U.S. & JAPAN CONTINUE COOPERATIVE RESEARCH IN NORTH PACIFIC (1970-71)

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Each spring since 1968, scientists of the United States and Japan have conducted cooperative cruises to study the distribution and migration of salmon in the North Pacific Ocean. Results of the first cruise were presented in Commercial Fisheries Review December 1968 (French and Bakkala, 1968).

The U.S., Japan, and Canada, as treaty members of the International North Pacific Fisheries Commission (INPFC), conduct research on fishery resources of common interest for effective utilization and conservation. In the INPFC treaty of 1953, Japan agreed to limit its commercial salmon fishing to waters west of 175° W. Since then, studies by INPFC member nations have shown that some sockeye salmon originating in Bristol Bay, Alaska, are distributed west of the abstention line.

Principal Objectives

Principal objectives of the cooperative spring cruises were to: (1) study distribution of maturing* Bristol Bay sockeye salmon relative to the abstention line at 175° W just prior to their inshore migration; (2) define oceanographic conditions that influence the distribution of sockeye salmon in relation to the abstention line; and (3) combine knowledge from spring research cruises with that from cruises in other seasons to further our understanding of the movements of Bristol Bay sockeye salmon during their life at sea.

This report briefly outlines findings from the earlier cooperative cruises in 1968 and 1969. It presents in more detail the results of the 1970 and 1971 spring cruises.

Vessels and Fishing Gear

The Seattle NMFS (National Marine Fisheries Service) Laboratory's RV 'George B. Kelez' (550 tons) participated in the four cooperative cruises from 1968 to 1971. Japanese research vessels were the 'Hokko Maru' (220 tons) during the 4 years and the 'Wakashio Maru' (150 tons) in 1968 and 1971. The three vessels are shown in Figure 1.

The primary fishing gear was surface multifilament gillnets of various mesh sizes. The Japanese vessels also used longlines to capture salmon for tagging experiments. The tagging data are not reported here. The U.S. vessel fished a basic string of 30 to 32 shackles of gillnets (1 shackle is 91.5 meters long) with five mesh sizes--63, 83, 98, 115, and 133 mm stretched measure. Experimental sections of deep nets and monofilament nets were also fished at various times. The Japanese usually fished a basic net string of 50 or 75 tans (1 tan is 50 meters long) with five mesh sizes--55, 72, 93, 121, and 157 mm stretched measure. In 1971, the 'Wakashio Maru' fished 25 tans of regular multifilament gillnets of 10 mesh sizes. Results reported here are of catches in the multifilament gillnets.

Communications

The language barrier between U.S. and Japanese scientists was overcome by means of the International Code. This allowed vessel activity to be coordinated and daily salmon catches and oceanographic data to be exchanged. The 'Kelez' also communicated daily via single side band radio with the Seattle NMFS Laboratory, sending data on catch results of the various vessels.

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* Maturing fish mature and spawn in the year of capture; immatures spawn one or two years later.

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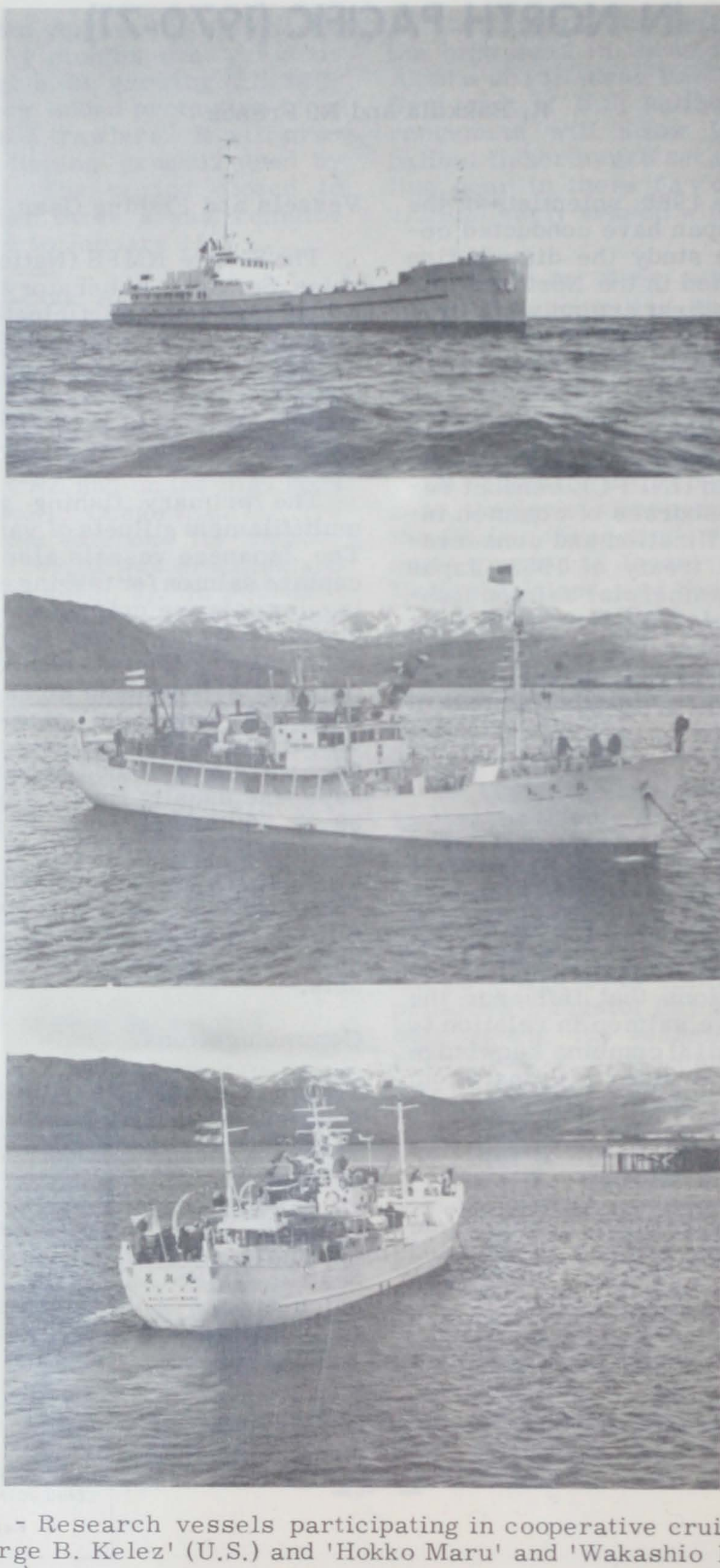


Fig. 1 - Research vessels participating in cooperative cruises-- 'George B. Kelez' (U.S.) and 'Hokko Maru' and 'Wakashio Maru' (Japan).

Following the cruises, scientists from the two nations met in Adak, Alaska, to exchange biological and oceanographic data.

RESULTS OF EARLIER STUDIES IN 1968-69

In the initial years of the cooperative cruises (1968 and 1969), the method of study involved fishing in a north-south direction for maturing sockeye salmon at various longitudes prior to their inshore migration (Figure 2). The fishing sites generally bracketed the area where tagging experiments have indicated that Bristol Bay sockeye salmon dominate the spring catches. These catch data allowed us to investigate the north-south distribution of maturing fish and their location in relation to various water masses and currents in the North Pacific Ocean; also, to gain some insight into the relative abundance and migrations of sockeye in relation to the abstention line at 175° W.

From these investigations and from the analyses of past tagging studies, several conclusions were reached on the distribution and migration of Bristol Bay sockeye in the spring (see Figure 2 for location of oceanographic features and other areas discussed):

1. Maturing fish are located in a broad band across the North Pacific Ocean from about 140° W to 170° E. They commence their inshore migration simultaneously from many points along this distribution.

2. This broad east-west band of maturing fish is found primarily in Ridge Area and Western Subarctic Intrusion Area waters in April and May.

3. The relative strength and continuity of the Alaskan Stream were previously hypothesized to influence the extent of westward migration by maturing sockeye salmon in late spring. Now they are tentatively considered to have little or no direct influence on migration routes in this time period. Maturing fish did not enter the Alaskan Stream until late May or early June when they were en route to Bristol Bay. They must have moved directly into the Bering Sea to have reached the Bay in their usual precise timing.

4. That portion of the maturing Bristol Bay stock east of 165° W primarily enter the Bering Sea through eastern Aleutian passes (east of 175° W). They are not vulnerable to the Japanese mothership fishery. Those fish between 165° W and 175° W in early spring are more vulnerable to the Japanese fishery because many of them migrate westward past the central Aleutian Islands to enter the Bering Sea through central or western Aleutian passes.

From these findings, we have hypothesized that the distribution of maturing sockeye in April and early May governs their routes of inshore migration--and their vulnerability to the Japanese fishing fleet in late May and June. In 1970 and 1971, the cruise pattern for the 'Kelez' was changed from the north-south track to an east-west track. This was designed to provide fishing stations through the main concentrations of maturing sockeye salmon and to test this hypothesis. The Japanese vessels continued their north-south pattern and provided data on the distribution of salmon west of the area covered by the U.S. vessel.

Although data from a series of years will be required to accomplish the major objectives of the study, some findings have immediate benefit. The cruises provide a forecast in May of the relative abundance and age composition of the Bristol Bay run--most of which occurs in early July--and an indication of the average size of the fish making up the run.

RESULTS OF STUDIES IN 1970-71

Distribution of Salmon

Sockeye and chum salmon were the main species taken in waters north of 49° N in April and May. Other species of salmon were seldom caught in this area. Earlier studies have shown that main concentrations of pink and coho salmon are in more southern waters (French, Bakkala, Osako, and Ito, 1971). The maturing chinook salmon that may be headed for western Alaska rivers are usually not taken in the mesh sizes used by the research vessels.

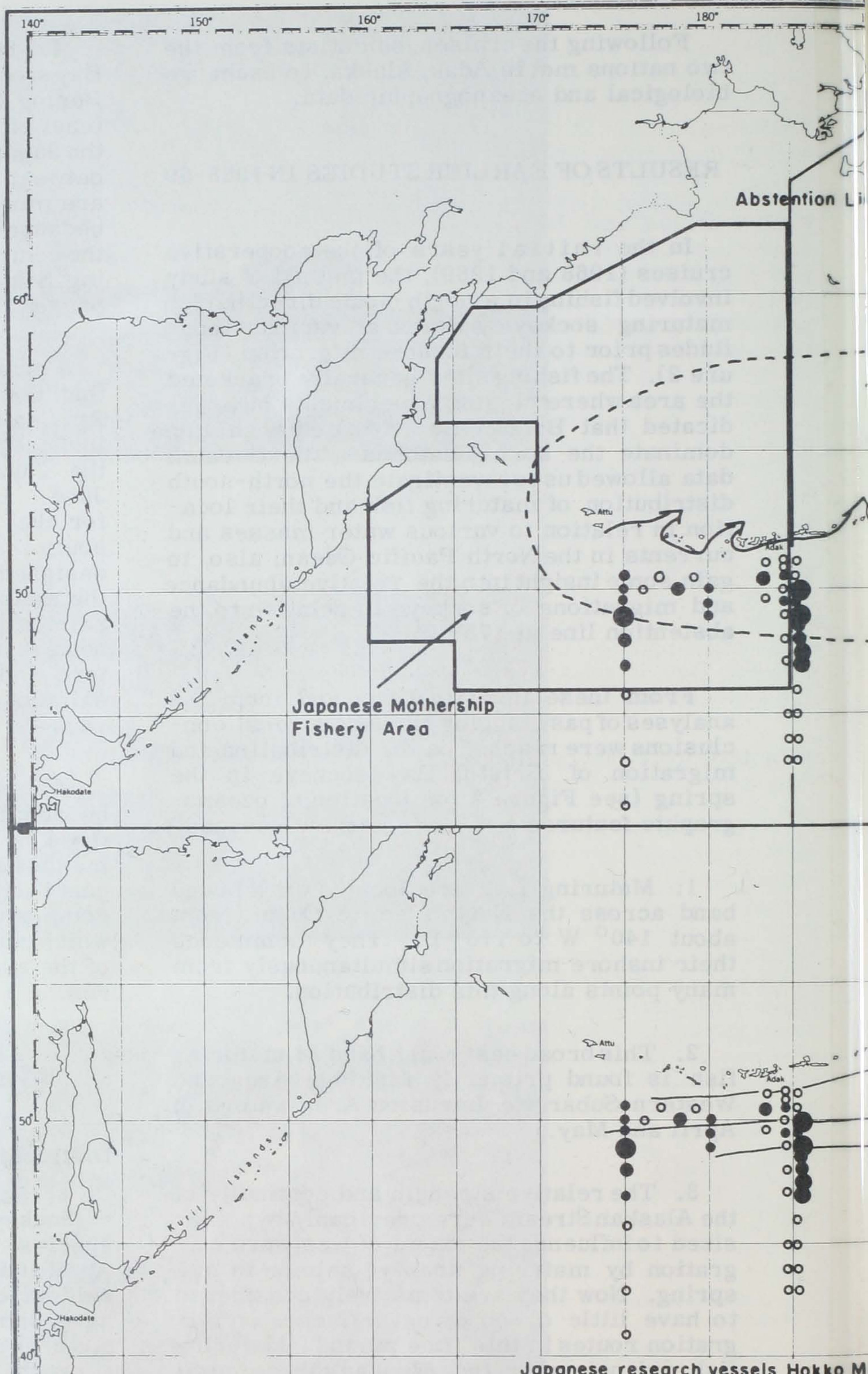


Fig. 2 - Distribution of maturing sockeye salmon in April and May of 1968 and 1969 in relation to the known limits of distribution and migration routes for maturing Bristol Bay sockeye salmon and in relation to the Japanese mothership fishing area, abstention line, and oceanographic features.

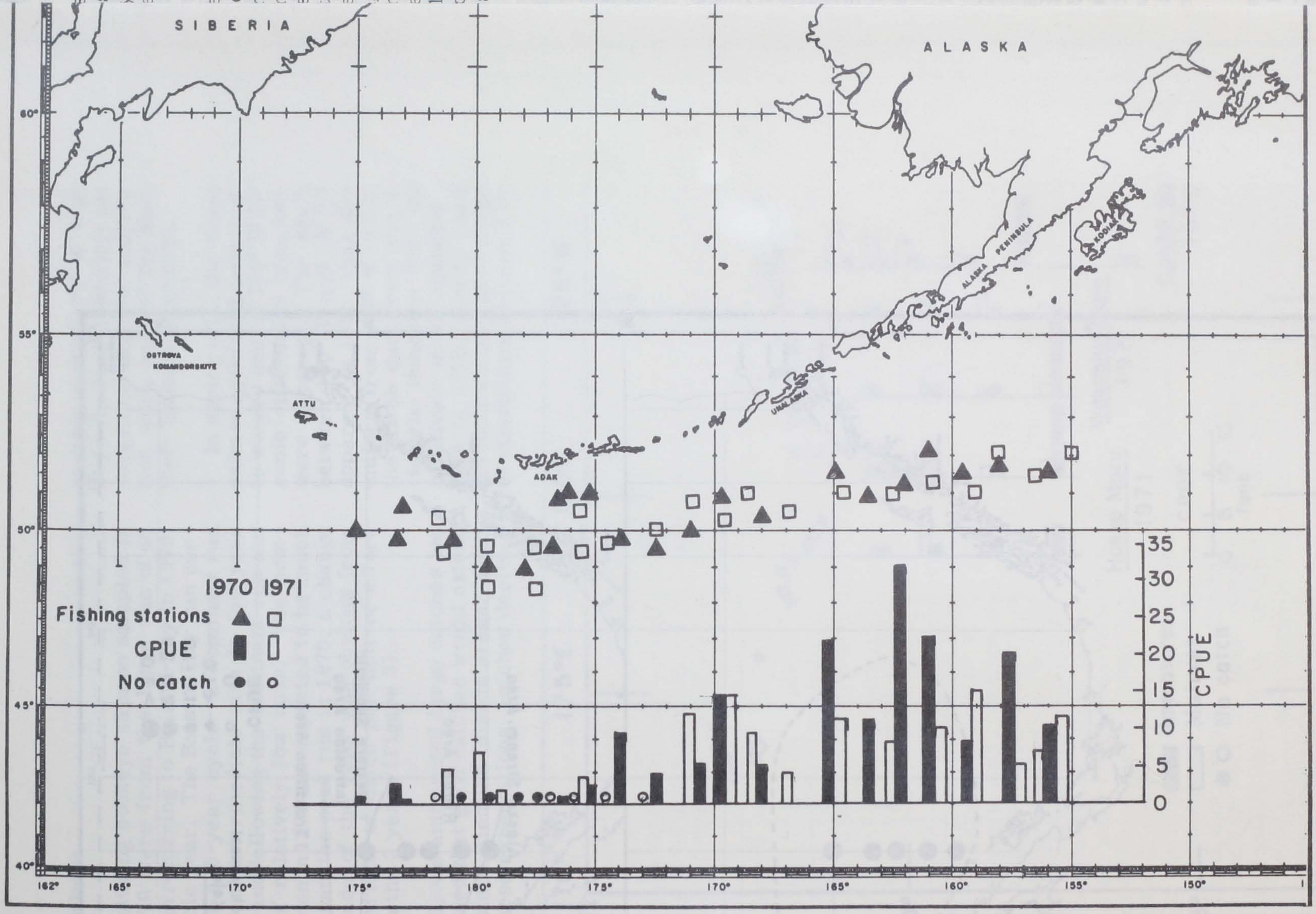
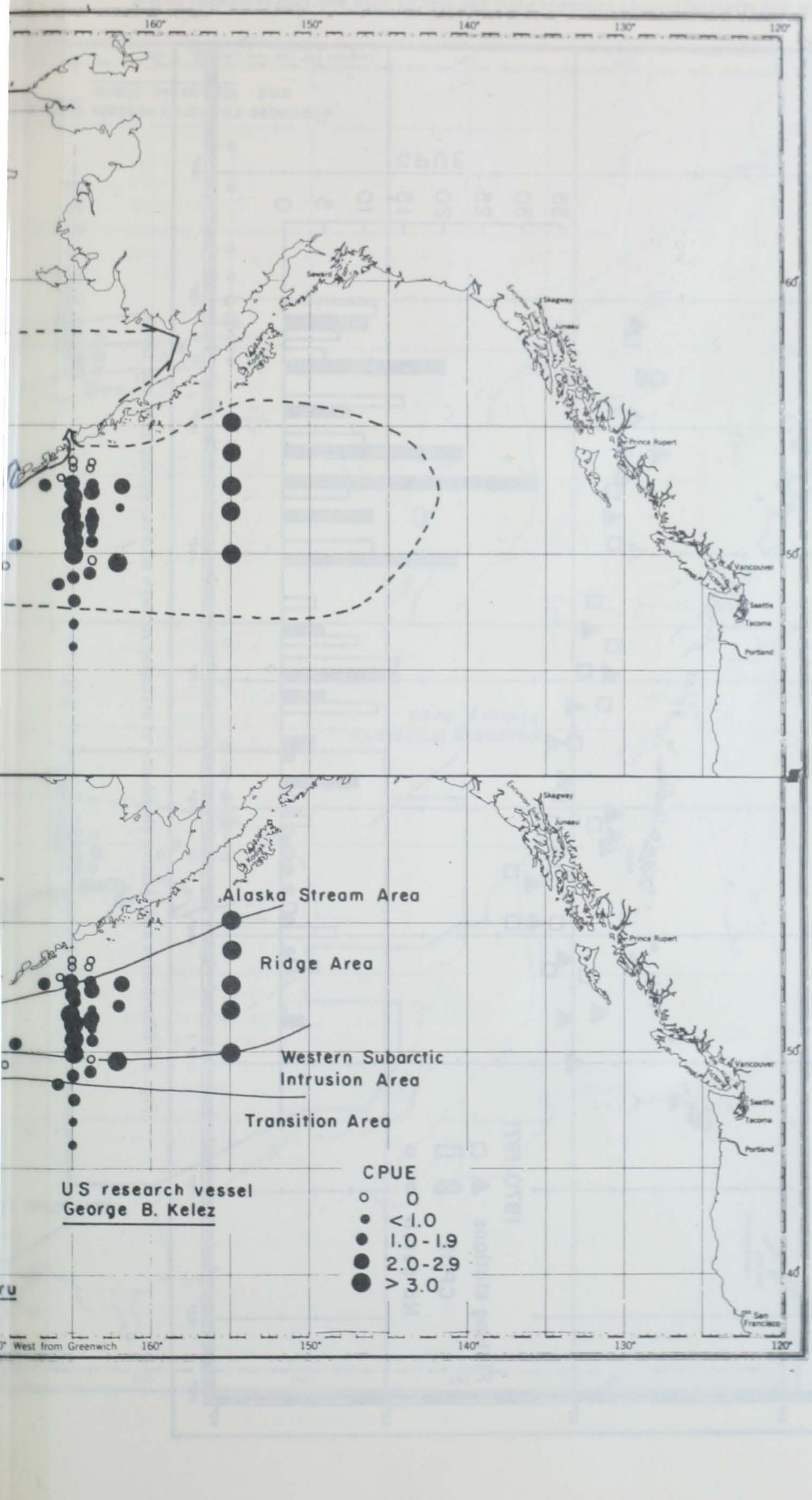


Fig. 3 - Distribution and relative abundance of maturing sockeye salmon--spring 1970 and 1971.


Seward
Skagway
Juneau
Prince Rupert
Vancouver
Seattle
Tacoma
Portland
San Francisco
Alaska Stream Area
Ridge Area
Western Subarctic
Intrusion Area
Transition Area
US research vessel
George B. Kelez
CPUE
0
< 1.0
1.0 - 1.9
2.0 - 2.9
> 3.0
West from Greenwich
160°
150°
140°
130°
120°
60°
50°
40°

Sockeye Salmon

The maturing sockeye salmon sampled in spring 1970 were from the large run of 40 million fish returning to Bristol Bay in 1970, a peak cycle year. The Bristol Bay run currently has a 5-year cycle--a dominant run with runs of intermediate size in the year preceding and following the dominant run and 2 years of relatively low runs. The post-dominant run in 1971 was expected to be much smaller than the peak run in 1970; a change in magnitude of the runs was obvious from the comparison of catch-per-unit-of-effort (CPUE) in the 2 years (Figure 3).

In 1970, we anticipated large catches but had assumed that good catches would extend to the western Aleutian Islands areas. Contrary to these expectations, catches declined sharply west of 175° W, where gillnet catches were small or frequently zero. These findings suggested that the majority of Bristol Bay fish were east of the abstention line before their inshore migration.

In spring 1971, the distribution of sockeye salmon again appeared to be largely restricted to waters east of 175° W (Figure 3), although some differences from the 1970 distribution were apparent. The sharp peak in catches between 160° W and 165° W in 1970 was not apparent in 1971, when abundance was more uniform from 155° W to 170° W. In addition, the catch data from the Japanese research vessels indicated that maturing fish were relatively more abundant near 180° in 1971 than in 1970. These changes, however, do not substantially alter the general similarities of distribution between 1971 and 1970.

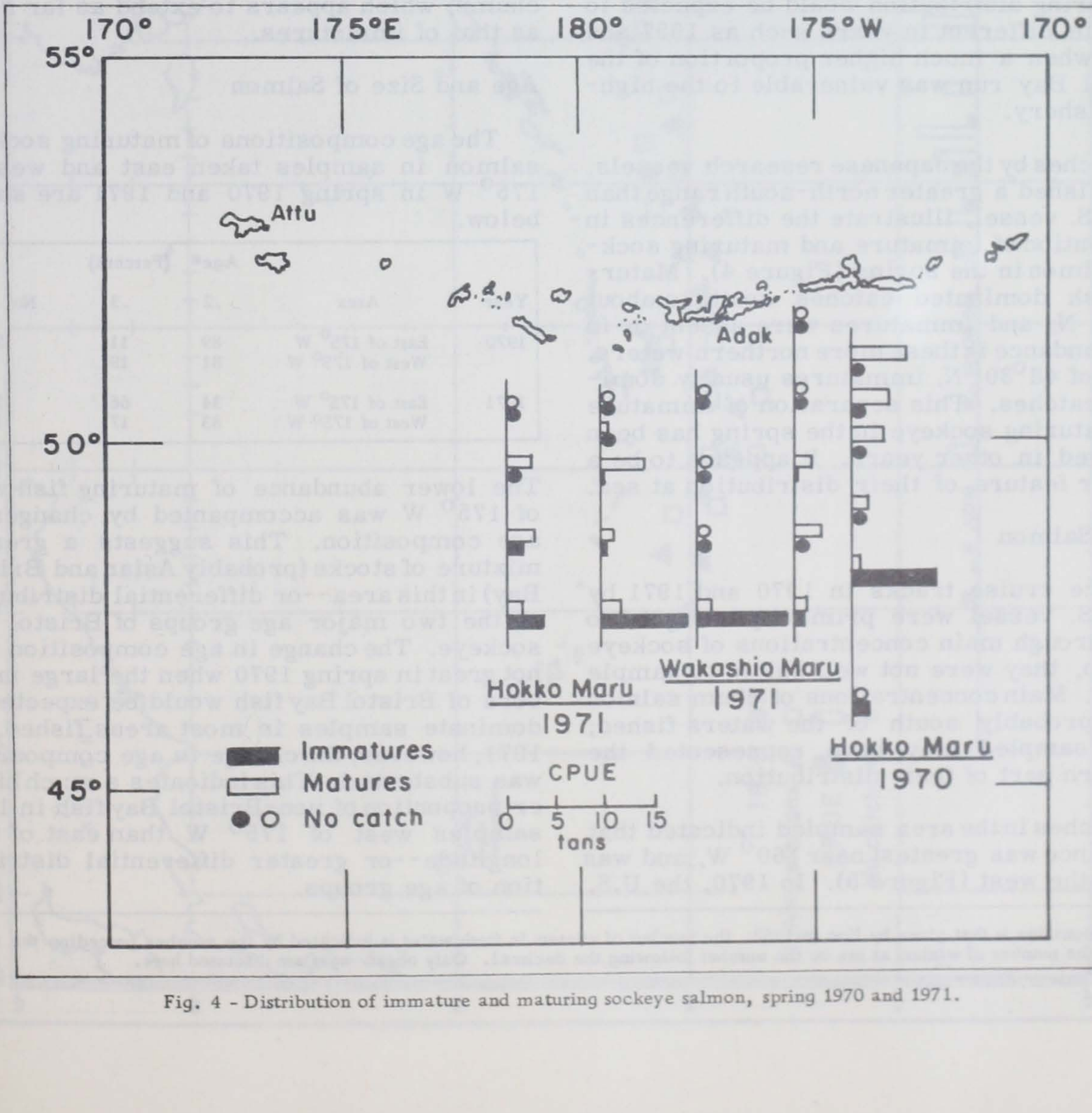


Fig. 4 - Distribution of immature and maturing sockeye salmon, spring 1970 and 1971.

The type of distribution shown in the 2 years may be typical for maturing Bristol Bay sockeye in April and May of most years. The proportion of the Bristol Bay run taken by the Japanese high-seas fishery has been estimated to range from 2% to 11% (average 7%) in 12 of 14 years from 1956 to 1969 (Fredin and Worlund, 1971). Only in 1957 and 1961 were estimates of the Japanese catch higher (35% and 24%). We anticipate that the type of distribution shown by research vessel catches in spring 1970 and 1971 would result in the usual exploitation rate of 11% or less. The majority of sockeye would be expected to use eastern Aleutian passes to reach the Bering Sea; a much smaller proportion would move west of the abstention line or already inhabit these waters and become available to the Japanese fishery. Data from Japanese commercial catches for 1970 and 1971 are not yet available to test these assumptions. The spring distribution would be expected to be quite different in years such as 1957 and 1961, when a much higher proportion of the Bristol Bay run was vulnerable to the high-seas fishery.

Catches by the Japanese research vessels, which fished a greater north-south range than the U.S. vessel, illustrate the differences in distribution of immature and maturing sockeye salmon in the spring (Figure 4). Maturing fish dominated catches south to about 48°30' N, and immatures were absent or in low abundance in these more northern waters. South of 48°30' N, immatures usually dominated catches. This separation of immature and maturing sockeye in the spring has been observed in other years. It appears to be a regular feature of their distribution at sea.

Chum Salmon

Since cruise tracks in 1970 and 1971 by the U.S. vessel were primarily designed to fish through main concentrations of sockeye salmon, they were not well suited to sample chums. Main concentrations of chum salmon were probably south of the waters fished; those sampled may have represented the northern part of their distribution.

Catches in the area sampled indicated that abundance was greatest near 160° W, and was less to the west (Figure 5). In 1970, the U.S. vessel failed to take chum salmon in many sets west of 175° W. In 1971, the Japanese vessels took chum salmon more consistently in this area but in low abundance; abundance was generally greater in 1971 than in 1970.

Fishing data furnished by the Japanese for 1970 and 1971 illustrated more accurately the location of chum salmon west of 175° W (Figure 6). Maturing chums were generally more abundant to the south--from about 47°30' N to 48°30' N. The north-south distribution of matures was extensive, extending from about 51° N to at least 41°30' N. The distribution of immatures was more restricted, extending northward to only about 48°30' N. In contrast to immature and maturing sockeye salmon, which were more clearly separated, the immature and maturing chums apparently intermingle to a much greater degree. This is due to the wide north-south range of maturing chums, which appears to extend as far south as that of immatures.

Age and Size of Salmon

The age compositions of maturing sockeye salmon in samples taken east and west of 175° W in spring 1970 and 1971 are shown below.

Year	Area	Age* (Percent) .2	.3	No. of fish
1970	East of 175° W	89	11	999
	West of 175° W	81	19	52
1971	East of 175° W	34	66	590
	West of 175° W	83	17	199

The lower abundance of maturing fish west of 175° W was accompanied by changes in age composition. This suggests a greater mixture of stocks (probably Asian and Bristol Bay) in this area--or differential distribution of the two major age groups of Bristol Bay sockeye. The change in age composition was not great in spring 1970 when the large numbers of Bristol Bay fish would be expected to dominate samples in most areas fished. In 1971, however, the change in age composition was substantial. This indicates a much higher proportion of non-Bristol Bay fish in 1971 samples west of 175° W than east of this longitude--or greater differential distribution of age groups.

*Age designation is that given by Koo in 1962: the number of winters in fresh water is indicated by the number preceding the decimal; the number of winters at sea by the number following the decimal. Only ocean ages are discussed here.

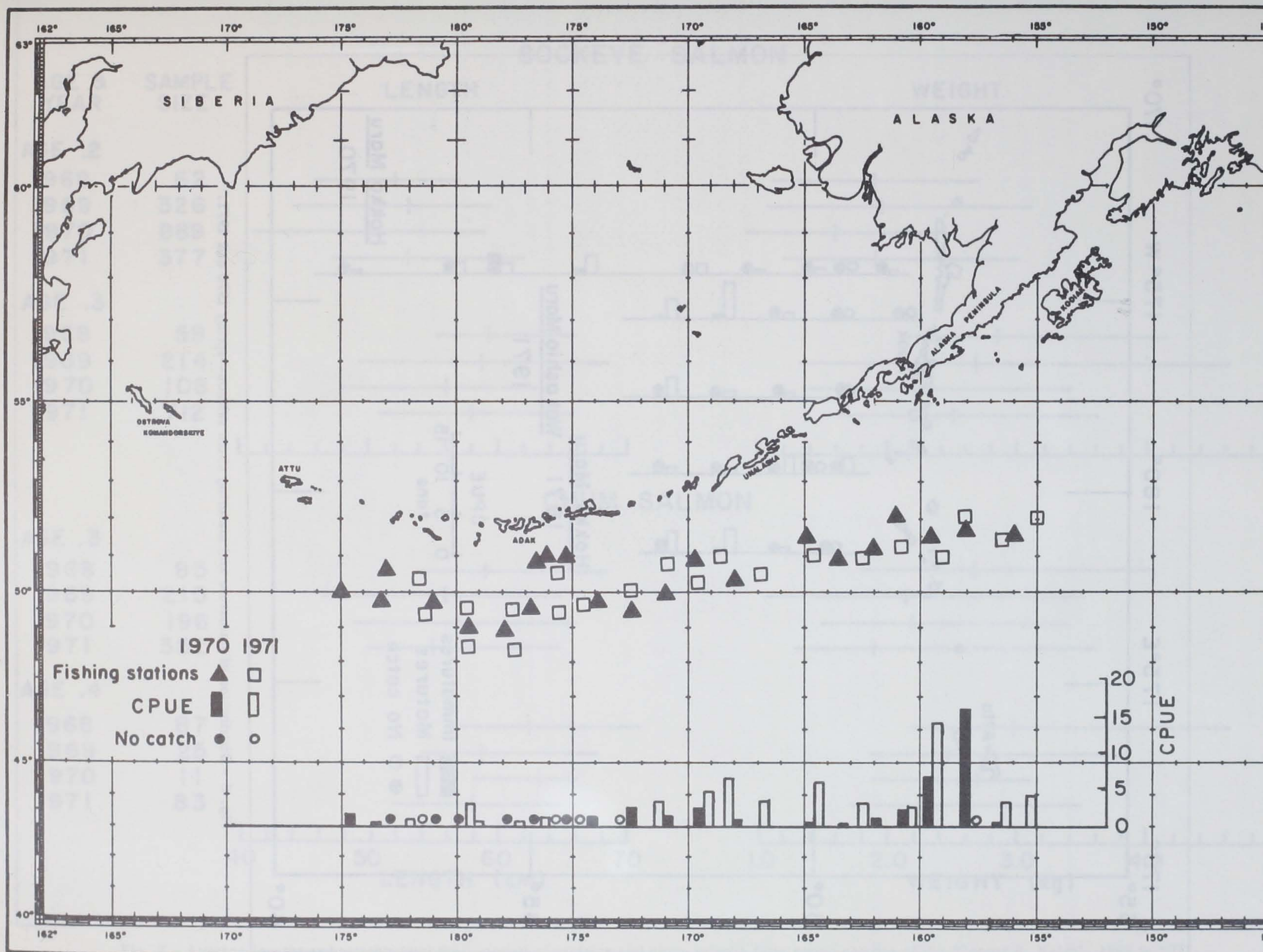


Fig. 5 - Distribution and relative abundance of maturing chum salmon--spring 1970 and 1971.

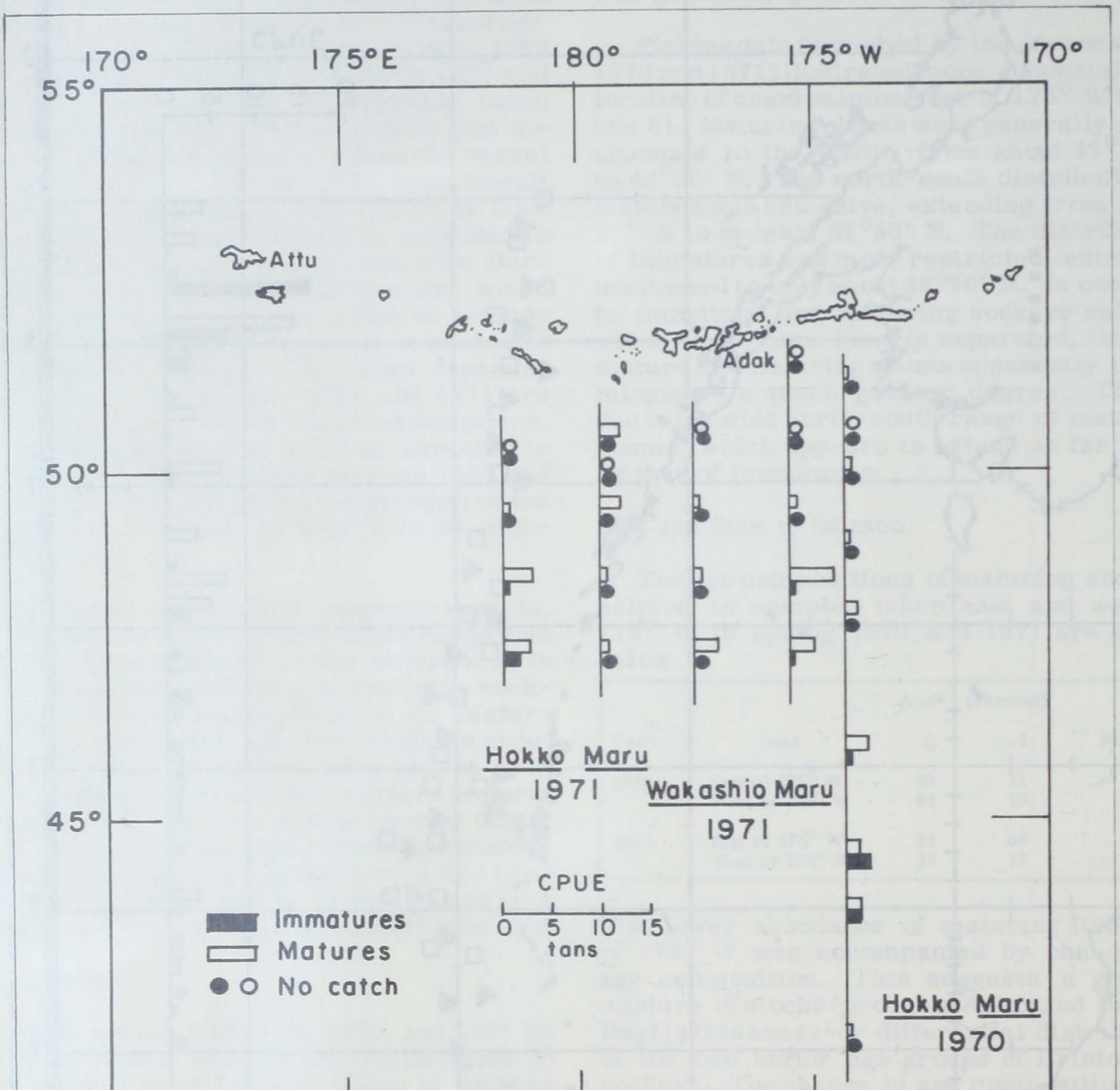


Fig. 6 - Distribution of immature and maturing chum salmon--spring 1970 and 1971.

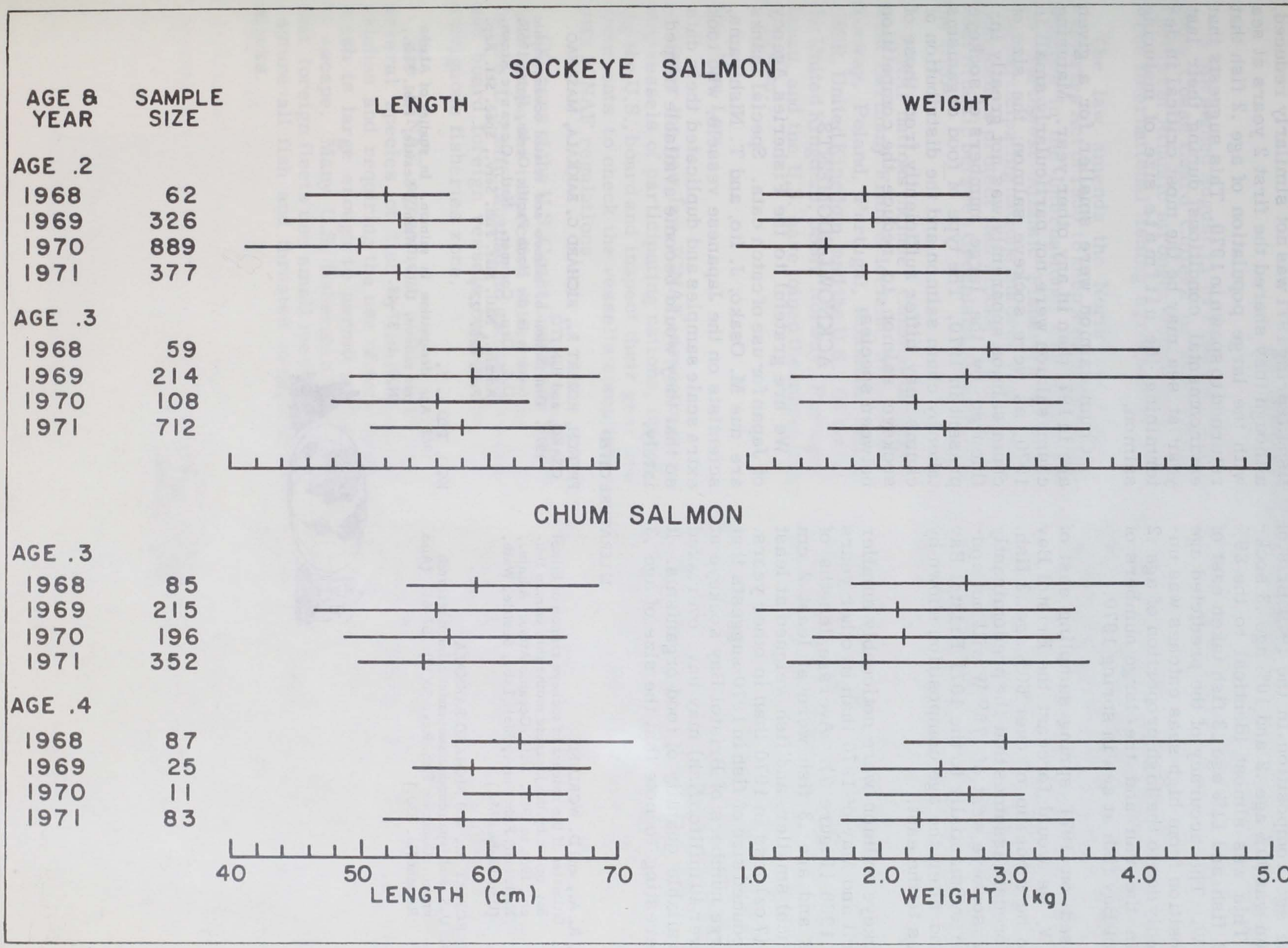


Fig. 7 - Average lengths and weights (and their ranges) of sockeye and chum salmon from spring catches of the 'George B. Kelez', 1968 to 1971.

The age composition in the 1970 Bristol Bay run was 90% age .2 and 10% age .3 sockeye. This was almost identical to the 89% age .2 fish and 11% age .3 fish taken east of 175° W. The accuracy of the predicted age composition from high seas catches was undoubtedly due to the high proportion of age .2 fish in the run and the large numbers of Bristol Bay fish at sea in spring 1970.

Based on 1971 spring sampling east of 175° W, we would forecast the Bristol Bay run to be made up of over 60% age .3 fish. This forecast assumes that the predominantly age .2 sockeye west of 175° W will not contribute substantially to the 1971 Bristol Bay run and alter the age composition shown by catches to the east.

Sockeye salmon were noticeably smaller in April and May of 1970 than in other years since 1968 (Figure 7). Average lengths of age .2 and age .3 fish were at least 2 cm (0.8 inch) smaller, and fish weighed at least 200 g (7 oz) less in 1970 than in other years. The reduced size of fish in 1970 suggests that the large numbers of Bristol Bay sockeye at sea (over 40 million fish) may have overtaxed the available quantity of food organisms. It is interesting to note that the size of age .3 fish in spring 1971 was not similarly reduced, although they shared the first 2 years at sea with the large population of age .2 fish that returned to spawn in 1970. This suggests that environmental conditions during their last year at sea may be the most critical in determining the ultimate size of maturing salmon.

Chum salmon were smaller for a given age in 1971 than in any other year. Maturing chum salmon were not particularly small in 1970, as were sockeye salmon; the size of chum salmon apparently was not greatly influenced by the large numbers of sockeye present in 1970. The type of food organisms taken by chum salmon and the distribution of chums may differ sufficiently from those of sockeye salmon to reduce the competition between species.

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