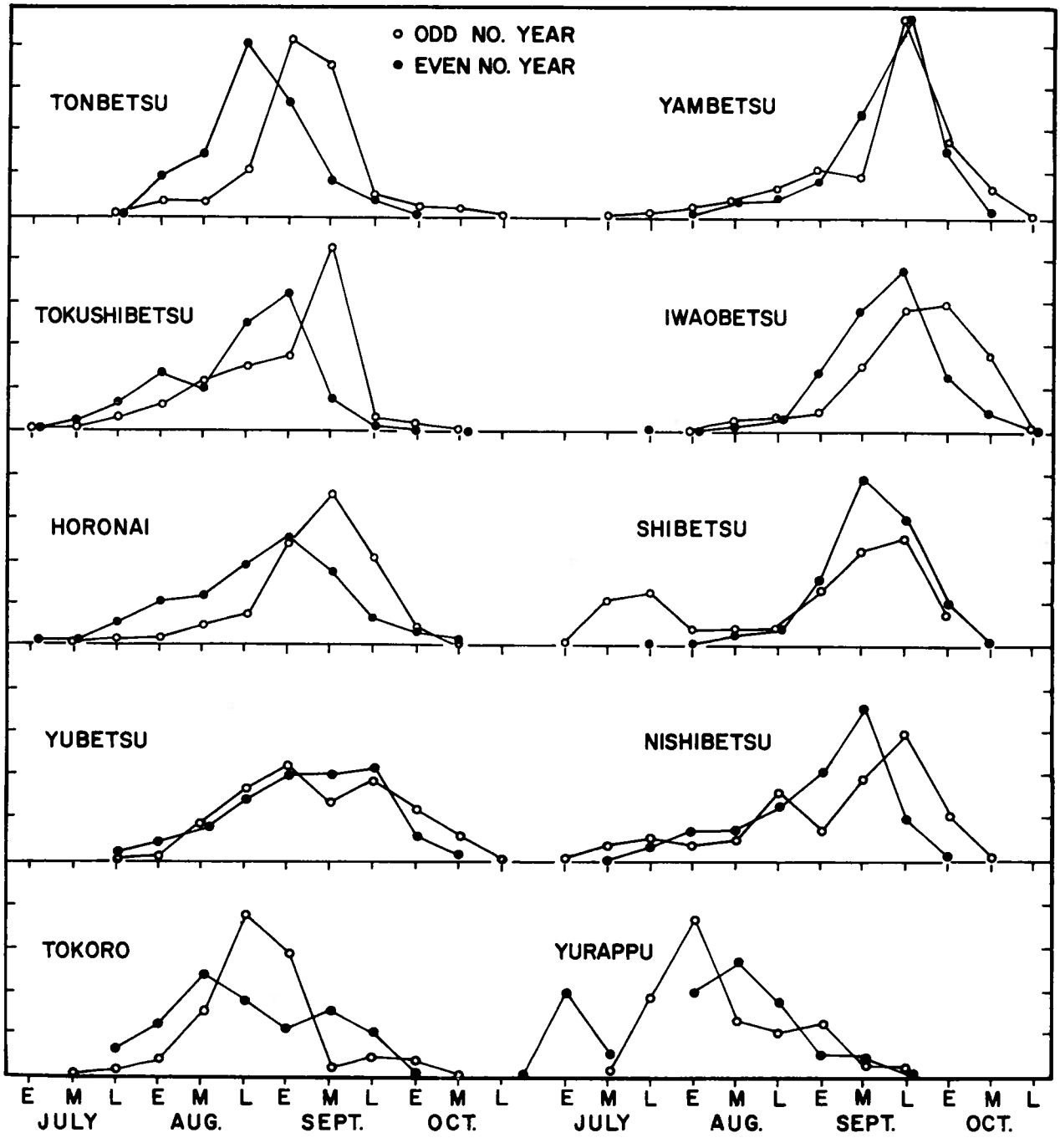

FIGURE 9. Seasonal changes in pink salmon catches in some Hokkaido rivers, averages for 1951–60.

streams by hatcheries about ten days after they reach the coast. However, since catching of pink salmon by hatcheries is made at stations relatively close to the sea, it is assumed that arrival at the spawning grounds may be considerably later.

In Figure 9, the average (1951–60) proportions of catches made in different ten-day periods are shown for the important pink salmon streams of Hokkaido.

Little information is available concerning pink salmon migration to streams of the Kuril Islands region. According to Takayasu *et al.* (1954), pink salmon go upstream on Iturup Island during the period from late June to late August with the peak in early July. This means that pink salmon runs there take place even earlier than on the Pacific coast of Hokkaido. According to Vedenskii (1949), the results of an investigation conducted during 1946–47 showed that there was a great variation in the timing of pink salmon runs to southern Kuril Islands, that migration occurred as early as June 28 and as late as September 28, and that, on the average, pink runs began on July 12 and ended on September 17, with peak runs occurring during the period from July 17 to September 5. Vedenskii's observations are considerably different from those of Takayasu and others. This might be explained by the possible presence of two peaks in the pink salmon runs of this area, their relative strengths varying from year to year. According to Mihara (1952), pink salmon migrate into the streams of Urup Island during the period from early August to late September, with peak runs occurring in August. If the peak period in the central Kuril area is August, pink salmon runs there occur about a half-month earlier than in Hokkaido, where pinks migrate into streams in August and September.

Spawning Areas in the U.S.S.R.

There are no published data on the sizes of pink salmon spawning populations in individual streams of the U.S.S.R. Hence, the relative sizes of spawning populations in various districts can only be inferred from the coastal catches. Also, records are fragmentary on the spawning seasons in individual streams; they can only be estimated from the fishing periods in respective districts. Available information regarding the chronological changes in the coastal and stream catches of pink salmon is given in Tables 4–7 and Figure 10.

These data from different sources show the same general tendencies. Figure 10 indicates that the coastal fishing period is July in East Kamchatka, July and August in West Kamchatka, mostly July and partly August in the Okhotsk district, from June to September in Sakhalin with the peak in July, and

Table 4. Pink salmon caught in eight U.S.S.R. coastal areas by 10-day periods, average for 1937–40 in percentage of total catch (Taguchi, 1957).

Area	June 21–30	July 1–10	July 11–20	July 21–31	August 1–10	August 11–20	August 21–31	September 1–10
Oliutorskii	2.3	31.6	39.7	26.3	0.1	—	—	—
Pankara	0.1	6.6	23.9	45.8	23.5	0.1	—	—
Kamchatka River	0.4	5.4	24.6	49.1	10.1	9.5	0.8	0.1
Iavina	—	0.4	6.3	40.7	34.6	17.1	0.8	0.1
Utka	—	0.3	10.8	36.7	37.6	14.5	0.1	—
Vorovskaia	—	0.8	5.6	43.7	41.8	6.8	1.3	—
Icha	—	0.1	1.2	46.0	47.3	4.3	0.1	—
Okhotsk	—	—	25.3	59.8	14.4	0.3	0.2	—

Table 5. Pink salmon fishing seasons in U.S.S.R. coastal areas, averages for 1932–41 (Taguchi, 1957). (Maximum fishing period is two or three weeks. Variations from mean do not exceed half a month.)

Area	Beginning	Maximum Period	Ending
Oliutorskii	June 17	July 8–July 22	August 5
Pankara	June 27	July 11–August 1	August 16
Kamchatka River	July 18		September 5
Iavina	July 1	July 28–August 7	August 29
Utka	July 3	July 15–August 8	August 22
Vorovskaia	July 3	July 22–August 14	August 22
Icha	July 9	July 25–August 13	August 24
Okhotsk	July 11	July 18–July 31	August 20

TABLE 6. Period of spawning migration of Kamchatka pinks at some areas (Semko, 1939).

Area	Stage of spawning migration	1931	1932	1933	1934	1935
Icha	Beginning	7/1–5	7/1–5	7/6–10	7/1–5	7/6–10
	Maximum[1]	7/26–30, 8/6–10	7/21–25, 8/11–15	7/21–25	7/26–30, 8/6–10	8/1–5
	Ending	8/11–15	8/21–25	8/11–15	8/21–25	8/16–20
Kikhchik	Beginning	6/21–25	7/11–15	7/6–10	6/16–20	7/11–15
	Maximum[1]	7/26–30	8/1–10	7/21–25	7/26–30	7/26–30, 8/1–5
	Ending	8/16–20	8/26–30	8/16–20	9/1–5	8/16–20
Ozernaia	Beginning	7/1–5	7/1–5	6/26–30	7/1–5	7/1–5
	Maximum[1]	7/16–20, 7/26–30	7/26–30	7/21–30	8/1–5, 8/11–15	7/26–30
	Ending	8/21–25	8/21–25	8/16–20	8/21–25	8/26–30
Karaginskii	Beginning	6/26–30	7/1–5	6/26–30	6/26–30	6/26–30
	Maximum[1]	7/6–20	7/21–25	7/6–10	7/21–25	7/11–15
	Ending	8/26–30	8/21–25	8/21–25	8/26–30	8/6–10
Oliutorskii	Beginning	7/1–5	7/1–5	6/26–30	6/21–25	6/21–25
	Maximum[1]	7/16–25	7/21–25	7/21–25	7/26–30	7/16–20
	Ending	8/6–10	8/21–25	8/21–25	8/1–5	8/6–10

[1] Two figures shows bimodal migration peaks.

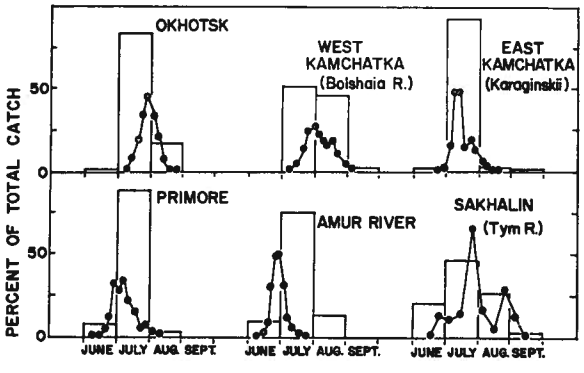

FIGURE 10. Seasonal changes in coastal pink salmon catches in some U.S.S.R. areas (Kaganovskii (1949), Taranets (1937), and unpublished catch statistics of the Japan-Soviet Fisheries Commission).

TABLE 7. Commencement of pink salmon spawning runs to rivers on the east coast of northern Sakhalin (Taranets, 1937).

Region	Start of run
Boundary district	Early July (1930)
Niivo	Late June (1933)
Niivo	Late June (1934)
Dagi	Early July (1933–1934)
Chaivo	Early July (1933)
Chaivo	Early July (1934)
Pil'tun	Middle July (1934)

TABLE 8. Sex ratio of pink salmon during the period of spawning migration (Kaganovskii, 1949).

		Date	7/3	7/7	7/17	7/28	8/5	8/10	8/19
1932	Kikhchik	M	64.1	61.0	53.6	48.0	43.0	36.0	40.8
		F	35.9	38.0	46.4	52.0	57.0	64.0	59.2
		Date		7/23	7/29	7/31	8/2	8/8	8/12	8/14
1926	Bolshaia	M		76.0	70.0	60.0	49.0	34.0	26.0	20.0
		F		24.0	30.0	40.0	51.0	66.0	74.0	80.0
		Date	7/14	7/19	7/23	7/27	8/1	8/4	8/8	8/15
1935	Bolshaia	M	95.0	91.0	78.0	46.0	42.3	38.0	32.0	29.0
		F	5.0	9.0	22.0	54.0	57.7	62.0	68.0	71.0

from June to August in Primore and the Amur with the peak in July.

Primore pink salmon begin to appear in inshore waters in early June or towards the end of May. The pink salmon migration into the Tumnin River continues to mid-August, although the number of migrants is small in the latter part of the season. Spawning occurs mostly in August and ends approximately in mid-September. Males outnumber females in the catches made during the early part of the season and

the proportions of females increase as the season progresses, females outnumbering males towards the end of the season. (Milovidova-Dubrovskaia, 1937.)

According to Kuznetsov (1928), observations at field stations revealed that Amur pink salmon arrived at the spawning grounds during the period from June 21 to July 19 and spawning occurred during the period from July 20–27 to September 15–20.

Sakhalin pinks migrate to the various parts of the east coast, including Terpenie Bay, at about the same time. Runs are earlier in the southern part of the west coast and in Aniva Bay. Pink runs on the east coast usually continue until late August, with intermissions, and they end in late September. Upstream migration usually occurs several days after pinks are caught by coastal traps, although sometimes fish appear in streams almost as soon as trap catches are made. In the main spawning streams such as the Poronai and Naibuchi Rivers, mass migrations of pink salmon begin usually during the few days around July 20 and continue to mid or late August. Migration ends in September. The timing of migration in Aniva Bay is only slightly different from that in the east coast streams. Pink salmon migrate into streams along the southern part of the west coast somewhat earlier than into the east coast streams. Pink runs here occur mostly during the period from June 15–20 to the end of July, and they end in August. Runs are 10–15 days later in areas a little northward. Pink salmon spawning on the west coast of southern Sakhalin usually begins in mid-July and continues to the end of August or the beginning of September. Spawning is somewhat later on the east coast (beginning with late July) and, in some years, continues for a longer period. Particularly in the years of high abundance, spawning continues until the end of September or the beginning of October. (Dvinin, 1952.)

According to Taranets (1937), pink salmon runs in the Tym River mouth (Niivo Bay) of northern Sakhalin begin towards the end of June and reach their height in August.

Coastal migration of pink salmon occurs earlier in the Okhotsk district than in West Kamchatka and lasts a shorter period of time (Kaganovskii, 1949; Taguchi, 1957).

Many studies have been made concerning pink salmon spawning in West Kamchatka, particularly in the Bolshaia River (Krokhin and Krogius, 1937; Kuznetsov, 1928; Semko, 1939 and 1954).

Pink salmon approach the various parts of the West Kamchatkan coast at about the same time; no delay towards the north is observed. Pinks begin to migrate upstream in five to eight days after they approach the coast. The spawning period varies depending on the abundance of fish, but spawning always occurs within the period from early August to mid-October. When abundance is low, spawning takes place from mid-August to mid-September, the total period being not over a month (Semko, 1939). In the Bolshaia River system, pink salmon arrive at the spawning grounds during the period from June 31 to early October; spawning continues from July 15 to the end of October (Kuznetsov, 1928).

There are no reports, to my knowledge, regarding the particulars of pink salmon spawning in East Kamchatka. In general, it may be said that spawning here is approximately half a month earlier than in West Kamchatka, as indicated in the figures and tables of this report. According to Semko (1939), the period of inshore migration differs from area to area even within the East Kamchatka region. Pink salmon fishing begins much earlier in the northern waters of the Karaginskii district than in the southern waters. He interpreted this fact as indicating that pink salmon schools moved (at least in the northern half of Litke Strait) towards the west and south. The period of inshore migration in the Oliutorskii district is not much different from that in the southern waters of the Karaginskii district. In general, pink salmon appear in inshore waters somewhat earlier in the Oliutorskii and Karaginskii districts than in the East Ozernaia district, an area farther southward.

Table 8 gives the chronological changes in the sex ratio of pink salmon during the period of spawning migration in West Kamchatka. The ratio is approximately 50 : 50 during the height of spawning migration, but males outnumber females prior to the peak, and females are more numerous than males after the peak.

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