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Distribution and Seasonal Abundance of *Salmo gairdneri* and *Salmo mykiss* in the North Pacific Ocean

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Abstract The distribution and seasonal abundance of the steelhead trout and the Kamchatkan trout in the North Pacific were analyzed by the temporal and spatial density of individuals collected by Japanese research operations from 1972 through 1982. Operation data showed that the individuals identified as the steelhead trout were distributed in the western waters of the North Pacific from spring to summer. However, some of the individuals might have been the Kamchatkan trout because the two species are separable only by the difference in vertebral counts. Judging from the time of return and endemic range of the Kamchatkan trout, it is considered that most of individuals caught in the Okhotsk Sea or the western waters of the North Pacific were the Kamchatkan trout, *Salmo mykiss*. It is presumed on the basis of the change of seasonal abundance that the anadromous populations of *S. mykiss* migrate northwest to coastal areas, where they originated, after wintering in the central or eastern North Pacific. The results of tagging experiments indicate that the distribution of the steelhead trout, *S. gairdneri*, extends at least to the waters around 175°E in summer. The long strip-like distribution of the two species across the North Pacific as well as no significant gaps in abundance shows that their geographical ranges in the ocean phase greatly overlap.

Steelhead trout, the anadromous population of the rainbow trout *Salmo gairdneri* is widely distributed in the North Pacific Ocean (Sutherland, 1973; Machidori and Ito, 1975). The rainbow trout originates in the streams from the Kuskokwim River, Alaska to the Rio Santo Domingo, Baja California, along the Pacific Coast of North America (Carl et al., 1959; MacCrimmon, 1971). The spawning stocks of the steelhead trout are presumably distributed from the Bristol Bay area, Alaska to the California-Mexican border (Car et al., 1959), but Sutherland (1973) stated that the true limit of their range may extend no further than the Alaska Peninsula to central or northern California (Fig. 1).

The Kamchatkan trout which is most closely related to the rainbow trout, is distributed on the Asian side of the Pacific. *Salmo mykiss* Walbaum (1792) is the first name applied to the Kamchatkan trout. Pallas (1814) gave the names, *S. purpuratus* and *S. penshinensis* for the anadromous form, but Derjavin (1930) stated that the anadromous form of the Kamchatkan trout consists of a single species, *Salmo penshinensis* Pallas. He recognized it as a good species based on the slight differences between it and the non-anadromous form in gill raker numbers and scale counts. The nomenclature for the Kamchatkan trout was reviewed in detail by Behnke (1966).

Recently, Savvaitova and Lebedev (1966) and Behnke (1966) reexamined the anadromous and non-anadromous forms and concluded that the two species of the Kamchatkan trout, *S. mykiss* and *S. penshinensis*, should be recognized as a single species, *S. mykiss*. The absence of genetic isolation between them is also suggested from the facts that (1) anadromous females and non-migratory males spawn together, (2) the spawning grounds of both forms are located in the same sections of the river and (3) spawning takes place during the same periods (Savvaitova, 1975; Maksimov, 1976).

The Kamchatkan trout is unevenly distributed in the northern regions of eastern Asia. The Kamchatka Peninsula is the center of its distribution (i.e., it originates in the rivers south of the Tigil' River on the west coast of the peninsula as well as the rivers south of the Kamchatka River on the east coast). Furthermore, a few stocks were confirmed in the Komandor Islands, Okhotsk and Amur Liman (Berg, 1948, fig. 1). The non-anadromous populations are distributed

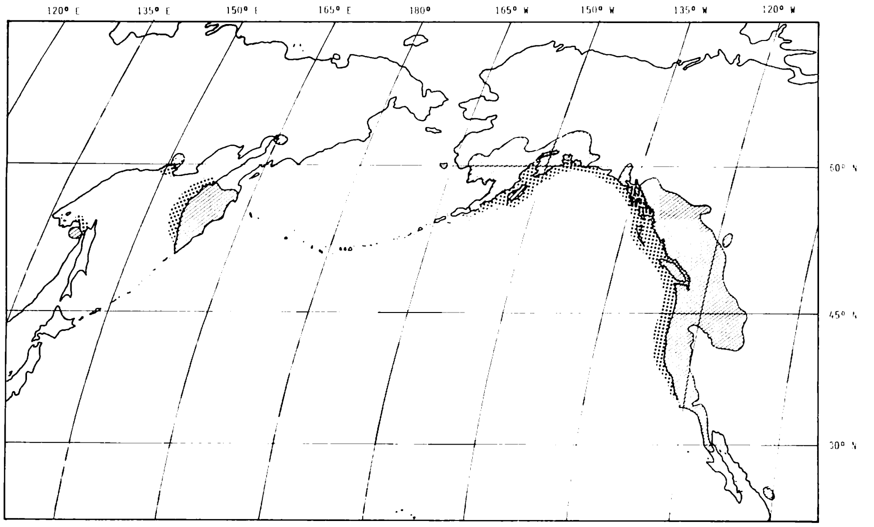

Fig. 1. Endemic range of *Salmo gairdneri* and *S. mykiss* (shaded). Stippled areas indicate coastline areas in which watersheds containing anadromous forms empty into the sea (from Carl et al., 1959; Berg, 1948; MacCrimmon, 1971; Sutherland, 1973; Savvaitova, 1975).

through the range. However, the anadromous populations are almost confined to the west coast and they are rarely distributed in the rivers south of the Bol'shaya River and on the east coast (Savvaitova, 1975).

The taxonomic relationship between *S. mykiss* and *S. gairdneri* has not been established. Behnke (1966) compared some morphological characters of *S. mykiss* with those of *S. gairdneri* and he found no significant differences between them except for vertebral counts. Therefore, he stated that they might properly be considered only subspecies. Okada and Kobayashi (1968) compared specimens caught off the west coast of the Kamchatka Peninsula with those caught along the coast of the Alaska Peninsula. They found slight differences between them in head length, depth of caudal peduncle and the number of pyloric caecum. The former is considered to be *S. mykiss* and the latter is *S. gairdneri*, whereas the differences noted between them fall within the range of intraspecific variation of *S. gairdneri*.

Both *S. gairdneri* and *S. mykiss* are presumably distributed in the North Pacific. For the reasons stated above, it is nearly impossible to distinguish *S. mykiss* from *S. gairdneri* with accuracy during field surveys. Thus, all the specimens collected through Japanese research activities over an extensive area of the North Pacific and the Okhotsk Sea have been treated as the steelhead trout. No knowledge has been obtained as to how far the distribution of the Kamchatkan trout extends eastward, or how the two species from the both continents are mixed.

The present report examines the catch data of the steelhead trout as well as the data of tag recoveries from 1972 to 1982 obtained by Japanese research vessels. The change of seasonal abundance and the distribution of *S. mykiss* and *S. gairdneri* in the North Pacific, particularly in its northwestern waters are discussed based on an analysis of their temporal and spatial density.

Materials and methods

The catch data of the steelhead trout caught by Japanese research vessels in the North Pacific Ocean, including the Okhotsk Sea and the Bering Sea, and the data of tag recoveries during the periods of 1972 to 1982 were used. Tagging experiments for the steelhead trout have been carried out by the Far Seas Fisheries Research Laboratory, Fisheries Agency of Japan, in the North Pacific Ocean. Tagging experiments for the steelhead smolts have been also conducted in many rivers in North America. The recoveries of the tagged fish examined in the current study were made by Japanese research and commercial vessels in the North Pacific from 1972 through 1982 and all of them were reported to the International North Pacific Fisheries Commission.

Research gears were gillnets and longlines. The latter were used for tagging operations. The net string used consisted of research and commercial nets. To eliminate fishing selectivity by using gillnets of constant mesh size research nets consisted of 10 different mesh sizes from 48 to 157 mm (Takagi, 1975). The same number of tans (a gill net unit of 50 m length) of each mesh size were joined to one another. Commercial nets consisted of a string from 111 to 121 mm mesh size.

Results

The catch per research vessel operation is shown in Figs. 2～5 by 2°×5° area and by month. The total number of tans most commonly used in gillnet operations was 294 (i.e., 264 tans of commercial nets and 30 tans of research nets) for the years between 1972 and 1976, and 132 (i.e., 102 tans of commercial nets and 30 tans of research nets) for the years following 1977. In Figs. 2～5, the number of individuals caught per operation is standardized at 132 tans. The distribution and migration of the steelhead trout are considered to vary to a certain degree from year to year. Since there is a limit of the number of fish caught in a single year, the fish caught in the 11-year period are summed.

The oceanic range of the steelhead trout as revealed by the catch data extended generally north of 39°N. However, its winter distribution is still obscure due to the lack of research operations in the western and central North Pacific. Its distribution was also confirmed in the Okhotsk Sea as well as a scattered distribution in the Bering Sea. There seems to be no report on the distribution of the steelhead trout in the Japan Sea (Machidori and Ito, 1975).

The relative abundance in all areas sampled was far less than that of Pacific salmon, *Oncorhynchus* spp. Therefore the steelhead trout is merely caught incidentally by salmon fisheries. Machidori and Ito (1975) reported that the ratio of steelhead trout to salmon, caught by research vessels in 1972, is 1: 1250.

Seasonal abundance. Definite seasonal fish shifts obtained from the catch and effort data are as follows.

March. The limited research vessel operations in March suggested that occurrence in the western North Pacific was extremely rare.

April. The research vessels operated in the extensive waters of the western and central North Pacific and the fish began to appear west of 160°E. The abundance was relatively high at 175°E～170°W.

May. Steelhead trout were distributed extensively across the North Pacific between 41°N and 47°N. The wide band-like distribution across the North Pacific was more pronounced and continuous, and a northward extention was evident. The main concentrations of fish were still located in waters east of 175°E and a high density had not yet appeared in the western waters.

June. A continuation of the northward and westward shifts in the distribution of the steelhead trout was shown in June. They were found across the North Pacific and exhibited a cline in their distribution. In the eastern North Pacific they were located north to near 55°N but in the western North Pacific only to about 47°N. The relative abundance in the eastern waters increased continuously.

Another feature in June was the first substantial catches in the Okhotsk Sea.

July. In the western and central North Pacific, the characteristic pattern observed in the previous month continued, but the area of distribution extended farther north. The southern limit of the steelhead trout distribution moved to 43°N and the distribution extended to waters just south of the Aleutian Islands. The relative abundance increased in the western waters including Kuril Island waters and the Okhotsk Sea, indicating the continuous movement of fish into the Okhotsk Sea.

Fishing was conducted by the research vessel extensively in the Gulf of Alaska and extreme concentrations of the fish occurred throughout the Gulf.

A few steelhead trout were caught in the southern waters of the Bering Sea.

August. The southern limit of the steelhead trout distribution moved northward continuously, but the results indicate that the fish rarely migrate to the Bering Sea. The relative abun-

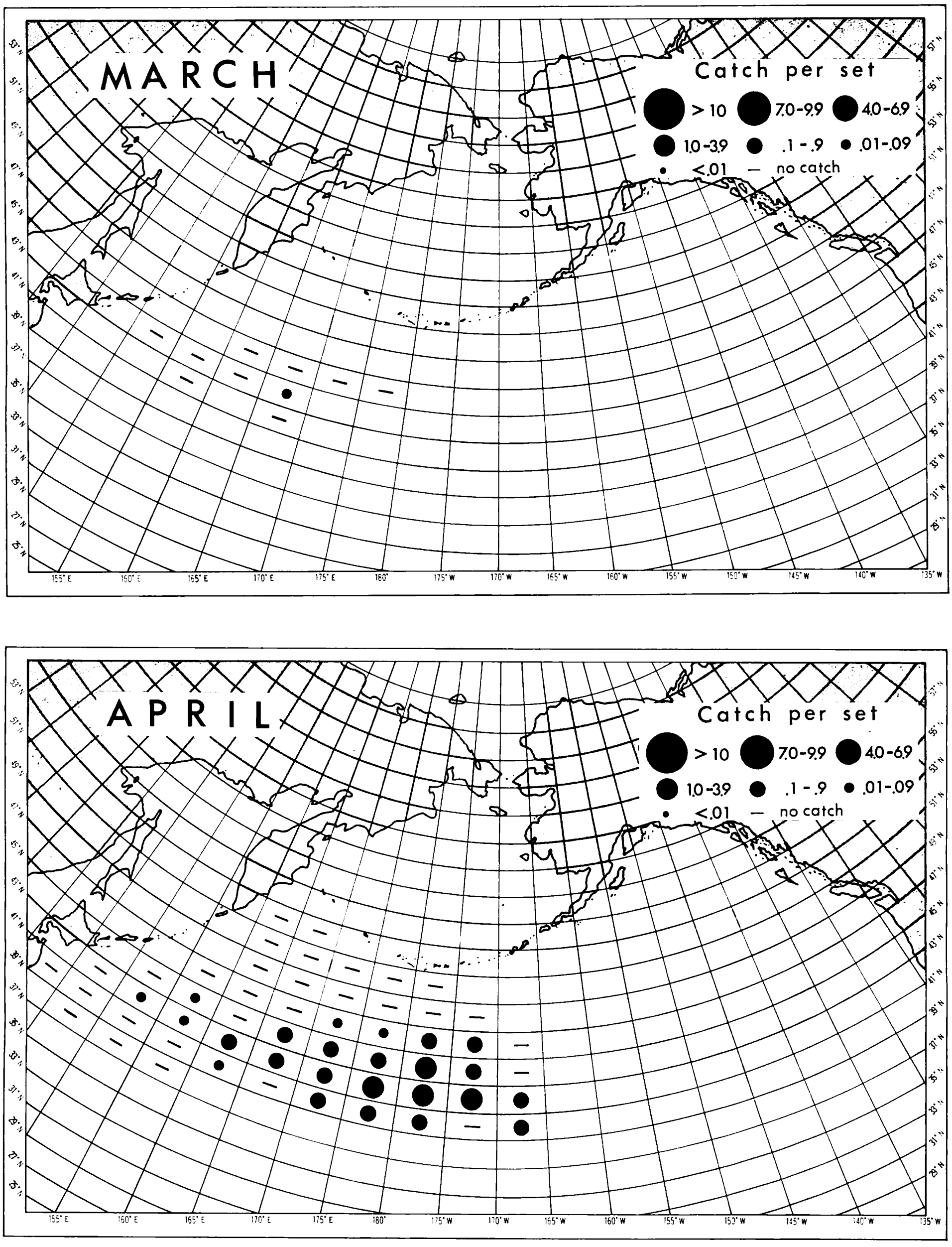

Fig. 2. Oceanic distribution and relative abundance of *Salmo gairdneri* and *S. mykiss* caught by Japanese research vessels with gillnets in March and April from 1972 through 1982.

dance increased in Kuril Island waters and the fish were found in broader waters of the Okhotsk Sea.

September. Although sampling in September was much less comprehensive than in July and August, it indicates that the remaining concentrations of the steelhead trout occurred in waters just south of the Aleutian Chain. The fish were also found in the Okhotsk Sea and Kuril Island waters.

In waters west of 175°W where major Japanese research efforts were made, the steelhead trout

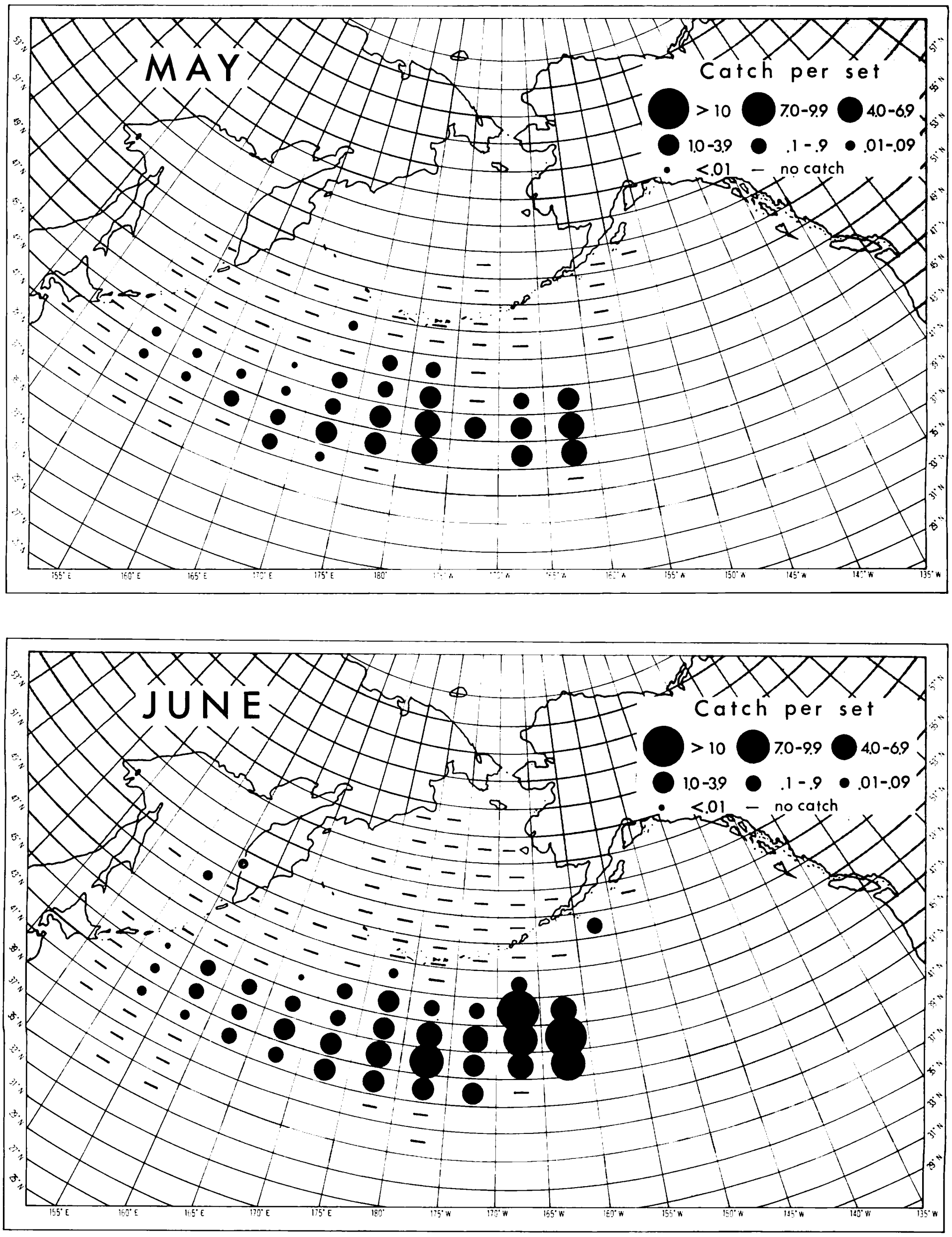

Fig. 3. Oceanic distribution and relative abundance of *Salmo gairdneri* and *S. mykiss* caught by Japanese research vessels with gillnets in May and June from 1972 through 1982.

was highly abundant in the eastern part of the area after spring. It was found from the annual research activities that the area with high concentrations of the fish gradually extended to the western waters until late summer. Sutherland (1973) indicated that the abundance of steelhead trout was greatest in the Gulf of Alaska and the eastern North Pacific and decreased to the westward throughout the year. The above suggests that the fish move northwestward from spring to summer.

Temperature. The steelhead trout is distrib-

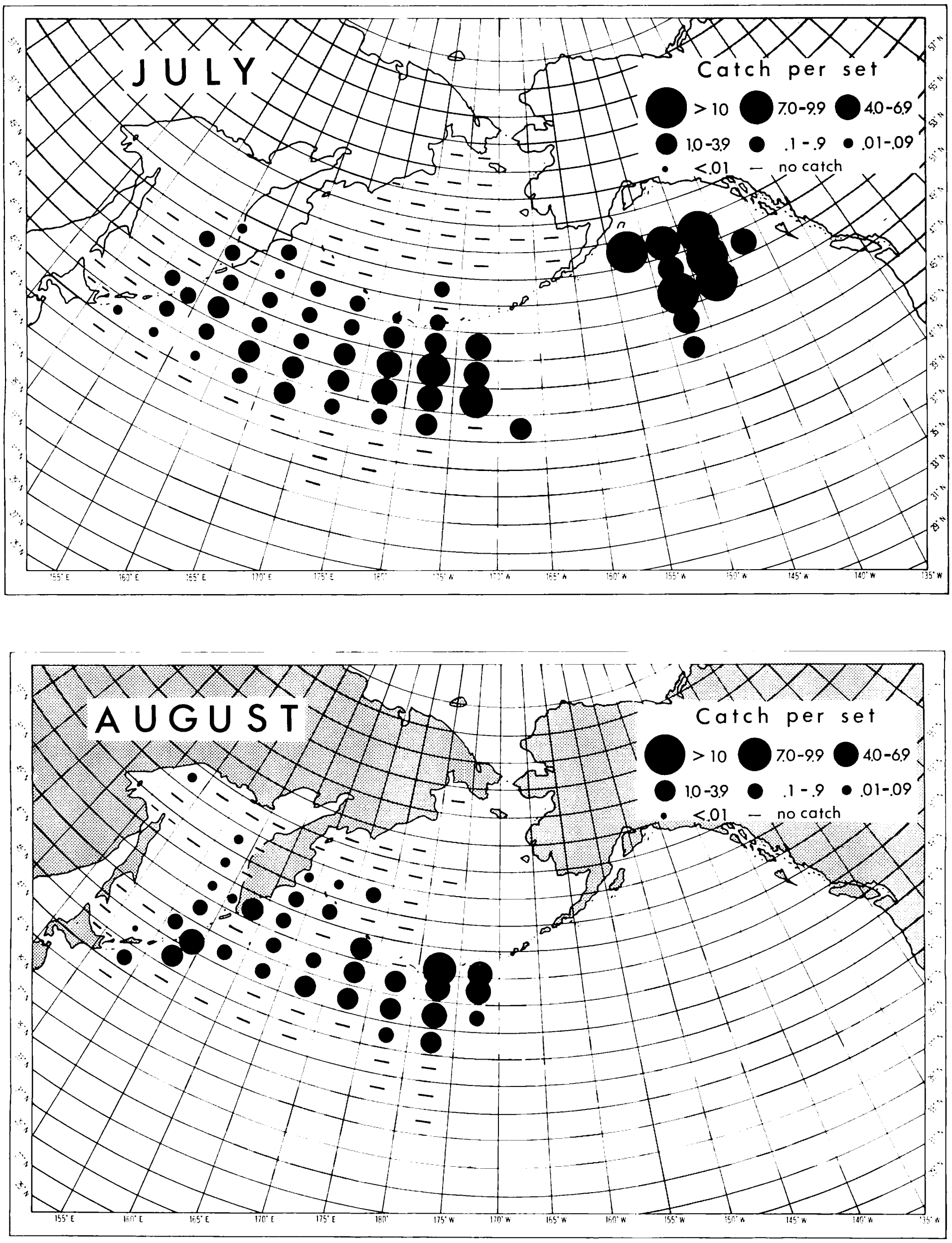

Fig. 4. Oceanic distribution and relative abundance of *Salmo gairdneri* and *S. mykiss* caught by Japanese research vessels with gillnets in July and August from 1972 through 1982.

uted in the more southern waters compared to Pacific salmon. Seasonal shifts in the boundaries of the oceanic regions occupied by the steelhead trout generally correspond to the changing positions of surface isotherms. The range of surface temperatures associated with the presence of the steelhead trout extended from 2.8°C to 15.2°C. Greatest overall frequency of catches occurred within the range of 6°C to 10°C (Table 1). The surface temperatures at the time of catch are similar to those of the coho salmon, *Oncorhynchus kisutch* (Machidori, 1972).

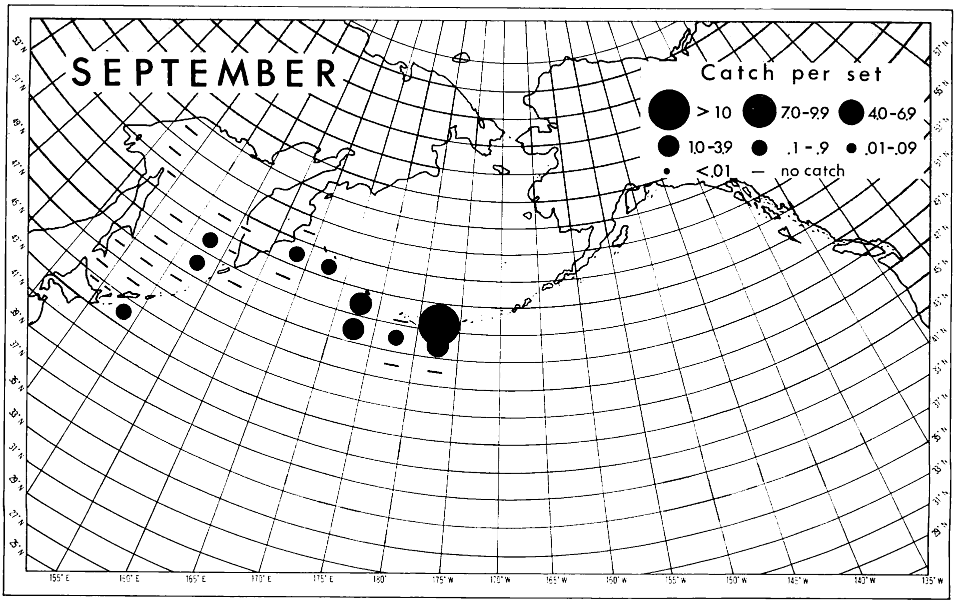

Fig. 5. Oceanic distribution and relative abundance of *Salmo gairdneri* and *S. mykiss* caught by Japanese research vessels with gillnets in September from 1972 through 1982.

On the other hand, Sutherland (1973) reported that the steelhead trout was caught in waters with temperatures of 5°C to 14.9°C and that the majority were caught in the waters with the temperatures of 8°C to 11.4°C. This shows that the fish occurred in waters with higher temperature than those where Japanese research vessels caught steelhead trout.

Results of tagging experiments. Available evidence indicates a very strong tendency for the steelhead trout to return to their area of origin for spawning (Pautzke and Meigs, 1940; Shapovalov and Taft, 1954). Because of this tendency tagging of the steelhead trout in offshore areas with subsequent recoveries of tags on or near their spawning areas provides a useful means of determining the dispersal of various stocks at sea.

Many recoveries from tagging in the eastern North Pacific have been reported and all of them were recaptured in North America centering around British Columbia, Washington and Oregon (Sutherland, 1973; Fisheries Agency of Japan, 1979). However, recoveries from the tagging in the central and western North Pacific were relatively few. Only seven recoveries of fish tagged in the central North Pacific are reported to date (Hartt, 1962; Fisheries Agency of Japan, 1980, 1982a, b, 1983; Fig. 6). Six specimens were recaptured in Washington and Oregon, and one was recaptured at sea (47°12′N, 167°35′E) in the following year. It was not confirmed whether the latter was *S. gairdneri* or *S. mykiss*.

Table 1. Ocean surface temperatures and catches of *Salmo gairdneri* and *S. mykiss* by Japanese research vessels, 1972～82.

Surface temperature (°C)	Number of fish caught
15.0～15.9	1 (—)
14.0～14.9	2 (—)
13.0～13.9	27 (0.3%)
12.0～12.9	97 (1.2%)
11.0～11.9	240 (3.0%)
10.0～10.9	370 (4.6%)
9.0～ 9.9	1,308 (16.1%)
8.0～ 8.9	2,881 (35.5%)
7.0～ 7.9	1,832 (22.6%)
6.0～ 6.9	901 (11.1%)
5.0～ 5.9	394 (4.9%)
4.0～ 4.9	55 (0.7%)
3.0～ 3.9	3 (—)
2.0～ 2.9	2 (—)

Recently coded-wire tags, which are small and magnetic wire tags injected into the snouts of smolts before they are released from hatcheries, have been used frequently for the steelhead trout in North America. Recoveries of these fish were also reported in the central North Pacific (Fig. 7). Six individuals that had been tagged in British Columbia, Washington and Idaho were recaptured (Dahlberg, 1981, 1982).

The above information indicates that the distribution of the steelhead trout originating in North America extends at least to waters around 175°E in summer. However, it seems that no recoveries of fish tagged in the North Pacific have been made to date in the U.S.S.R. This is partly because the actual abundance of the Kamchatkan trout is low in the North Pacific Ocean and partly because the recovery efforts in the U.S.S.R. are extremely low.

Discussion

In North America, the steelhead trout attracts much attention as a target for sport fishing, and it is also commercially caught in some areas. An actual numerical estimation for the various steelhead stocks in North America is not available at this time, but Sheppard (1972) estimated the stocks along the Pacific coast to have been around 1.5 million.

In the U.S.S.R., the catch of the Kamchatkan trout is not known. No commercial fisheries are thought to be carried out in the area. The Kamchatkan trout is less popular in the U.S.S.R. than the steelhead trout is in North America, and knowledge on the ecology and life history of the Kamchatkan trout is limited. This suggests that the stocks of this species in Kamchatka are not large.

The above observation suggests that, although both *S. gairdneri* and *S. mykiss* are presumably distributed in the North Pacific, the majority has its origin in the continent of North America.

The spawning migration of the Kamchatkan trout to rivers in the western Kamchatka was observed from August to November and spawning occurs from April through June (Maksimov, 1972, 1976). It also returns to some rivers from April through May (Maksimov, 1976). The occurrence of the fish from June in the Okhotsk Sea agrees well with the timing of the spawning migration to the coastal areas. Furthermore, the fish which had returned to the sea after spawning, known as kelts, were caught by Japanese research vessels in summer in waters off the west coast of the Kamchatka Peninsula. This fact indicates that it is reasonable to recognize this population as the Kamchatkan trout. The fish occurring in the Okhotsk Sea and Kuril Island waters in summer apparently had migrated from the western North Pacific where they were distributed during the previous season. Therefore, it is considered that the Kamchatkan trout moves westward through the western North Pacific and enters the Okhotsk Sea to approach the coastal areas of their origin. The distribution of the fish in the Okhotsk Sea during July and August suggests that the fish enter the Okhotsk Sea through channels in central and southern Kuril Islands in addition to those in the northern Kuril Islands.

The extensive migration of the steelhead trout beyond 180° longitude was confirmed from the tagging experiments. The life history of the steelhead trout is fundamentally similar to that of the Kamchatkan trout. The steelhead trout enters some rivers during every month of the year. They are generally categorized into two groups based on the anadromous timing, namely summer steelhead and winter steelhead (Smith, 1960). This suggests that it is nearly impossible to relate immediately the eastward movement of the fish at any season with its spawning migration.

The available data are scanty during late fall through winter, as no research vessels have been operated by Japan in the high seas since 1972. Sutherland (1973) reviewed the catch data of the steelhead trout before 1967 and reported the occurrence of the high concentrations of the fish in the eastern North Pacific. However, the fish were rarely found in the central and western North Pacific. In a broad way, the fish occurred in areas with surface water that ranged in temperature from 7°C to 11°C during these periods (Laviolette and Seim, 1969). This feature of the distribution does not differ substantially from that observed in March.

Some stocks of the chum salmon *Oncorhynchus keta* and the pink salmon *O. gorbuscha*, which originate in the U.S.S.R., are known to be distributed in the western North Pacific between 40°N and 45°N in high concentrations in early spring (Neave et al., 1976; Takagi et.al., 1981).

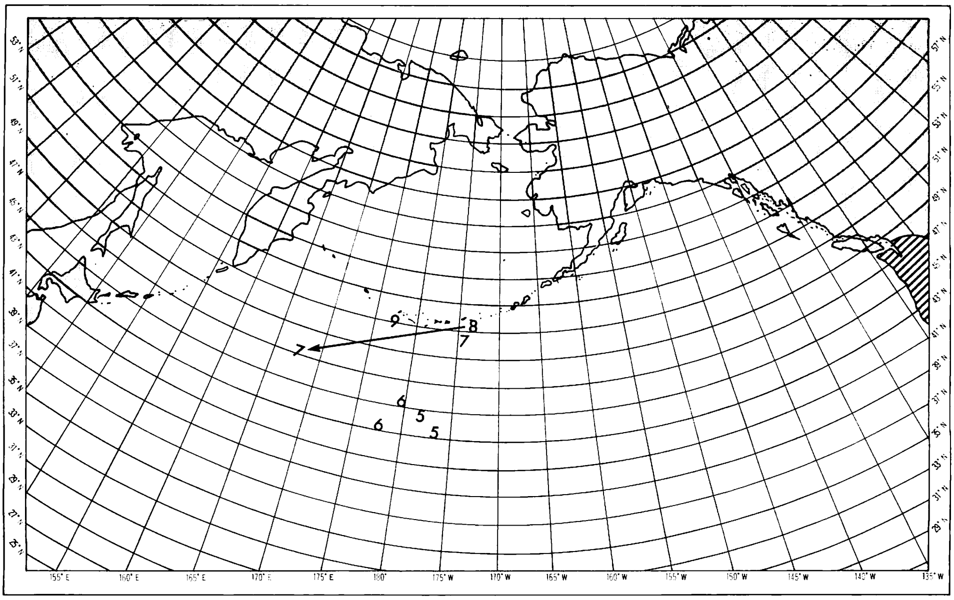

Fig. 6. Distribution of recoveries of steelhead trout in the continent of North America (shaded) in high seas from the tagging in waters west of 170°W. The numerals show the month and location of tagging. The arrow indicates the fish which was tagged and liberated in August and recaptured in the following July, but it is not determined whether the specimen is a steelhead trout or Kamchatkan trout.

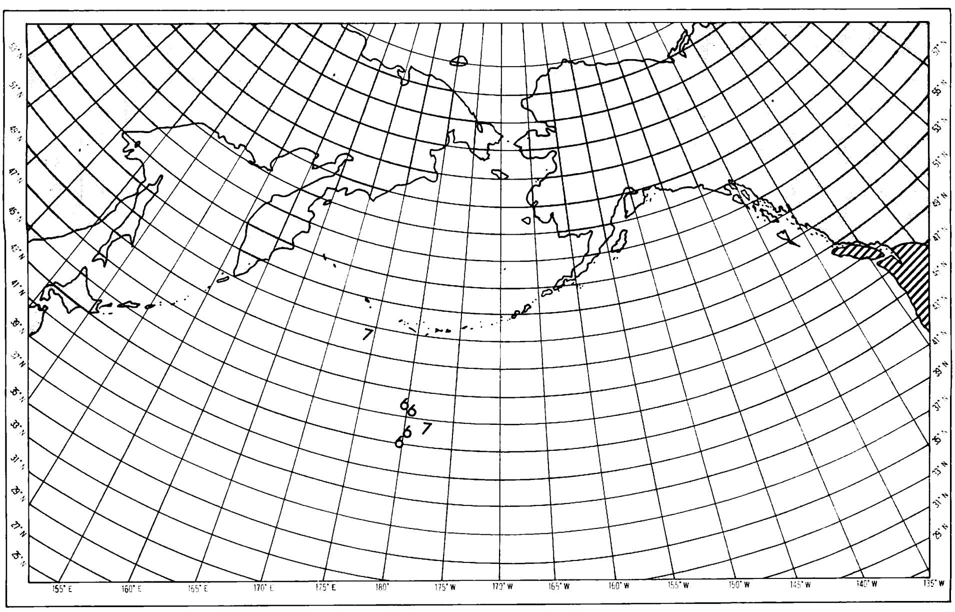

Fig. 7. Distribution of high-sea recoveries of coded-wire tagged steelhead trout in waters west of 175°W from the tagging in British Columbia, Washington and Idaho (shaded). The numerals show the month and location of recapturing.

Afterward, they exhibit northward and inshore migrations toward coastal areas of their origin. However, the figures obtained from the current study do not support such migration patterns of the Kamchatkan trout. The areas with temperatures ranging from 6°C to 10°C, which are considered to be preferred by the fish, have already moved up to 40～42°N at 150～160°E by April (Laviolette and Seim, 1969). However, the concentrations of the fish were not observed in these waters. The above observation also indicates that the fish which proceeded toward the Okhotsk Sea in summer migrated from the central or eastern North Pacific. Therefore it is presumed that the wintering areas of the Kamchatkan trout are mainly located in waters east of 180° longitude.

With respect to the surface temperatures in the North Pacific, in general, the warmer areas extend farther north in the eastern North Pacific than in the western North Pacific. For example, in spring in the Gulf of Alaska temperatures begin to rise first in the coastal waters off southern North America, and then rise progressively northward in waters along the coast, and finally increase toward offshore areas (Laviolette and Seim, 1969).

There are significant differences in coastal temperatures between North America and the Kamchatka Peninsula during the period of smolt migration toward the sea and that of the spawning run to rivers. Particularly, a remarkable difference is observed between both continents in the temperatures during the period of smolt migration. Although the information is limited, the smolts of the Kamchatkan trout in some rivers migrate to the sea from June through July (Maksimov, 1972, 1976). In North America, the steelhead smolts are known to migrate to sea throughout the year, however the largest number migrates from April through June (Sheppard, 1972). The surface temperature in waters off the coast of the Kamchatka Peninsula from April through July is usually at least 4°C, lower than that of British Columbia, Washington and Oregon (Laviolette and Seim, 1969). Among the populations of the Kamchatkan trout, the spawning of the anadromous form takes place in lower temperatures than that of the non-anadromous form (Savvaitova et al., 1975). This fact suggests that the Kamchatkan trout have become adapted to low temperatures, and this is in agreement with the observed tendency that the temperatures in which the fish were caught by Japanese research vessels were lower than those reported by Sutherland (1973). It is probably because the Japanese research vessels have mainly operated in waters west of 175°W where the majority of Kamchatkan trout are considered to be distributed.

The data presented herein suggest that the distribution areas of both *S. gairdneri* and *S. mykiss* are not separated in the North Pacific during spring and summer. The fact that no significant gaps were observed in the distribution of the fish throughout the North Pacific Ocean also supports this view. However, the extent of the distribution of the Kamchatkan trout far to the east has not been clarified in the current study. A complete picture will only gradually emerge with the accumulation of other data, such as age compositions, scale patterns, gene frequency data and others over the years.

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Literature cited

Behnke, R. J. 1966. Relationships of the far eastern trout, *Salmo mykiss* Walbaum. Copeia, 1966 (2): 346～348.

Berg, L. S. 1948. Freshwater fishes of the U.S.S.R. and adjacent countries, I. Zool. Inst. Acad. Sci., No. 27. English Transl. Israel Prog. Sci. Transl. Ltd., Jersalem, v+504 pp.

Carl, G. C., W. A. Clemens and C. C. Lindsey. 1959. The fresh-water fishes of British Columbia. British Columbia Provincial Museum, Victoria, 192 pp.

Dahlberg, M. L. 1981. Report of incidence of coded-wire tagged salmonids in catches of foreign commercial and research vessels operating in the North Pacific Ocean during June and July 1980～1981. Intern. North Pacific Fish. Comm., Doc. 2468: 1～6.

Dahlberg, M. L. 1982. Report of incidence of coded-wire tagged salmonids in catches of foreign commercial and research vessels operating in the North Pacific Ocean and Bering Sea during 1980～1982. Intern. North Pacific Fish. Comm., Doc. 2581: 1～11.

Derjavin, A. 1930. Kamchatka "semga" (*Salmo penshinensis* Pallas). Gidrobiol., Zh., SSSR, 8 (10/12): 330～332.

Fisheries Agency of Japan. 1979. The record of tag recoveries on Pacific salmon in 1956～1978. xx+328 pp. (In Japanese).

Fisheries Agency of Japan. 1980. Release data for Japanese salmon tagging experiments in 1980 (May to August) and new recovery data up to September, 1980. Intern. North Pacific Fish. Comm., Doc. 2317: 1～29.

Fisheries Agency of Japan. 1982a. Additional information of tag recoveries in 1981. Intern. North Pacific Fish. Comm., Doc. 2490: 1～3.

Fisheries Agency of Japan. 1982b. Release data for Japanese salmon tagging experiments in 1982 (May to August) and recovery data up to August, 1982. Intern. North Pacific Fish. Comm., Doc. 2531: 1～9.

Fisheries Agency of Japan. 1983. Additional information on tag recoveries in 1981 and 1982 Japanese high seas salmon tagging. Intern. North Pacific Fish. Comm., Doc. 2621: 1～3.

Hartt, A. C. 1962. Movement of salmon in the North Pacific Ocean and Bering Sea as determined by tagging, 1956～1958. Bull. Intern North Pacific Fish. Comm., (6): 1～157.

Laviolette, P. E. and S. E. Seim. 1969. Monthly charts of mean, minimum, and maximum sea surface temperature of the North Pacific Ocean. U. S. Nav. Oceanogr. Office, Washington, iii+57 pp.

MacCrimmon, H. R. 1971. World distribution of rainbow trout (*Salmo gairdneri*). J. Fish. Res. Bd. Can., 28 (5): 663～704.

Machidori, S. 1972. Relationships between the distribution of coho salmon, *Oncorhynchus kisutch*, and surface temperature during pre-fishing season. Bull. Japan. Soc. Fish. Oceanogr., (21): 112～123. (In Japanese).

Machidori, S. and S. Ito. 1975. Steelhead trout in the North Pacific Ocean. Bull. Japan. Soc. Fish. Oceanogr., (27): 119～126. (In Japanese).

Maksimov, V. A. 1972. Some data on the ecology of the Kamchatka trout (*Salmo mykiss* Walbaum) from the Utkholok River. J. Ichthyol., 12 (5): 759～766.

Maksimov, V. A. 1976. The ecology of the Kamchatka trout *Salmo mykiss* population from the Bol'shaya River (Western Kamchatka). J. Ichthyol., 16 (1): 12～17.

Neave, F., T. Yonemori and R. G. Bakkala. 1976. Distribution and origin of chum salmon in offshore waters of the North Pacific Ocean. Bull. Intern. North Pacific Fish. Comm., (35): 1～79.

Okada, S. and K. Kobayashi. 1968. Colored illustrations of pelagic and bottom fishes in the Bering Sea. Japan Salmon and Trout Resource Conservation Association, Tokyo. ×+179 pp., 24 pls. (In Japanese).

Pallas, P. 1814. Zoographia Rosso-Asiatica, III. Petropoli, Paris. cxxv+423 pp., 21 pls.

Pautzke, C. F. and R. C. Meigs. 1940. Studies on the life history of the Puget Sound steelhead trout (*Salmo gairdnerii*). Trans. Am. Fish. Soc., 70 (2): 209～220.

Savvaitova, K. A. 1975. The population structure of *Salmo mykiss* in Kamchatka. J. Ichthyol., 15 (6): 876～888.

Savvaitova, K. A. and V. D. Lebedev. 1966. On the systematic position of the Kamchatka trout, *Salmo penshinensis*, *Salmo mykiss* and their ralationship to American species of the genus *Salmo*. Vopr. Iktiol., 6 (4): 593～608. (In Russian).

Savvaitova, K. A., M. V. Mina and V. A. Maksimov. 1975. Evolutionary aspects of the reproductive ecology of trout of the genus *Salmo* in Kamchatka. J. Ichthyol., 15 (1): 18～27.

Shapovalov, L. and A. C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. Fish. Bull., California Dept. Fish and Game, (98): 1～375.

Sheppard, D. 1972. The present status of the steelhead trout stocks along the Pacific coast. *In* A review of the oceanography and renewable resources of the northern Gulf of Alaska. Institute Marine Science, University Alaska, 519～536.

Smith, S. B. 1960. A note on two stocks of steelhead trout (*Salmo gairdneri*) in Capilano River, British Columbia. J. Fish. Res. Bd. Can., 17 (5): 739～742.

Sutherland, D. F. 1973. Distribution, seasonal abundance, and some biological features of steelhead trout, *Salmo gairdneri*, in the North Pacific Ocean. Fish. Bull., 71 (3): 787～826.

Takagi, K. 1975. A non-selective salmon gillnet for research operations. Bull. Intern. North Pacific Fish. Comm., (32): 13～41.

Takagi, K., K. V. Aro, A. C. Hartt and M. B. Dell. 1981. Distribution and origin of pink salmon (*Oncorhynchus gorbuscha*) in offshore waters of the North Pacific Ocean. Bull. Intern. North Pacific Fish., Comm., (40): 1～195.

Walbaum, J. J. 1792. Petri Artedi renovati, i.e. bibliotheca et philosophia ichthyologica. Ichthyologiae pars III. Grypeswaldiae. Ant. Ferdin. Roese., viii +723 pp., 3 pls.

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北太平洋におけるスチールヘッド・トラウト及びカムチャツカン・トラウトの季節的分布とその豊度

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北太平洋には北米大陸の諸河川を起源とするスチールヘッド・トラウトが広範に分布していることが知られている．また，アジア側にはカムチャツカ半島を中心とした地域にこれと極めて近縁なカムチャツカン・トラウトが分布しており，その降海型が北太平洋にも分布することが推定されていた．1972～82 年に日本のサケ・マス調査活動によってスチールヘッドとして記録された漁獲データに基づき，北太平洋における両種の分布，豊度及び季節移動について検討した．

分布域は春から夏にかけて北太平洋の西部にまで広がり，6 月以降はオホーツク海にも分布が認められた．溯上地域及び溯上時期との関連から，オホーツク海や北太平洋の西部で漁獲され，スチールヘッドとして記録されたものの大部分はカムチャッカン・トラウトであったものと考えられた．季節的分布の推移から，これらは北太平洋の中部以東で越冬し，その後カムチャツカの溯上河川へ向けて北西へ回遊するものと考えられた．一方，標識放流結果からはスチールヘッドが夏季には少なくとも東経 175° 付近にまで分布を広げていることが確認された．北太平洋での分布は東西に帯状に連なっており，その豊度には特に切目がみられないことから，両種の海洋生活期中における分布は大きく重複しているものと考えられた．

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